

WPTP Raw Sewage Pumps (RSP) and Grit Classifier Replacement Project

Contract KC001060

Funded in part by the
Department of Ecology Clean Water State Revolving Fund,
and the U.S. Environmental Protection Agency (EPA)

Volume 3 of 11

Technical Specifications
Raw Sewage Pumps (RSP)
Division 2 through 30

March 2024

Protection of the Environment:

No construction related activity shall contribute to the degradation of the environment, allow material to enter surface or ground waters, or allow particulate emissions to the atmosphere, which exceed state or federal standards. Any actions that potentially allow a discharge to state waters must have prior approval of the Washington State Department of Ecology.



King County

Department of Natural Resources and Parks
Wastewater Treatment Division

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West Point Treatment Plant Raw Sewage Pump Replacement

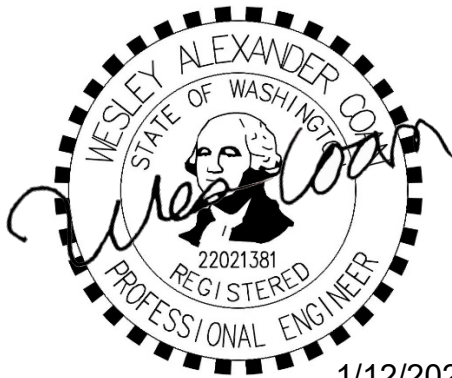
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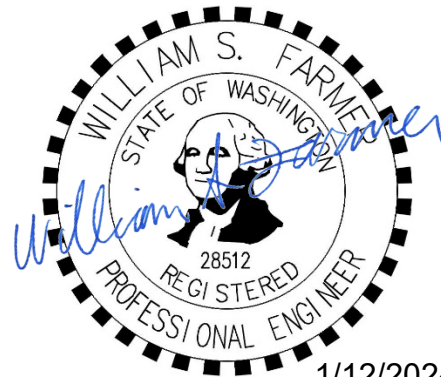
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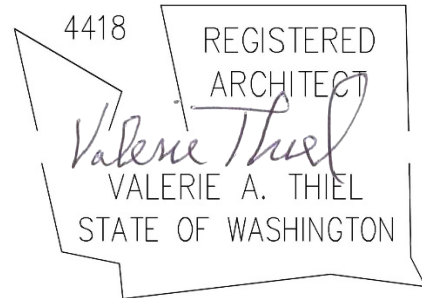
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1/12/24



01/12/2024



1/12/2024

**Raw Sewage Pump Replacement
Volume 3 - Stamping Responsibilities**

		STAMPING FIRM				
Specification	Primary Author	Jacobs	HDR	Roberts	SAGE	Stantec
02 21 00	Jacobs	W. Coan/D. Buck				
02 26 00	Jacobs	K. Kasick				
02 32 00	Jacobs	K. Kasick				
02 41 00	Jacobs	D. Buck/K. Birchok				
02 82 00	Jacobs	K. Kasick				
02 83 00	Jacobs	K. Kasick				
02 84 01	Jacobs	K. Kasick				
03 01 32	Roberts			R. Roberts	V. Thiel	
03 10 00	Roberts			R. Roberts		
03 15 19	Roberts			R. Roberts		
03 20 00	Roberts			R. Roberts		
03 30 00	Roberts			R. Roberts		
03 37 13	Roberts			R. Roberts		
03 60 00	Roberts			R. Roberts		
03 83 00	Roberts			R. Roberts		
05 05 19	Roberts			R. Roberts		
05 05 20	Roberts			R. Roberts		
05 05 23	Roberts			R. Roberts		
05 12 00	Roberts			R. Roberts		
05 31 00	Roberts			R. Roberts		
05 41 00	Roberts			R. Roberts		
05 50 00	Roberts			R. Roberts		
05 52 00	Roberts			R. Roberts		
05 55 00	Roberts			R. Roberts		
05 58 01	HDR		C. Petilla			
05 58 02	Roberts			R. Roberts		
06 10 00	SAGE				V. Thiel	
06 83 16	SAGE				V. Thiel	
06 84 00	Roberts			R. Roberts	V. Thiel	
06 84 02	Roberts			R. Roberts	V. Thiel	
06 84 10	Roberts			R. Roberts		
07 0 50.91	SAGE			R. Roberts	V. Thiel	
07 20 00	SAGE				V. Thiel	
07 20 10	SAGE				V. Thiel	
07 22 00	SAGE				V. Thiel	
07 27 20	SAGE				V. Thiel	
07 42 14	SAGE				V. Thiel	
07 44 56	SAGE				V. Thiel	
07 52 16.13	SAGE				V. Thiel	
07 62 00	SAGE				V. Thiel	
07 71 23	SAGE				V. Thiel	
07 84 00	SAGE				V. Thiel	

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West Point Treatment Plant

Raw Sewage Pump Replacement

**Raw Sewage Pump Replacement
Volume 3 - Stamping Responsibilities**

07 92 00	SAGE				V. Thiel	
08 11 00	SAGE				V. Thiel	
08 22 00	SAGE				V. Thiel	
08 33 23	SAGE				V. Thiel	
08 43 13	SAGE				V. Thiel	
08 45 00	SAGE				V. Thiel	
08 63 63	SAGE				V. Thiel	
08 71 00	SAGE				V. Thiel	
08 80 00	SAGE				V. Thiel	
08 90 00	SAGE				V. Thiel	
09 06 90	SAGE				V. Thiel	
09 20 00	SAGE				V. Thiel	
09 30 13	SAGE				V. Thiel	
09 51 13	SAGE				V. Thiel	
09 65 00	SAGE				V. Thiel	
09 66 00	SAGE				V. Thiel	
09 90 00	SAGE				V. Thiel	
09 90 05	SAGE				V. Thiel	
10 14 00	SAGE				V. Thiel	
10 28 00	SAGE				V. Thiel	
10 44 21	SAGE				V. Thiel	
10 51 13	SAGE				V. Thiel	
11 30 13	SAGE				V. Thiel	
12 35 54	SAGE				V. Thiel	
21 13 00	HDR		S. Graham			
22 13 19	HDR		K. Sutton			
22 13 33	HDR		L. Meschke			
22 33 33	HDR		K. Sutton			
22 42 00	HDR		K. Sutton			
22 45 33	HDR		K. Sutton			
23 05 93	HDR		K. Sutton			
23 07 13	HDR		K. Sutton			
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23 09 13.13	HDR		K. Sutton			
23 09 23	HDR		K. Sutton			
23 09 93	HDR		K. Sutton			
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23 21 18	Jacobs	R. Grove				
23 21 23	HDR		K. Sutton			
23 25 00	Jacobs	R. Grove				
23 31 13	HDR		K. Sutton			
23 33 13.13	HDR		K. Sutton			
23 33 13.16	HDR		K. Sutton			
23 34 13.10	HDR	R. Grove	K. Sutton			
23 34 16.20	HDR		K. Sutton			
23 34 16.30	HDR		K. Sutton			

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23 37 13	HDR		K. Sutton			
23 37 23	HDR		K. Sutton			
23 41 13	HDR		K. Sutton			
23 52 39.16	Jacobs	R. Grove				
23 75 00	HDR		K. Sutton			
23 81 29	HDR		K. Sutton			
23 82 21	HDR		K. Sutton			
23 82 30	Jacobs	B. Farmer				
23 82 39	HDR		K. Sutton			
26 05 00	Jacobs	J. Hellen				
26 05 13	Jacobs	J. Hellen				
26 05 19	Jacobs	J. Hellen				
26 05 26	Jacobs	J. Hellen				
26 05 33	Jacobs	J. Hellen				
26 05 36	Jacobs	J. Hellen				
26 08 00	Jacobs	J. Hellen				
26 09 11	Jacobs	J. Hellen				
26 09 16	Jacobs	J. Hellen				
26 11 17	Jacobs	J. Hellen				
26 13 13	Jacobs	J. Hellen				
26 22 00	Jacobs	J. Hellen				
26 24 16	Jacobs	J. Hellen				
26 24 19	Jacobs	J. Hellen				
26 27 26	Jacobs	J. Hellen				
26 29 23	Jacobs	J. Hellen				
26 31 00	Jacobs	J. Hellen				
26 33 53	Jacobs	J. Hellen				
26 33 54	Jacobs	J. Hellen				
26 43 00	Jacobs	J. Hellen				
26 50 00	Jacobs	J. Hellen				
27 13 13	Jacobs	J. Thompson				
28 46 00	HDR		S. Graham			

SECTION 02 21 00

SITE SURVEYS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies survey work requirements.

1.02 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Qualifications of the surveyor.
- C. Cut sheets for pavement restoration work.
- D. Survey field notes and all survey calculations.

1.03 SURVEY BY KING COUNTY

- A. Control point(s) for vertical and horizontal control are indicated on the Drawings. Base all work on the Contract control points as listed in the Drawings.

1.04 SURVEY BY CONTRACTOR

- A. Using the Contract control point(s), develop and make such additional surveys as needed for construction, such as control lines, slope stakes, settlement markers, batter boards, stakes for pipe locations, and other working points, lines and elevations. Re-establish any benchmarks and survey control points destroyed.
- B. Complete the layout for the work and be responsible for all measurements that may be required for the execution of the work to the location and limits prescribed on the Drawings. Perform survey work under the supervision of a land surveyor licensed in the State of Washington.
- C. Perform all survey monument referencing for tie-out prior to the work in the right-of-way and prior to pavement restoration. Check and restore monuments and their casings at completion of work.
- D. Maintain and preserve all stakes and other marks established until authorized by the Project Representative to remove them.
- E. The Project Representative may require that work be suspended at any time when location and limit marks established by the Contractor are not reasonably adequate to permit inspection of the work.
- F. In advance of the restoration paving, produce survey information in order to check the line and grade which the Contractor shall use for paving elevations and slopes.
- G. Comply with the survey requirements for all monitoring as specified in other Sections.
- H. Provide new replacement monuments and boxes when removed or damaged during construction.
- I. Re-establish all permanent survey control monuments prior to final inspection.

- J. Provide correct line and grade of the pipelines to be installed.
- K. Provide all requirements of the Record Documents per Section 01 78 39.

1.05 SURVEYOR QUALIFICATIONS

- A. Surveyor shall be a Professional Land Surveyor who is licensed in the State of Washington.
- B. The Project Representative reserves the right to disallow the person(s) selected by the Contractor for surveying. If in the Project Representative's opinion, the person is not qualified to do the work, select another surveyor and submit qualifications until a qualified person is approved.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. Perform surveys based on control points as shown on the Drawings. Use surveys to establish base lines, line and grade hubs, stake elevations, and other reference and construction points.
- B. Replaced monuments shall be set by a licensed land surveyor, registered in the State of Washington.
- C. Offset reference stakes:
 - 1. Set at a minimum 50 feet intervals on tangents and 25 feet intervals on curves.
 - 2. Set additional points as required by the Project Representative.
- D. In advance of the final or restoration paving, produce survey information required to establish paving elevations, slopes, and cross sections.

3.02 FIELD NOTES

- A. Keep in standard bound survey field notebooks using a clear, orderly manner consistent with standard surveying practice. Include titles, numbering, and indexing.
- B. Keep a copy of all field notes including references to monuments and property corners. Submit if required by the Project Representative.
- C. Keep a copy of grade sheets completed prior to all permanent restoration paving.

END OF SECTION

SECTION 02 26 00

HAZARDOUS MATERIAL ASSESSMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section provides information pursuant to 29 CFR 1926.1101, WAC 296-62-077, WAC 296-65, WAC 296-155-176 and to all other applicable requirements concerning working on, working around and reporting on hazardous materials.
- B. The information in this Section is based on the results of a good faith review of the Contract Work requirements and a site inspection of the proposed work areas to determine the presence of hazardous materials. This review and inspection were performed by an AHERA Certified Building Inspector in strict accordance with 29 CFR 1926.1101, WAC 296-62-077, WAC 296-65, WAC 296-155-176, and with the accepted principles and protocol mandated by AHERA.
- C. The reports are of investigations of piping, painted surfaces, building and structural materials. The reports do not apply to hazardous materials which may be found in soils, vegetation or other environments.
- D. Notify all employees and subcontractors who are on site or perform work subject to this Section of the contents of this Section.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AHERA	(Federal) Asbestos Hazard Emergency Response Act
29 CFR 1926.1101	Safety and Health Regulations for Construction: Asbestos
WAC 296-62-077	Occupational Health Standards: Asbestos, Tremolite, Anthrophyllite and Actinolite
WAC 296-65	WISHA Asbestos Standards
WAC 296-155-176	Safety Standards for Construction Work - Lead

1.03 ASBESTOS INSPECTION

- A. The County's Inspection has determined to the best of its ability that the proposed construction areas under this Contract and the materials therein, do contain asbestos.
- B. A copy of the report documenting the review and inspection and the findings is included in a separate Volume of these Contract Documents.

1.04 LEAD INSPECTION

- A. The County's Inspection has determined to the best of its ability that the proposed construction areas, under this Contract and the materials therein, do contain lead.
- B. A copy of the report documenting the review and inspection and the findings is included in a separate Volume of these Contract Documents.

1.05 PCB INSPECTION

- A. The County's Inspection has determined to the best of its ability that the proposed construction areas, under this Contract and the materials therein, do contain PCB.
- B. A copy of the report documenting the review and inspection and the findings is included in a separate Volume of these Contract Documents.

1.06 CONTRACTOR'S RESPONSIBILITIES

- A. Should suspect material not identified in this Section be encountered, immediately suspend all work that could disturb said material and notify the Project Representative who will implement the proper action. Do not proceed with work that could disturb the material until authorized by the Project Representative, in writing, to do so.
- B. Take the necessary precautions for compliance with Local, State and Federal regulations.
- C. When regulated substances are present, submit an abatement and disposal plan for review and approval by the Project Representative.
- D. Comply with Section 01 35 29.
- E. Fully inform workers of the presence of hazardous materials.

1.07 COUNTY'S RESPONSIBILITIES

- A. Upon notification by the Contractor of the existence of suspect material not identified in this Section, the Project Representative will have said material inspected and analyzed for the presence of asbestos, lead, or PCB as required.
- B. If the results of the inspection and analysis confirm the presence of asbestos in the suspect material, the County will take the necessary actions for compliance with 29 CFR 1926.1101 and WAC 296-62-077. After compliance is obtained, the Project Representative will notify the Contractor in writing so that work suspended can proceed.
- C. If the results of the inspection and analysis confirm the presence of lead in the suspect material, the County will take the necessary actions for compliance with WAC 296-155-176. After compliance is obtained, the Project Representative will notify the Contractor in writing so that work under this Contract can proceed.
- D. If the results of the inspection and analysis confirm the presence of PCB in the suspect material, the County will take the necessary actions for compliance with WAC 296-173-303. After compliance is obtained, the Project Representative will notify the Contractor in writing so that work under this Contract can proceed.
- E. If the results of the inspection and analysis confirm the presence of other dangerous, hazardous or regulated substances in the suspect material, the County will take the necessary actions for compliance with State and Federal regulations. After compliance is obtained, the Project Representative will notify the Contractor in writing so that work under this Contract can proceed.
- F. If the results of the inspection and analysis confirm that the suspect material is free of asbestos, lead, or other regulated substances, the Project Representative will notify the Contractor in writing so that work suspended can proceed.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 HEALTH AND SAFETY

- A. Comply with Section 01 35 29.
- B. Comply with Section 02 82 00 for the requirements for the abatement and disposal of asbestos containing materials.
- C. Comply with Section 02 83 00 for the requirements for lead paint removal.
- D. Comply with Section 02 84 01 for the requirements for PCB Bulk Waste Removal.

END OF SECTION

Attachment 1 Regulated Building Materials Survey
King County West Point RSP
07/31/2020
Pac Rim #16639

Attachment 2

**Attachment 3 Final Sampling and Analysis for PCB
King County West Point Treatment Plant RSP Building
12/03/2021
Pac Rim #16639**

**Attachment 4 Supplemental Regulated Building Materials Survey
King County West Point RSP – Boiler Room
04/01/2022
Pac Rim #16639**

SECTION 02 32 00
GEOTECHNICAL INFORMATION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies geotechnical information for the Contract.

1.02 DOCUMENTS

- A. The following geotechnical document is considered a part of the Contract and is incorporated as Contract Documents to provide Geotechnical Information:
1. West Point Treatment Plant Raw Sewage Pump Replacement Project, Soil Boring Log, Dated January 2020, Prepared by Gregory Drilling Inc.
- B. The Geotechnical Data Report is included as a reference document. See Section 01 13 00.

1.03 GEOTECHNICAL INFORMATION USE

- A. The Contractor shall: make its own interpretations, evaluations and conclusions as to the nature of the geotechnical materials and conditions to determine the difficulties performing the Work affected by the geotechnical conditions.
- B. In making interpretations, evaluations, and conclusions, use the Contract geotechnical documents and the available geotechnical information in a manner that includes a reasonable interpretation after consulting with a registered professional civil engineer with geotechnical expertise or a certified engineering geologist with applicable expertise.
- C. The Contractor may also conduct other investigations and tests it deems appropriate. Any additional Contractor obtained investigation and test information shall be shared with the County.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION

**Attachment 1 West Point Treatment Plant Raw Sewage Pump Replacement Project, Soil
Boring Log
Dated 1/27/2020 thru 1/29/2020**

**Prepared by Jacobs Engineering Group Inc,
1100 112th Avenue NE, Suite 500,
Bellevue, Washington 98004-5118.**



PROJECT NUMBER:

W3X90000

BORING NUMBER:

B-1

SHEET 1 OF 5

SOIL BORING LOG

PROJECT : West Point Raw Sewage Pump, West Point Treatment Plant LOCATION : (245698.8 N, 1246868.0 E)

ELEVATION : 111.4 ft

DRILLING CONTRACTOR : Gregory Drilling Inc.

DRILLING EQUIPMENT AND METHOD : Track Mounted CME-55, Hollow Stem Auger and Mud Rotary

ORIENTATION : Vertical

WATER LEVELS : 12.5 ft bgs

START : 01/27/20 13:10

END : 01/29/20 16:00

LOGGER : P. Bennett

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
				6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
0.0					POORLY GRADED SAND with SILT and GRAVEL (SP-SM), gray and brown, moist, some shell fragments		0.2-ft of asphalt pavement King County cleared the boring for utilities with a vactor truck down to 8.5-ft bgs. Soil consists of fill material. 2.75-inch diameter slope indicator casing was installed for downhole shear-wave velocity testing to a depth of 127.5-feet bgs. Slope indicator casing was abandoned at the end of the downhole testing.
5.0							
10.0	10.0	0.7	1-SS	9-17-20 (37)	POORLY GRADED GRAVEL with SAND (SP), dark olive gray, moist, dense, approximately 50-55% fine to coarse, angular to subangular gravel (max size 3/4"), approximately 45-55% coarse to fine sand, trace nonplastic fines		Driller began drilling with Hollow Stem Auger MC = 7.0%
	11.5						
	12.5						
	14.0	0.8	2-SS	3-6-9 (15)	POORLY GRADED GRAVEL with SAND (SP), dark olive gray, moist, medium dense, fine to coarse angular to subangular gravel, fine to coarse sand, trace fines		Groundwater observed at 12.5-ft bgs at time of drilling MC = 7.5%
	15.0				51% Gravel, 47% Sand, 2% Fines		
15.0	16.5	0.5	3-SS	3-6-12 (18)	Same as above		
	17.5						
	19.0	0.7	4-SS	3-9-14 (23)	POORLY GRADED SAND with GRAVEL (SP), gray, wet, medium dense, fine to coarse sand, fine rounded gravel		MC = 10.1%
	20.0						
20.0	21.5	1.5	5-SS	5-8-8 (16)	POORLY GRADED SAND (SP), gray, wet, medium dense, fine to medium sand, trace coarse gravel, trace fines		
	22.5				91% Sand, 6% Gravel, 3% Fines		
	24.0	1.5	6-SS	10-15-23 (38)	Same as above but becomes dense		
	25.0						
25.0	26.5	1.5	7-SS	7-16-34 (50)	POORLY GRADED SAND (SP), gray, wet, very dense, fine to medium sand, trace fines		
	27.5				96% Sand, 4% Fines, 0% Gravel		
	29.0	1.5	8-SS	7-15-31 (46)	Same as above but becomes dense		MC = 20.0%



PROJECT NUMBER:

W3X90000

BORING NUMBER:

B-1

SHEET 2 OF 5

SOIL BORING LOG

PROJECT : West Point Raw Sewage Pump, West Point Treatment Plant LOCATION : (245698.8 N, 1246868.0 E)

ELEVATION : 111.4 ft

DRILLING CONTRACTOR : Gregory Drilling Inc.

DRILLING EQUIPMENT AND METHOD : Track Mounted CME-55, Hollow Stem Auger and Mud Rotary

ORIENTATION : Vertical

WATER LEVELS : 12.5 ft bgs

START : 01/27/20 13:10

END : 01/29/20 16:00

LOGGER : P. Bennett

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
				6"-6"-6" (N)			DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
30.0	30.0	1.5	9-SS	8-19-28 (47)	POORLY GRADED SAND (SP), dark olive gray, wet, dense, fine to medium sand, trace fines 95% Sand, 5% Fines, 0% Gravel		Drilling paused on 1/27/20, resumed on 1/28/20 with mud rotary drilling
	31.5						
	32.5						
	34.0	1.1	10-SS	13-15-16 (31)	POORLY GRADED SAND with SILT (SP-SM), dark gray, wet, dense, fine to medium sand, nonplastic fines 90% Sand, 10% Fines, 0% Gravel		
	35.0						
35.0	36.5	1.1	11-SS	13-14-15 (29)	POORLY GRADED SAND with SILT (SP-SM), similar to above but with trace fine, subrounded gravel		
	37.5						Archeologist screened sample for artifacts
	39.0	1.1	12-SS	14-18-20 (38)	POORLY GRADED SAND with SHELL FRAGMENTS (SW), gray, wet, dense, fine to medium sand		
	40.0						
40.0	41.5	0.9	13-SS	15-15-17 (32)	SILTY SAND with SHELL FRAGMENTS (SM), dark brown, wet, dense, fine sand, nonplastic silt 82% Sand, 18% Fines, 0% Gravel		Archeologist screened sample for artifacts
	42.5						Archeologist screened sample for artifacts
	44.0	0.9	14-SS	18-19-19 (38)	Same as above but with trace black organics		
	45.0						
45.0	46.5	0.9	15-SS	16-15-15 (30)	SILTY SAND with GRAVEL and SHELL FRAGMENTS (SM), dark brown, wet, dense, fine to coarse sand, fine gravel, nonplastic fines, trace black organics 73% Sand, 12% Gravel, 15% Fines		Archeologist screened sample for artifacts
	47.5				Same as above but becomes medium dense		Archeologist screened sample for artifacts
	49.0	0.9	16-SS	12-18-17 (35)			
	50.0						
50.0	51.5	0.9	17-SS	12-15-13 (28)	SILTY SAND with SHELL FRAGMENTS (SM), dark olive gray, moist, dense, fine sand, nonplastic fines, increased shell fragments 78% Sand, 22% Fines, 0% Gravel		Archeologist screened sample for artifacts
	52.5						Archeologist screened sample for artifacts
	54.0	0.8	18-SS	16-21-20 (41)	Same as above but with no organics and fewer shell fragments		
	55.0						
55.0	56.5	0.8	19-SS	16-15-16 (31)	SILTY SAND (SM), dark gray, moist, dense, fine sand, nonplastic fines 70% Sand, 30% Fines, 0% Gravel		Archeologist screened sample for artifacts



PROJECT NUMBER:

W3X90000

BORING NUMBER:

B-1

SHEET 3 OF 5

SOIL BORING LOG

PROJECT : West Point Raw Sewage Pump, West Point Treatment Plant LOCATION : (245698.8 N, 1246868.0 E)

ELEVATION : 111.4 ft

DRILLING CONTRACTOR : Gregory Drilling Inc.

DRILLING EQUIPMENT AND METHOD : Track Mounted CME-55, Hollow Stem Auger and Mud Rotary

ORIENTATION : Vertical

WATER LEVELS : 12.5 ft bgs

START : 01/27/20 13:10

END : 01/29/20 16:00

LOGGER : P. Bennett

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
				6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
60.0	60.0	1.0	20-SS	13-12-11 (23)	SILTY SAND with SHELL FRAGMENTS (SM), dark olive gray, moist, medium dense, fine sand, nonplastic fines 53% Sand, 47% Fines, 0% Gravel		Archeologist screened sample for artifacts
	61.5						
	65.0						
65.0	65.0	1.0	21-SS	12-15-16 (31)	Same as above but becomes dense		Archeologist screened sample for artifacts
	66.5						
	70.0						
70.0	70.0	1.0	22-SS	12-24-25 (49)	SILTY SAND with SHELL FRAGMENTS (SM), dark olive gray, moist, dense, fine sand, nonplastic fines, trace black organics 69% Sand, 31% Fines, 0% Gravel		Archeologist screened sample for artifacts
	71.5						
	75.0						
75.0	75.0	0.8	23-SS	14-21-22 (43)	Same as above but without organics		Archeologist screened sample for artifacts
	76.5						
	80.0						
80.0	80.0	0.8	24-SS	17-24-25 (49)	SILTY SAND with SHELL FRAGMENTS (SM), dark olive gray, moist, dense, fine sand, nonplastic fines 69% Sand, 31% Fines, 0% Gravel		Archeologist screened sample for artifacts
	81.5						Drilling paused on 1/28/20, resumed on 1/29/20
	85.0						
85.0	85.0	1.0	25-SS	11-15-11 (26)	SILTY SAND with SHELL FRAGMENTS (SM), dark olive gray, moist, medium dense, fine sand, trace black organics 66% Sand, 34% Fines		Archeologist screened sample for artifacts
	86.5						Driller observed change in drilling conditions, estimated transition to Lawton Clay layer

SOIL BORING LOG

PROJECT : West Point Raw Sewage Pump, West Point Treatment Plant LOCATION : (245698.8 N, 1246868.0 E)

ELEVATION : 111.4 ft

DRILLING CONTRACTOR : Gregory Drilling Inc.

DRILLING EQUIPMENT AND METHOD : Track Mounted CME-55, Hollow Stem Auger and Mud Rotary

ORIENTATION : Vertical

WATER LEVELS : 12.5 ft bqs

START : 01/27/20 13:10

END : 01/29/20 16:00

LOGGER : P. Bennett

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
				6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
90.0	90.0	1.5	26-SS	12-21-24 (45)	SILTY SAND (SM), dark gray, moist, dense, fine sand, low plasticity fines 57% Sand, 43% Fines, 0% Gravel		Archeologist screened sample for artifacts
	91.5						
	95.0						
95.0	96.5	1.5	27-SS	13-21-27 (48)	LEAN CLAY (CL), gray, moist, hard, low plasticity, trace shell fragments in top of the sampler, some oxidation, rock in sampler approximately 1-in diameter		MC = 22.7% LL = 31%, PI = 14
	96.5						
	100.0						
100.0	101.5	1.5	28-SS	14-25-32 (57)	LEAN CLAY with SAND (CL), gray, hard, low plasticity, fine to medium sand		
	101.5						
	105.0						
105.0	106.5	1.5	29-SS	12-21-28 (49)	Same as above		MC = 21.9% LL = 33%, PI = 17
	106.5						
	110.0						
110.0	111.5	1.5	30-SS	13-24-25 (49)	SANDY CLAY (CL), dark gray, moist, hard, low plasticity, fine sand 86% Fines, 14% Sand, 0% Gravel		
	111.5						
	115.0						
115.0	116.5	1.5	31-SS	14-24-29 (53)	Same as above		
	116.5						



PROJECT NUMBER:

W3X90000

BORING NUMBER:

B-1

SHEET 5 OF 5

SOIL BORING LOG

PROJECT : West Point Raw Sewage Pump, West Point Treatment Plant LOCATION : (245698.8 N, 1246868.0 E)

ELEVATION : 111.4 ft

DRILLING CONTRACTOR : Gregory Drilling Inc.

DRILLING EQUIPMENT AND METHOD : Track Mounted CME-55, Hollow Stem Auger and Mud Rotary

ORIENTATION : Vertical

WATER LEVELS : 12.5 ft bgs

START : 01/27/20 13:10

END : 01/29/20 16:00

LOGGER : P. Bennett

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	SAMPLE RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
				6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
120.0	120.0	1.5	32-SS	12-18-25 (43)	LEAN CLAY (CL), dark gray, moist, hard, low plasticity		MC = 22.3% LL = 31%, PI = 14
	121.5						
125.0	125.0				Same as above		
	126.5	1.5	33-SS	12-17-30 (47)			
	130.0						
	131.5	1.5	34-SS	13-20-25 (45)	SANDY CLAY (CL), dark gray, moist, hard, low plasticity, fine sand 86% Fines, 14% Sand, 0% Gravel		
					Bottom of Boring at 131.5 ft bgs on 01/29/20 16:00		The boring log was backfilled with bentonite grout. Two vibrating wire piezometers (TD-Diver Data Logger) and a barometer (Baro-Diver D1600/800) were installed in the boring. Barometer SN: VEI_AU089 Vibrating Wire SN: VEI_BW244 installed at 85-feet bgs Vibrating Wire SN: VEI_BW936 installed at 35-feet bgs Unique Well Number: BLE247
135.0							
140.0							
145.0							

SECTION 02 41 00
DEMOLITION AND SALVAGE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies demolition, equipment salvage, cutting, and patching.
- B. For documentation requirement, refer to Section 01 74 19, Construction and Demolition Material Management; and Section 01 78 40, Assets Attribute Collection.

1.02 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Schedule of work planned, schedule to avoid interference with facility operations.
- C. Shop drawings for items to be repaired or replaced.
- D. List of items to be salvaged or reused.

1.03 SALVAGE DISPOSITION, STORAGE AND HANDLING

- A. Salvage Equipment:
 - 1. Refer to Section 01 78 40 and form 01 78 40-A for the identification and documentation procedures for equipment identified for salvage. As designated in Section 01 78 40, equipment to be removed from the project shall be:
 - a. Delivered to the County's possession or
 - b. Removed by the Contractor for Contractor's possession and recycling.
 - c. Final disposition of the asset will be documented on form 01 78 40-A.
- B. Materials disposal:
 - 1. Unless otherwise identified, all materials removed from the project become the property of the Contractor and shall be recycled per Section 01 74 19.
- C. Delivery of Salvage Items to the County
 - 1. Remove items designated for removal and salvage or reuse as a unit.
 - 2. Clean, condition, tag, and protect from damage.
 - 3. Deliver to King County facility, 1400 Discovery Park Blvd, Seattle, WA, between the hours of 0800 and 1600, Mondays through Friday, except for County holidays.
- D. Recycled by Contractor:
 - 1. Removal and recycling of equipment and materials shall not occur until the Project Representative has been notified of this work.
 - 2. Refer to Specification 01 74 19 for coordination and documentation of recycled equipment and materials.
 - 3. Upon completion of review, promptly remove from site.
 - 4. Do not store or sell Contractor salvaged items or materials on site.

1.04 SALVAGED EQUIPMENT

- A. Equipment without asset numbers or components of equipment with asset numbers are identified on the Drawings and listed below:

EQUIPMENT DESCRIPTION	LOCATION
Retain rotating assembly of first Raw Sewage Pump removed. Dispose of after final Raw Sewage Pump is removed.	Internal to Raw Sewage Pump in the Pump Room of Building 704

- B. Equipment with asset numbers: See Section 01 78 40-A for the list of equipment to be removed from the project and disposition of that equipment. Any changes or additions to this list shall be relayed to the Project Representative before removal. Final disposition column will be completed /verified by Contractor and form submitted to the Project Representative prior to Commissioning.
- C. Instrumentation: Salvage all instrumentation assets manufactured by Rosemount (transmitters), Fluid Components International (flow meters), Fisher (control valves), and Yokogawa (single loop controllers). Form 01 78 40-A may not be all inclusive of all instrumentation assets to be salvaged. Contractor to field verify.

1.05 JOB CONDITIONS

- A. Protection:
1. Comply with Section 01 14 30.
 2. Remove salvaged equipment in a manner that protects adjacent equipment and piping.
 3. Large temporarily salvaged equipment, such as the RSP Engine, may be stored inside the RSP Building and Boiler Room areas. Confirm storage locations with Project Representative. Refer to form 01 78 40- A for items to be salvaged. Protect temporarily salvaged equipment from damage during construction.
 4. If chipping of concrete is required, perform work in a manner that contains and exhausts concrete dust to a bag filter or other means of complete containment and capture.
 5. Repair or replace property that is damaged.
- B. Proper Approval:
1. Obtain approval of authorities having jurisdiction for work which affects existing exit ways, exit stairs, means of egress, or access to or exit from such areas.
 2. Review with and obtain approval of authorities for temporary construction which affects such areas.
 3. Special attention is directed to approvals by fire authorities.
- C. Special Requirements:
1. Clean as required and cut in pieces pressure vessels and closed containers which may have contained hazardous or contaminated materials. Disposal of equipment shall not occur until the Project Representative has approved.

1.06 VERIFICATION OF ASSET REMOVAL

- A. Document disposal or salvage of assets removed from the project by completing the Final Disposition column for removed assets in Form 01 78 40- A. The finalized form shall be submitted to the Project Representative prior to final acceptance.
- B. Document salvage of assets per Section 01 78 40.

1.07 VERIFICATION OF DEMOLITION MATERIALS

- A. Document salvage, reuse, disposal, and recycling of demolition materials per Section 01 74 19.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. Comply with Section 01 14 30 for facility equipment protection.
- B. Notify the Project Representative prior to beginning salvage work so that the proper salvage items are identified and the condition of the salvage item and adjacent equipment, piping and structures can be documented. Refer to prepopulated form 01 78 40-A provided by Project Representative for assets to be removed. Notify the Project Representative if there are any changes to, additions to, or discrepancies in the list.

3.02 OPERATION PROCEDURES

- A. Start and complete work in order of precedence as established by approved schedule. The sequence of work may be adjusted with prior approval by the Project Representative, as long as the work does not infringe upon or violate the schedule.
- B. Execute work to protect County employees, County Representatives and the public from injury. Provide protection to persons and property. Conduct work to ensure minimum interference with roads, walks, entrances, exits, and other adjacent occupied facilities as approved by the Project Representative.
- C. Where temporary partitions are required in public areas, construct partitions of clean, painted, minimum 1/2-inch thick, plywood. In interior areas, adequately braced 1/4-inch pre-finished paneling may be used. Provide the following:
 - 1. Passageways where necessary to ensure safe passage of persons in or near areas of work.
 - 2. Substantial barricades and safety lights as required.
 - 3. Temporary dust proof partitions as necessary to prevent infiltration of dust into occupied areas or the atmosphere.
 - 4. Temporary weather protection as necessary to prevent damage to existing facilities and discomfort to persons in occupied areas.

3.03 CUT AND REMOVE

- A. For concrete breaking, cutting and patching comply with Section 03 83 00.
- B. Neatly cut and remove materials and prepare openings to receive new work.
- C. Remove materials in small sections.
- D. Provide shoring, bracing, and other supports to prevent movement, settlement, or collapse of remaining or adjacent wall areas, structure, or facilities. Arrange shoring, bracing, and supports to prevent overloading of structure.
- E. Take precautions necessary to prevent damage to existing remaining work or to adjacent facilities. Execute work using methods that will prevent interference with use of remaining and adjacent facilities by the County, utilities, or the public.
- F. Properly disconnect salvaged items to retain their full salvage value, remove from their foundations when applicable, and carefully store at location(s) specified.

3.04 MATCHING AND PATCHING

- A. Where items are removed from existing walls, ceilings, floors, or partitions to remain, repair wall, ceiling, floor, or partition disturbed by removal.
- B. Where walls, ceilings, floors, or partitions are removed, repair abutting walls, ceilings, or floors disturbed by removal.
- C. Where existing construction is cut or otherwise disturbed to permit installation of new work, match and patch existing disturbed construction.
- D. Use methods and materials identical in appearance and equal in quality to areas or surfaces being repaired.
- E. Remove areas, surfaces, or items which cannot be satisfactorily matched, patched and replaced as approved by the Project Representative.

3.05 EXTENTS

- A. Unless otherwise specified when demolishing equipment, demolish appurtenant items such as piping, accessories, supports, piping and tubing supports, fasteners, anchor bolts, conduits and wiring from equipment back to nearest junction box, concrete pads that support equipment, and other accessories.
- B. Unless otherwise specified when demolishing piping or conduit, demolish all fittings, valves, supports, joints, insulation, connections, inline instruments, labels, and other accessories.
- C. Unless otherwise indicated, when demolishing existing equipment or utility support framing structures, remove flush and finish smooth with the adjacent surface to remain.
- D. Unless otherwise indicated, where removing existing grout pad, remove flush with surrounding surface and grind or repair to a smooth surface.
- E. Unless otherwise indicated, remove existing equipment or housekeeping pads, as indicated on the Drawings.
- F. For existing circuits no longer needed, remove conductors from the conduit. Remove all surface-mounted conduit that is no longer needed. For conduit below grade, cap and abandon conduit in place. For conduit penetrating walls or slabs, plug empty conduit with fireproof sealant to maintain fire rating per Section 07 84 00.
- G. Cut off or burn back concealed or embedded conduit, boxes, anchor bolts, supports, piping, or other materials a minimum of 1 inch below finished surface. Plug pipes or conduits. Fill holes with epoxy grout to prevent water from entering and to create a finished surface uniform in appearance.
- H. For existing circuits to remain operational, intercept existing conduit at the most convenient location or as shown on Drawings and splice and extend conduit to new location. Install new conductors where required to accomplish indicated results. Provide continuous new conductors without splices between terminals.
- I. No lines should be active or full of liquid when cut and plugged.
- J. Thoroughly clean any piping, conduits, valves, equipment, or other appurtenances that will be re-used after demolition of connecting features.

3.06 CLEANUP

- A. Remove debris, rubbish and materials resulting from cutting, demolition or patching operations.
- B. Transport materials and legally recycle or dispose of offsite.

END OF SECTION

SECTION 02 82 00

ASBESTOS REMOVAL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section applies to:
1. The removal of asbestos containing materials (ACM) and presumed asbestos containing materials (PACM), and describes the resultant procedures and equipment required to protect workers, the environment and occupants of the building and area from contact with airborne asbestos fibers.
 2. The disposal of any ACM generated by the work. The ACM to be removed was identified in the roof and interior items of the Raw Sewage Pump (RSP) Building. The boiler rooms have PACM fire doors.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.
1. Federal regulations codified in the Code of Federal Regulations (CFR) governing ACM removal and waste management include but are not limited to:

Reference	Title
29 CFR 1910.1001	Safety and Health Regulations for Construction: Asbestos
40 CFR 61, Subpart M	National Emission Standards for Hazardous Air Pollutants - Asbestos

2. Washington State regulations codified in the Washington Administrative Code (WAC) governing ACM removal and waste management include but are not limited to:

Reference	Title
WAC 296-62, Part I-1	General Occupational Health Standards-Asbestos, Tremolite, Anthophyllite, and Actinolite
WAC 296-65	Asbestos Removal and Encapsulation
WAC 296-62 Part A General	General Occupational Health Standards
WAC 296-62-07703	Definitions
WAC 296-62-07712	Requirements for Asbestos Activities in Construction and Shipyard Work
WAC 296-62-010	Purpose and Scope

3. Puget Sound Clean Air Authority:

Reference	Title
Chapter 3, Regulation III Article 4	Asbestos Control Standards

1.03 ASBESTOS INSPECTION, SAMPLING AND TESTING

- A. Through various surveys, it has been determined that the proposed construction areas, under this Contract and the materials therein, do contain asbestos. Asbestos was discovered in the RSP roof, exterior, and interior in various items. The doors to/from the boiler rooms are also considered PACM.
- B. A copy of the report, prepared by Pacific Rim Environmental Inc., documenting the inspection, sampling, and testing program and the findings and recommendations for asbestos removal is

referenced in Volume 5, Hazardous Materials Assessment, as “West Point Treatment Plant Raw Sewage Pump Replacement Project, Hazardous Materials Assessment, September 2, 2020” and “Supplemental Regulated Building Survey King County West Point RSP – Boilers Room.”

1.04 COUNTY RESPONSIBILITIES

- A. Will inspect all activities and work related to asbestos for strict compliance with the Contract Documents and all applicable regulations.
- B. Inspection by the County will not relieve the Contractor from any responsibility regarding compliance with applicable laws and regulations.

1.05 CONTRACTOR RESPONSIBILITIES

- A. Take the necessary precautions for compliance with Federal, State and Local regulations. Employ work methods that will not expose workers to asbestos that will exceed the Permissible Exposure Level set by the Washington State Department of Labor and Industries.
- B. Be responsible for all work and costs associated with the compliance of regulations related to monitoring Contractor's and subcontractor's employees.
- C. Be responsible for all costs associated with the re-sampling and re-testing required due to defective work and/or failure to comply with the Contract Documents.
- D. Be responsible for supplying all samples required to demonstrate compliance with the Contract Documents as required by the Project Representative.
- E. Provide all facilities, protective clothing, respiratory equipment, hook-ups to air supply sources, access to work areas, etc., as may be required to facilitate the specified inspection and testing by the County to inspect the work.
- F. Notify the Project Representative at least 48 hours before starting any portion of the work to allow the Project Representative time to schedule inspection, monitoring and testing.
- G. Be responsible for the disposal of all asbestos contaminated items discovered as a result of inspection, testing, and any other activities related to the work.
- H. Fully cooperate to facilitate all inspection, testing and monitoring activities including, but not necessarily limited to, monitoring of Contractor's employees when the Project Representative determines that such monitoring is required to ensure compliance with the Contract Documents.
- I. Submit an Asbestos Removal and Disposal Plan for acceptance by the County.
- J. Comply with Section 01 35 29.
- K. Fully inform workers of the presence of asbestos.
- L. If suspect ACM not identified is encountered, the Contractor shall notify the County and submit a plan to the County on how they will confirm the presence of ACM before removing.
- M. If ACM is confirmed, Contractor shall provide results to the County and remove in accordance with their Asbestos Removal and Disposal Plan.
- N. If the Asbestos Removal and Disposal Plan is modified to address the additional ACM, submit copy of the updated plan to the County.

1.06 CONTRACTOR'S, SUBCONTRACTOR'S AND PERSONNEL'S QUALIFICATIONS

- A. General:
 - 1. The Contractor, all subcontractors and their respective personnel involved in this Contract shall have the applicable accreditations and current and valid certifications necessary to satisfy the requirements of these Contract Documents and the rules and regulations incorporated therein.
 - 2. The Contractor and all subcontractors shall have a traceable record of at least five years of experience in the satisfactory completion of work of complexity equal to or greater than that involved in this Contract.
 - 3. All personnel involved shall have a traceable record of satisfactory work experience in the same capacity as assigned for this Contract and for a minimum length of time as specified hereinafter.
- B. Laboratory Services: Laboratory services required by the Contractor for compliance with these Contract Documents shall be provided by an accredited laboratory which proficiency shall be demonstrated by current, satisfactory participation in the EPA's Proficiency Analytical Testing Program and the Quality Assurance Program.
- C. Industrial Hygienist: Industrial Hygienist services required by the Contractor for compliance with these Contract Documents shall be provided by an Industrial Hygienist who:
 - 1. Is accredited to practice industrial hygiene as related to asbestos abatement.
 - 2. Has obtained a certificate of completion of the NIOSH 582 Course issued by a nationally
 - 3. accepted institution.
 - 4. Has a satisfactory record of at least three years acting in the above described capacity.
- D. Competent person: meet the qualification requirements specified in WAC 296-62-07703(6) and WAC 296-62-07712(3) and shall have a satisfactory record of at least one year working in that capacity for work of equal or greater complexity than the one involved in this work.
- E. Asbestos Workers: have a current, valid, asbestos worker certification in conformance with WAC 296-62-010 and shall have a record of at least one year of satisfactory completion of asbestos abatement work.
- F. Asbestos Supervisor: Individual who supervises asbestos removal projects or oversee asbestos workers, and trained in accordance with WAC 296-65.
- G. Asbestos Contractor: Contractor working on an asbestos removal project in Washington State and registered with the Washington State Department of Labor and Industries, in accordance with WAC 296-65.
- H. If the Project Representative is satisfied that special circumstances exist that require the Contractor to substitute a subcontractor or personnel, the Project Representative may approve said substitution providing that the substitute subcontractor or individual is determined by the Project Representative to be equally or better qualified than the one being substituted.

1.07 SUBMITTALS

- A. Procedures: 01 33 00.
- B. Asbestos Removal and Disposal Plan:
 - 1. Submit a detailed plan of the safety precautions such as lockout, tagout, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan shall include but not be limited to:
 - a. The precise personal protective equipment to be used including, but not limited to, respiratory protection, type of whole-body protection, the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method,

interface of trades involved in the construction, sequencing of asbestos related work, type of wetting agent, locations of local exhaust equipment, air monitoring plan, and a detailed description of the method to be employed in order to control environmental pollution.

- b. Fire and medical emergency response plans and an Activity Hazard Analyses (AHAs). The Asbestos Removal and Disposal Plan shall be approved in writing prior to starting any asbestos work. The Asbestos Supervisor and designated Competent Person shall meet with the Project Representative prior to beginning work, to discuss in detail the Asbestos Removal and Disposal Plan, including work procedures and safety precautions. Compliance with this the plan will be enforced as if an addition to the specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan for approval by the Project Representative prior to starting work.
- c. Asbestos waste handling and disposal procedures in accordance with the Washington State Department of Labor and Industry, Washington State Department of Ecology, and the Puget Sound Clean Air Authority standards.
- d. Proposed landfills for disposal of asbestos waste.

C. Product data:

- 1. Safety Data Sheets for all materials.
- 2. Respirators.

D. Test Reports

- 1. Air Sampling Results.
- 2. Asbestos Disposal Quantity Report.
- 3. Asbestos Test Reports.

E. Certificates and Records:

- 1. Asbestos Worker, Supervisor, and Contractor Licenses (and/or Certification and Registrations) from Washington State Department of Labor and Industry.
- 2. Agency (10 Day) Notification.
- 3. Respiratory Protection Program.
- 4. Testing Laboratory if suspect materials are tested.
- 5. Landfill Approval.
- 6. Delivery Tickets.
- 7. Puget Sound Clean Air Agency - Asbestos Waste Material Shipment Records.
- 8. Medical Certification.
- 9. Designated Competent Person.
- 10. Equipment Used to Contain Airborne Asbestos Fibers.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials of construction:

Component	Material
Disposal Containers	Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers shall be provided for ACM wastes as required by 29 CFR 1926.1101. Disposal containers can be in the form of: <ul style="list-style-type: none">a. Disposal Bagsb. Fiberboard Drumsc. Cardboard Boxes
Sheet Plastic	Sheet plastic shall be polyethylene of 6 mil minimum thickness and shall be provided in the largest sheet size necessary to minimize seams. Film shall conform to ASTM D4397.

Component	Material
Mastic Removing Solvent	Mastic removing solvent shall be nonflammable and shall not contain methylene chloride, glycol ether, or halogenated hydrocarbons. Solvents used onsite shall have a flash point greater than 140 degrees F and approved by the Project Representative.
Leak-Tight Wrapping	Two layers of 6 mil minimum thick polyethylene sheet stock shall be used for the containment of removed asbestos-containing components or materials such as large tanks, boilers, insulated pipe segments and other materials. Upon placement of the ACM component or material, each layer shall be individually leak-tight sealed with duct tape.

Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the Project Representative.

B. Equipment:

1. Provide the County with complete sets of personal protective equipment as required for entry to and inspection of the asbestos control area. Provide manufacturer's certificate of compliance for all equipment used to contain airborne asbestos fibers.

PART 3 EXECUTION

3.01 HEALTH AND SAFETY

A. Comply with Section 01 35 29.

B. Permits, Licenses, and Notifications:

1. Prior to the start of work, obtain necessary permits and licenses in conjunction with asbestos removal, hauling, and disposition, and furnish notification of such actions required by Federal, State, regional, and local authorities.
2. Notify the State of Washington and Puget Sound Clean Air Authority in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-Subpart M; WAC 296-65; and Puget Sound Clean Air Authority, Chapter 3, Regulation III, Article 4.
3. Pay applicable agency fees.
4. Also notify the Project Representative in writing 20 working days prior to the start of asbestos work.

3.02 WARNING SIGNS AND LABELS

- A. Provide warning signs printed in English, Spanish or other languages represented by the work force involved in asbestos removal activities at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to the requirements are acceptable.

- B. Warning Sign. Provide vertical format conforming to 29 CFR 1926.200, and 29 CFR 1926.1101 minimum 20 by 14 inches displaying the following legend in the lower panel:

Legend	Notation
DANGER	One inch Sans Serif Gothic or Block
ASBESTOS	One inch Sans Serif Gothic or Block
MAY CAUSE CANCER	One inch Sans Serif Gothic or Block
CAUSES DAMAGE TO LUNGS	1/4-inch Sans Serif Gothic or Block

Legend	Notation
AUTHORIZED PERSONNEL ONLY	1/4-inch Sans Serif Gothic or Block
WEAR RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING IN THIS AREA (if required)	1/4-inch Sans Serif Gothic or Block

Spacing between lines shall be at least equal to the height of the upper of any two lines.

- C. Warning Labels. Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST AVOID CREATING DUST

3.03 WORK AREA PREPARATION

- A. A decontamination area (equipment room/area) shall be provided for Class I work involving less than 25 feet or 10 square feet of thermal system insulation or surfacing ACM, and for Class II and Class III asbestos work operations where exposures exceed the permissible exposure limits or where there is no negative exposure assessment. The equipment room or area shall be adjacent to the regulated area for the decontamination of employees, material, and their equipment which could be contaminated with asbestos. The area shall be covered by an impermeable drop cloth on the floor or horizontal working surface. The area shall be of sufficient size to accommodate cleaning of equipment and removing personal protective equipment without spreading contamination beyond the area.
- B. Confirm that the following procedures are followed:
1. Before leaving the regulated area, remove all gross contamination and debris from work clothing using a high efficiency particulate air filter (HEPA) vacuum.
 2. Employees shall remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers for disposal or laundering.
 3. Employees shall not remove their respirators until showering.
 4. Employees shall shower prior to entering the clean room. If a shower has not been located between the equipment room and the clean room or the work is performed outdoors, confirm that employees engaged in Class I asbestos jobs:
 - a. Remove asbestos contamination from their work suits in the equipment room or decontamination area using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or
 - b. Remove their contaminated work suits in the equipment room, without cleaning worksuits, and proceed to a shower that is not adjacent to the work area.

3.04 WORK PROCEDURE

- A. Perform asbestos related work in accordance with 29 CFR 1926.1101; 40 CFR 61-Subpart M; WAC 296-62, Part I-1; WAC 296-65; Puget Sound Clean Air Authority, Chapter 3, Regulation III, Article 4; and as specified herein. Use wet removal procedures as listed in the Asbestos Removal and Disposal Plan. Wear and utilize protective clothing and equipment as specified herein. No eating, smoking, drinking, chewing gum, tobacco, or applying cosmetics is permitted in the asbestos work or control areas. Personnel of other trades not engaged in the removal of asbestos containing material shall not be exposed at any time to airborne concentrations of asbestos unless all the personnel protection and training provisions of this specification are complied with by the trade personnel. Stop asbestos removal work in the regulated area immediately when the airborne total fiber concentration:
1. Equals or exceeds 0.01 f/cc, or the pre-removal concentration, whichever is greater, outside the regulated area; or
 2. Equals or exceeds 1.0 f/cc inside the regulated area.
- Correct the condition to the satisfaction of the Project Representative, including visual inspection and air sampling. Work shall resume only upon notification by the Project Representative. Corrective actions shall be documented. If an asbestos fiber release or spill occurs outside of the asbestos control area, stop work immediately, correct the condition to the satisfaction of the Project Representative including clearance sampling, prior to resumption of work.
- B. Remove and dispose of the materials identified as having less than 1% asbestos according to 29 CFR 1926.1101, where that regulation refers to "asbestos" rather than "asbestos containing material" or "ACM".
- C. Perform work without damage or contamination of adjacent work. Where such work is damaged or contaminated as verified using visual inspection or sample analysis, it shall be restored to its original condition or decontaminated by the Contractor at no additional expense. This includes inadvertent spill of dirt, dust, or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, stop work immediately and clean up the spill. When satisfactory visual inspection and air sampling results are obtained, work may proceed at the discretion of the Project Representative.
- D. Establish designated limits for the asbestos control area for Class II removal activities with the use of red barrier tape; install critical barriers, splash guards and signs, and maintain all other requirements for asbestos control area except local exhaust. Place impermeable dropcloths on surfaces beneath removal activity extending out 3 feet in all directions. A detached decontamination system may be used. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct.
- E. Wet asbestos material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water or wetting agent in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Project Representative for approval. For example, in the case where both piping and insulation are to be removed, the Contractor may elect to wet the insulation, wrap the pipes and insulation in plastic and remove the pipe by sections. Containerize asbestos containing material while wet. Do not allow asbestos material to accumulate or become dry. Handle asbestos containing material as indicated in 40 CFR 61-Subpart M; WAC 296-65; WAC 296-62, Part I-1; and Puget Sound Clean Air Authority, Chapter 3, Regulation III, Article 4.
- F. The Contractor will arrange for an independent third party to conduct indoor clearance sampling following WAC 296-62-07711. Clearance sampling will be done using aggressive methods. If clearance sampling does not pass per WAC 296-62-07711, the Contractor will re-clean the area and an additional clearance sample will be collected. Re-cleaning and additional clearance sampling will fall onto the Contractor including any additional fees incurred.

3.05 CLEAN-UP AND DISPOSAL

- A. Housekeeping: Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. When asbestos removal is complete, including passing clearance sampling, all asbestos waste is removed from the worksite, and final clean-up is completed, the Contractor shall attest that the area is safe before the signs can be removed. After final clean-up and acceptable airborne concentrations are attained but before the HEPA unit is turned off and the enclosure removed, remove all pre-filters on the building heating, ventilation, and air conditioning system and provide new pre-filters. Dispose of filters as asbestos contaminated materials. The Contractor shall visually inspect all surfaces within the enclosure for residual material or accumulated dust or debris. The Contractor shall re-clean all areas showing dust or residual materials. If re-cleaning is required, air sample and establish an acceptable asbestos airborne concentration after re-cleaning. The Project Representative shall agree that the area is safe in writing before unrestricted entry will be permitted, and have the option to perform monitoring to determine if the areas are safe before entry is permitted.
- B. Procedure for Disposal: Coordinate all waste disposal manifests with the Project Representative. Collect asbestos waste, contaminated wastewater filters, asbestos contaminated water, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing which may produce airborne concentrations of asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g., double plastic bags 6 mils thick, cartons, drums, or cans). Wastes within the containers shall be adequately wet in accordance with 40 CFR 61-Subpart M; WAC 296-65; WAC 296-62, Part I-1; and Puget Sound Clean Air Authority, Chapter 3, Regulation III, Article 4. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag. Clearly indicate on the outside of each container the name of the waste generator and the location at which the waste was generated. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an landfill authorized to accept asbestos waste. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids comply with 40 CFR 61-Subpart M; WAC 296-65; WAC 296-62; Part I-1; and Puget Sound Clean Air Authority, Chapter 3, Regulation III, Article 4 standards for hauling and disposal. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.
- C. Contractor cannot deviate from the facilities identified in the Asbestos Removal and Disposal Plan without Project Representative prior approval.
- D. Asbestos Disposal Quantity Report: The Contractor shall record and report the amount of ACM and PACM removed and released for disposal. Deliver the report for the previous day at the beginning of each day shift with amounts of material removed during the previous day reported in linear feet or square feet as described initially in this specification and in cubic feet for the amount of asbestos containing material released for disposal.
- E. Title to Non-Asbestos Materials. All non-asbestos waste materials become the property of the Contractor and shall be disposed of as specified in applicable local, State, and Federal regulations and herein.

3.06 QUALITY CONTROL

- A. The Contractor shall provide copies of all records and reports to the Project Representative.

- B. The Project Representative will review Contractor's documents for compliance with the applicable local, state, and federal regulations.

END OF SECTION

SECTION 02 83 00
LEAD PAINT REMOVAL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section provides information pursuant to 29 CFR 1926.62 and WAC 296-155-176 and to all other applicable requirements concerning working on, working around, demolishing, and reporting on paint that contains lead (lead paint).
- B. The information in this Section is based on the results of a good faith review of the Contract Work requirements and a site inspection of the proposed work areas to determine the presence of lead paint. Preliminary inspections were performed followed by additional field inspection, sampling, and testing for lead.
- C. The reports summarize the findings of investigations of painted surfaces on concrete and metal structures, equipment and piping in the interior of the RSP building and boiler rooms at West Point Treatment Plant (WPTP). The reports do not apply to lead which may be found in soils, vegetation or other facilities or environments at the site.
- D. Notify all employees and subcontractors who are on site or perform work subject to this Section of the contents of this Section.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
29 CFR 1926.62	Safety and Health Regulations for Construction: Lead
RCRA	Resource Conservation Recovery Act
WAC 173-303	Dangerous Waste Regulations
WAC 173-350	Solid Waste Handling Standards
WAC 296-155-176	Safety Standards for Construction Work - Lead

1.03 DEFINITIONS

- A. Degraded paint. Paint is paint that is peeling, chipped, chalking, flaking or others separating from a building component or surface.
- B. Lead Control Area. Control methods or system to prevent the spread of lead dust, paint chips or debris to adjacent areas that may include temporary containment, floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel. High efficiency particulate air (HEPA) filtered local exhaust equipment may be used as engineering controls to further reduce personnel exposures or building/outdoor environmental contamination.
- C. Lead paint. Any paint which contains lead as determined by the testing laboratory using a valid test method. The requirements of this Section do not apply if no detectable levels of lead are found using a quantitative method for analyzing paint using laboratory instruments with specified limits of detection (usually 0.01 percent). An X-Ray Fluorescence instrument is not considered a valid test method.

- D. Lead paint waste. Waste stream that includes lead paint chips and dust (i.e., debris physically removed from painted surfaces) and demolition debris coated with lead paint.
- E. Paint with lead. Any paint with detectable amount of lead.

1.04 LEAD INSPECTION, SAMPLING AND TESTING

- A. The proposed construction areas, under this Contract, do contain lead based off X-Ray Fluorescence (XRF) sampling methodology. Although XRF is an approved method to sample paint for the presence of lead, it is limited in its detection capability compared to paint chip sampling.
- B. A copy of the report, prepared by Pacific Rim Environmental Inc., documenting the inspection, sampling and testing program and the findings and recommendations for lead paint is referenced in 02 26 00, Hazardous Materials Assessment, as "West Point Treatment Plant Raw Sewage Pump Replacement Project, Hazardous Materials Assessment, September 2, 2020" and "Supplemental Regulated Building Survey King County West Point RSP – Boilers Room."

1.05 CONTRACTOR'S RESPONSIBILITIES

- A. All painted materials are considered to be suspect for paint with lead.
- B. It is the employer's responsibility that employees are not being exposed to lead in excess of the Permissible Exposure Limit (PEL) which is defined by OSHA and the Washington State Department of Labor and Industries as 50 micrograms per cubic meter averaged over an 8 hour time weighted average (TWA). The employer will comply with applicable rules and regulations pertaining to paint with lead, as required in 29 CFR 1926.62 and WAC 296-155-176.
- C. Comply with Section 01 35 29.
- D. Fully inform workers of the presence of paint with lead and lead paint removal or disturbance activities.
- E. Ensure that all workers with the potential to impact painted surfaces in a manner that can cause an airborne release are appropriately trained per OSHA (29 CFR 1926.62) and Washington State Department of Labor and Industry.
- F. The Contractor can stop work at any time to assess and make corrective actions to reduce potential for exposure to airborne concentrations of lead.

1.06 COUNTY'S RESPONSIBILITIES

- A. All painted surfaces are considered to be suspect for the presence of lead. If any activities by the Contractor has the potential to cause an airborne release, the County's responsible person has the ability to stop all work in the immediate vicinity until corrective actions are taken to ensure that airborne concentrations of lead are not exceeding the PEL.

1.07 SUBMITTALS

- A. Lead Removal Plan:
 - 1. Site-specific work plan that demonstrates the methods for demolition and renovation activities with the potential to impact paint with lead, including handling, waste containment, and disposal of waste with paint with lead. Additionally, if waste materials are to be recycled, the plan will identify how painted materials intended for recycling are segregated, stored, and transported to an approved recycling facility. As a minimum, the plan shall include:
 - a. A general description of work practices, engineering controls, air monitoring and decontamination involving removal or disturbance of painted materials.
 - b. Description of whether the work will involve removal or disturbing painted materials.
 - c. Control methods during activities that can disturb painted materials in a manner that can cause an airborne release, such as cutting, torching, or impacts causing flaking.

- d. Employee exposure assessment process.
 - e. Content otherwise necessary to demonstrate that the Contractor meets the requirements WAC 296-155-176, Lead.
 - f. Qualification/certification/training certificates and role of each person (including Contractor's or subcontractor's employee) involved in painted surface removal or demolition.
 - g. The Contractor will be responsible for waste characterization sampling of waste stream bound for landfill. This will include sampling of the waste stream to determine if the waste is hazardous per 40 CFR 261.24 which sets the threshold for lead at 5.0 mg/L based on Toxicity Characteristic Leaching Procedure (TCLP) of lead. The Contractor will provide a method for collecting waste characterization sample of the waste stream and provide analytical laboratory certification.
 - h. Qualifications of the proposed testing laboratory to perform analysis of air monitoring and waste characterization samples as required to support the Contractor's plans and procedures for the removal or disturbance of painted materials.
 - i. Contractor will provide name and address of recycling facility where painted materials will be sent.
 - j. Proposed dangerous/hazardous waste landfills permitted by the state under Subtitle C of the Resource Conservation and Recovery Act (RCRA) for disposal of hazardous wastes as determined by waste characterization sampling completed by the Contractor.
 - k. Proposed non-dangerous/hazardous waste landfills (see list of approved non-dangerous waste landfills in 3.04.E below).
 - l. Manufacturer's product information, specifications and directions for use for all products used for the chemical removal of painted surfaces.
 - m. Procedures for personnel and equipment cleanup/decontamination.
 - n. Waste management, recycling, and/or disposal plan including description of the process and procedures for removal of the material from the site and transportation to the landfill or recycling facility. The removal plan shall identify container selection and labeling, as applicable.
 - o. Qualification/certificates of waste transportation subcontractor.
 - p. Qualification/certification of waste disposal facilities and documentation of final lead waste transportation and disposal.
 - q. Interface with trades and sequencing of paint removal or disturbance. Include a description of arrangements made among subcontractor's work areas to inform affected employees and to clarify responsibilities to control exposures.
- B. Prior to Construction: If the Contractor intends to reduce the full implementation of the requirements of 29 CFR 1926.62 and WAC 296-155-176, submit Exposure Assessment Data Report supporting the justification to reduce full implementation of these regulations and supporting the Lead Removal Plan.
- C. Close-Out Submittals:
- 1. Upon disposal of the waste in the selected and approved landfill, submit completed waste manifests or appropriate shipping documentation signed by the Contractor, all transporters, transferors and disposal facilities.
 - 2. Submit manifests or appropriate shipping documentation within 30 days of the time at which the lead wastes are received at the disposal facility.
 - 3. Submit certificate of recycling within 30 days of the time at which lead wastes are received at the recycling facility.

PART 2 PRODUCTS

- A. Deliver all materials used for the removal of paint in the original packages, containers or bundles bearing the name of the manufacturer and the brand name, where applicable.
- B. Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient to prevent damage or contamination. Replacement materials shall be stored outside the work area until removal is completed.
- C. Damaged, deteriorating, or previously used materials shall not be used and shall be removed from the work site and disposed of properly.

PART 3 EXECUTION

3.01 HEALTH AND SAFETY

- A. Comply with Section 01 35 29.

3.02 WORK AREA PREPARATION

- A. Establish control area that includes a perimeter sufficient to perform the construction work around each area where work practices has the potential to cause an airborne release of lead. The control areas shall be demarcated according to the requirements of 29 CFR 1926.62 and WAC 296-155-176.
- B. Containers used for the storage of waste and recyclable materials will be closed unless when actively being filled. Roll-off dumpsters will be equipped with a means to prevent storage piles from migrating (i.e. covers).
- C. Waste Accumulation Area: Prepare an area for use for the temporary storage of any waste. Waste containers will be closed unless when actively being filled, including roll-off dumpsters.
- D. Recycling Accumulation Area: Prepare an area for use for the temporary storage of recyclable materials.

3.03 WORK PROCEDURE

- A. General Procedures: The work includes all measures necessary to adequately protect workers, authorized personnel, King County WTD and WPTP personnel, and the public from lead exposure during the paint removal or disturbance activities.
- B. Degraded paint will be removed prior to any activity that can cause flaking/peeling of degraded paint. These activities include demolition or preparing surfaces for saw cutting, sanding, blast cleaning or removal, grinding, or torch cutting. Paint with lead will also be removed as necessary to protect workers/comply with OSHA rules, the public, and the environmental during these activities.
- C. Coordinate work of all trades and County personnel: Coordinate the work and activities of all trades and County personnel working at the RSP building to assure that work is performed in accordance with the applicable regulations and that the control limits are maintained at all times.
- D. Access to work area: During paint removal activities, limit access to the control areas to Contractor and subcontractor personnel, County, and construction management staff and personnel.
- E. Prevent dust generation at all times to the maximum extent practicable.
- F. Provide barriers or covers to prevent dust, abrasive materials or other products used in paint removal or disturbance from accumulating on the operating level or settling into the RSP building.
- G. Use procedures and equipment to limit occupational and environmental exposure to lead when paint with lead is removed or disturbed or when painted building components are impacted or demolished. The procedure employed by the Contractor shall not create the potential for contaminating surrounding areas with airborne lead. Dust generation shall be kept to a minimum.
- H. The use of powered machine for vibrating, sanding, grinding, or abrasive blasting is prohibited unless equipped with local exhaust ventilation systems equipped with HEPA filters or the paint was removed from the surface prior to using any of these tools.
- I. All painted waste debris shall be handled, stored, and disposed of in a manner that meets or exceeds applicable federal, state, and local requirements.

- J. Personnel and equipment decontamination shall occur whenever people or equipment leave the work site as described in the approved work plan. Decontamination waste shall be packaged, stored, labeled, and disposed of according to all applicable requirements. All contaminated equipment, tools or materials that cannot be decontaminated shall be stored and disposed of by the Contractor in accordance with all federal, state and local regulations.

3.04 RECYCLING OR DISPOSAL

- A. Contain/package, transport, and recycle or dispose painted wastes in accordance with applicable local, state and federal regulations.
- B. Except for scrap metal, including painted scrap metal, that will be recycled, determine if painted waste is a /hazardous waste, as defined in RCRA (40 CFR 261.24) and WAC 173-303:
 - 1. Demolition debris coated with lead will be characterized by:
 - a. Characterize demolition waste using whole building approach. .
 - b. Testing the individual building components and separate from other demolition debris, or
- C. Coordinate the off-site shipment, and recycling or disposal of wastes with the County.
- D. Disposal of hazardous waste:
 - 1. Prepare waste disposal manifest package that includes a waste profile naming the County as the waste generator; analytical data summary applicable to the waste; letter of acceptance from the proposed waste disposal facility to accept the waste; a completed hazardous waste manifest; and any other applicable information necessary for the County to complete review of the waste disposal package and provide signature as the hazardous waste generator.
 - 2. The County, as the waste generator, will sign the profile and the signed profile will then be submitted to the disposal facility for acceptance any hazardous waste. Once the acceptance letter is received from the disposal facility, transportation can be scheduled.
 - 3. Transport hazardous waste to the RCRA Subtitle C/Permitted Dangerous Waste landfill identified in Lead Removal Plan.
- E. Disposal of non-dangerous, solid waste:
 - 1. The County has determined that the following landfills will accept the non-dangerous/non-hazardous demolition debris generated under this project:
 - a. Columbia Ridge Landfill, Arlington, OR, operated by Waste Management, Inc.
 - b. Greater Wenatchee Regional Landfill, Wenatchee, WA, operated by Waste Management, Inc.
 - c. Roosevelt Regional Landfill, Roosevelt, WA, operated by Republic Services, Inc.
 - 2. Proposed alternative non-dangerous waste landfills shall be properly permitted under WAC 173-350 or applicable local, state and federal requirements to accept the construction debris containing lead paint.
- F. Scrap Metal Recycling
 - 1. Scrap metal that will be recycled, including scrap metal coated with lead paint, is excluded from being designated as dangerous/hazardous waste under WAC 173-303-071.
 - 2. Scrap metal that is disposed rather than recycled is fully regulated under Washington's Dangerous Waste Regulations, including the requirement to determine if a waste is dangerous/hazardous as defined WAC 173-303.
- G. Contractor cannot deviate from the recycling or disposal facilities identified in the Lead Removal Plan without County prior approval.
- H. Verify the specific requirements for the handling, transporting, unloading and disposal of the concrete with the selected landfill, including the maximum allowable size of debris allowed at the specific landfill.
- I. Concrete coated with paint with lead will not be recycled, unless specifically permitted by the recycling facility and approved by the Project Representative.

3.05 CLEAN-UP

- A. Housekeeping:
 - 1. Maintain all surfaces throughout the area free of lead paint dust and debris to the maximum extent practicable.
 - 2. Restrict debris from being distributed over the general area.
- B. Clean-up:
 - 1. Maintain surfaces of the lead control area as free of accumulation of paint chips and dust as practicable.
 - 2. Restrict the spread of dust and debris.
 - 3. Keep waste from being distributed over the work area.
 - 4. The use of compressed air or dry sweeping to clean up the area is strictly prohibited.
 - 5. At the end of each shift, clean the area of visible paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area, or cleanup by other appropriate means.
 - 6. At the end of paint removal activities, wet wipe and HEPA vacuum all surfaces in the lead control area after visible dust and debris is removed. If adjacent areas become contaminated at any time during the work, clean, and visually inspect.

END OF SECTION

SECTION 02 84 01
PCB BULK WASTE REMOVAL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section applies to work related to removal, handling, storage, transportation, and disposal of polychlorinated biphenyl (PCB) as Bulk Product Waste and PCB Remediation Waste as defined in Title 40 of the Code of Federal Regulations, Section 3 (40 CFR 761.3).
 - 1. PCB Bulk Product Waste includes PCB-containing caulking, paint, mastic, or sealant, as well as concrete and other building materials attached to or coated with PCB-containing caulk, paint, mastic, or sealant.
 - 2. PCB Remediation Waste includes PCB-containing sediment in detected in a drain in the boiler room.
- B. PCB-containing materials shall be removed and disposed in areas scheduled for demolition or impact during the work including spot abatements, if necessary, to facilitate the work of all trades. Refer to the “Final Sampling and Analysis for PCB, King County West Point Treatment Plant RSP Building, Seattle, WA” and “Supplemental Regulated Building Survey King County West Point RSP – Boilers Room” included in Volume V for the locations of PCB Bulk Product and Remediation Waste and associated contaminated materials to be removed.
- C. The work includes the following:
 - 1. Removal, packaging, transporting, and disposal of PCB Bulk Product and Remediation Wastes:
 - a. PCB Bulk Product Waste. When building materials contain PCBs at concentrations greater than or equal to 50 parts per million (ppm) are identified at County facilities:
 - 1) This material is classified as PCB Bulk Product Waste and regulated for removal and disposal by the United States Environmental Protection Agency (EPA) regulations under the Toxic Substances Control Act (TSCA) in 40 CFR 761.62.
 - 2) Building material that are “coated or serviced” with the PCB Bulk Product Waste are also classified as PCB Bulk Product Waste upon removal and as long as the caulk (or paint, mastic, or sealant) is attached to the building material per the PCB Bulk Product Waste Reinterpretation Memo issued by EPA (October 2012).
 - 3) Every effort shall be made to minimize waste included in the PCB Bulk Product waste stream to the extent practicable.
 - b. PCB Remediation Waste. Drain sediment containing greater than or equal to 50 ppm has been identified at County facilities:
 - 1) Drain sediment in drain located on Pump Room northeast of RSP 404 and in drain located near boiler 3 are classified as PCB Remediation Waste and will be removed and disposed in accordance with Performance Based Removal requirements for PCB Remediation Waste in 40 CFR 761.61(b) of TSCA.
 - 2) If sediment from other boiler room drains is removed, it will be managed and disposed as PCB Remediation Waste in accordance with 40 CFR 761.61(b) unless it is sampled and sample results confirm that this media contains less than 50 ppm PCBs.
 - 3) Contractor shall determine if drain sediment is also a Dangerous Waste as defined WAC 173-303.
 - c. Non-aqueous wastes generated during cleanup activities after PCB Bulk Product and Remediation Waste removal (e.g., cleaning materials, personal protective equipment, etc.) are classified as Cleanup Waste and are assumed to contain less than or equal to 50 ppm PCBs, and not regulated for disposal under TSCA.

- d. Aqueous Cleanup Waste will be sampled and disposed in accordance with 40 CFR 761.79.
2. Placement of PCB Bulk Product, Remediation and Cleanup Waste in County approved containers. County approved containers may be roll-off boxes or drums, or other containers pre-approved by the County.
3. Labeling of PCB Bulk Product Waste, Remediation and Cleanup Waste containers.
4. Transportation of PCB Bulk Product Waste to a facility in accordance with 40 CFR 761.62. Transportation of PCB Remediation Waste to a facility in accordance with 40 CFR 761.61(b). Transportation of Cleanup Waste to an approved permitted facility, as non-TSCA waste.
5. Coordination with the County for waste identification, temporary waste storage, profiling, manifesting, facility acceptability, and shipments.
6. The Contractor shall pay all necessary fees and obtain all necessary permits related to the removal, transportation, and disposal of all PCB Bulk Product and Remediation Waste, except as noted in the Drawings.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
29 CFR 1926.1153	Respirable Crystalline Silica
40 CFR 260 thru 268	Resource Conservation and Recovery Act Regulations
40 CFR 311	Worker Protection
40 CFR 761	PCB Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR	Subtitles A and B - Transportation
RCRA	Resource Conservation Recovery Act
WAC 173-303	Dangerous Waste Regulations
WAC 173-350	Solid Waste Handling Standards
Washington State Industrial Safety & Health Act (WISHA), WAC 296-800	Safety and Health Core Rules

Washington State regulations codified in the Washington Administrative Code governing hazardous materials work and waste management include but are not limited to:

WAC 296-24	General Safety and Health Standards
WAC 296-62	General Occupational Health Standards
WAC 296-155	Safety Standards for Construction Work

- B. Refer to the following EPA guidance documents on the internet for information on PCB waste and sealant removal:
1. Steps to Safe PCB Abatement Activities: <https://www.epa.gov/pcbs/steps-safe-pcb-abatement-activities>.
 2. Summary of Tools and Methods for Caulk Removal: <https://www.epa.gov/pcbs/summary-tools-and-methods-caulk-removal>.
 3. PCB Bulk Product Waste Reinterpretation Memorandum, EPA, October, 2012: <https://www.epa.gov/pcbs/polychlorinated-biphenyl-pcb-guidance-reinterpretation>.
 4. PCB Q&A Manual, 2015: <https://www.epa.gov/pcbs/polychlorinated-biphenyl-pcb-question-and-answer-manual-and-response-comment-documents>.
- C. All other applicable Federal, State, county and city standards codes.

1.03 PCB INSPECTION, SAMPLING AND TESTING

- A. Through various surveys, it has been determined that the proposed construction areas, under this Contract and the materials therein, do contain PCBs. PCBs were discovered in the RSP building exterior panel caulking and inside the RSP building on various coated surfaces.
- B. A copy of the reports, prepared by Pacific Rim Environmental Inc., documenting the inspection, sampling and testing program and the findings and recommendations for removal and disposal of concrete framing components coated with PCBs is referenced in 02 26 00, Hazardous Materials Assessment, as "West Point Treatment Plant Raw Sewage Pump Replacement Project, Hazardous Materials Assessment, September 2, 2020" and "Supplemental Regulated Building Survey King County West Point RSP – Boilers Room."
- C. The findings of the Inspection determined that:
 - 1. PCBs in building materials
 - a. The caulking at the locations identified contains PCBs at a concentration greater than 50 ppm, and is classified caulking as PCB Bulk Product Waste as defined in 40 CFR 761.3.
 - b. The concrete adjacent to the architectural panel caulking joints did not contain PCBs at distances of 3-inches and 6-inches from the caulking joint.
 - c. Various interior coated surfaces contained PCBs.
 - d. PCB contaminated concrete/substrate is considered PCB Bulk Product waste as long as it is attached to PCB containing caulking, paint, or other coatings. Refer to the PCB Bulk Product Waste Reinterpretation Memorandum (EPA, 2012).
 - e. The PCB Bulk Product Waste shall be disposed in compliance with 40 CFR 761.62. Construction and other debris that do not contain PCBs and Cleanup Waste can be disposed at a RCRA Subtitle D landfill.
 - 2. PCBs in boiler sediment
 - a. Drain sediment in the boiler room was sampled and determined to contain PCBs at a concentration greater than 50 ppm and is classified as PCB Remediation Waste as defined in 40 CFR 761.3. Only one drain waste sampled.
 - b. It is assumed that sediment in other drains in this room contain similar PCB concentrations and if removed, will be managed and disposed as PCB Remediation Waste unless Contractor samples and determines that it contains less than 50 ppm PCBs.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Be responsible for the removal and disposal of PCB Bulk Product and waste from the removal of other building materials (the architectural panel caulking and coated surfaces) inside the RSP building. Should suspect materials containing PCBs not identified in this Section is encountered, immediately suspend all work that could disturb said material and notify the Project Representative who will implement the proper action. Do not proceed with work that could disturb the material until authorized by the Project Representative, in writing, to do so.
- B. Be responsible for the removal and disposal of PCB Remediation Waste.
- C. Take the necessary precautions for compliance with Federal, State and Local regulations.
- D. Submit a PCB Abatement Plan for review by the Project Representative.
- E. Comply with Section 01 35 29.
- F. Fully inform workers of the presence of PCBs.

1.05 COUNTY'S RESPONSIBILITIES

- A. Upon notification by the Contractor of the existence of suspect building material containing PCBs not identified in this Section, the Project Representative will have said material inspected and analyzed for the presence of PCBs, as required.
- B. If the results of the inspection and analysis confirm the presence of PCBs in the suspect building material, the County will take the necessary actions for compliance with 40 CFR 761. After compliance is obtained, the Project Representative will notify the Contractor in writing so that work under this Contract can proceed.

1.06 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Preconstruction Submittals:
 - 1. Site-specific PCB Abatement/Work Plan which demonstrates the methods by which removal, handling and disposal of PCB Bulk Product and Remediation Waste will be performed, including associated Cleanup Waste. At a minimum the Plan shall include:
 - a. Specific work practices and procedures for removal, handling, storage, and disposal of PCB Bulk Product and Remediation Waste in accordance with 40 CFR 761.
 - b. A complete list of all materials and equipment proposed for use in the work. Include such items as containers, sorbents, and solvents.
 - c. Worker protection requirements including PPE and respiratory protection.
 - d. Dust and debris control, containment, and enclosure equipment and procedures necessary to protect workers and the environment (including interior and exterior drains).
 - e. Qualifications, experience, and role of each individual performing or managing PCB Bulk Product and Remediation Waste removal work. At a minimum, site personnel working on the project shall have:
 - 1) A site-specific training on PCB Awareness.
 - 2) Drivers hauling PCB Bulk Product and Remediation Waste shall have a DOT hazardous materials endorsement to their CDL.
 - 3) Companies Transporting PCB Bulk Product and Remediation Waste shall have a MCS-90 endorsement attached to their auto liability policy.
 - f. Qualifications of the proposed testing laboratory.
 - g. Procedures for personnel and equipment cleanup and decontamination.
 - h. PCB Waste Management and Disposal Plan, including:
 - 1) Waste minimization (for example, work plan to include procedures for minimizing amount of building material included in the PCB waste stream to the extent practicable).
 - 2) Location of the designated PCB Waste Storage Area.
 - 3) Waste container management during the work.
 - 4) Procedures for transportation of PCB waste.
 - 5) Proposed treatment or disposal facility that is permitted to will PCB Bulk Product Waste.
 - 6) Proposed treatment or disposal facility that is permitted to accept PCB Remediation waste.
 - 7) Proposed permitted facility for disposal of aqueous Cleanup Waste.
 - 8) Proposed permitted facility for disposal solid/non-aqueous Cleanup Waste.
- C. Post-Construction Closeout Submittals:
 - 1. Disposal Shipping Documentation:
 - a. Copies of waste acceptance forms and all PCB Bulk Product and Remediation Waste transportation and disposal manifests or bill of lading forms.
 - b. Include signed receipts from the County approved permitted disposal facilities.
 - c. PCB-containing building materials where PCB concentrations are above 1 ppm may not be recycled.

2. Certificates of Disposal: Submit a certificate of disposal from permitted disposal facility for all shipments of PCB Bulk Product and Remediation Waste.

1.07 DEFINITIONS

- A. Cleanup Waste: Waste generated during PCB Bulk Product and Remediation Waste removal activities. Examples of Cleanup Waste include: rags, wipes, mops, personal protection equipment (PPE), dust, and filters. Aqueous wastes (e.g., decontamination water, excess water used for dust suppression) are also considered Cleanup Waste.
- B. PCB(s): Polychlorinated Biphenyl(s). A class of organic compounds with chlorine atoms attached to biphenyl, a molecule composed of two benzene rings. PCBs are a class of industrial chemicals that were historically used as lubricants, heat-transfer fluids, insulators, and plasticizers.
- C. PCB Bulk Product Waste: Waste derived from manufactured products containing PCBs in a non-liquid state, at any concentration where the concentration at the time of designation for disposal was greater than or equal to 50 ppm PCBs.
- D. PCB Remediation Waste: Media containing PCBs (e.g., sediment or sludge) where the “as-found” concentration of PCBs is greater than or equal to 50 ppm. As-found concentration means the PCB concentration in the waste at the site, as opposed to the concentration of the PCBs in the material that was originally spilled, released, or disposed at the site.
- E. PCB Waste Storage Area: The Project Representative will identify a temporary storage facility located at the Project site that will be used to store PCB Bulk Product and Remediation Waste and Cleanup Waste prior to Contractor transportation and disposal. If PCB Bulk Product or Remediation Waste will be stored for more than 30 days onsite, the PCB Waste Storage Area shall be in compliance with 40 CFR 761.65(c)(9).

1.08 COORDINATION

- A. Coordinate the removal of PCB Bulk Product and Remediation Waste with the Project Representative to set up the disposal profile, confirm disposal facility acceptability and report any leaking equipment or spills. Only the Project Representative or a representative assigned by the Project Representative can sign the waste profile, waste manifest, or bill of lading.

PART 2 PRODUCTS

2.01 MATERIAL AND EQUIPMENT FOR PCB BULK PRODUCT, REMEDIATION, AND CLEANUP WASTE

- A. Containers:
 1. All PCB Bulk Product, Remediation, and Cleanup Waste shall be placed in County approved containers. County approved containers will be roll-off boxes, or DOT approved drums. Roll off boxes shall have hard lids capable of closing to keep rainwater out of the box.
 2. Provide all containers for PCB Waste.

PART 3 EXECUTION

3.01 HEALTH AND SAFETY

- A. Comply with Section 01 35 29.

3.02 PCB BULK PRODUCT, REMEDIATION, AND CLEANUP WASTE

A. PCB Bulk Product, Remediation, and Cleanup Waste:

1. Inspections:
 - a. Removal of PCB Bulk Product and Remediation Waste shall not begin until the work area, containment systems have been inspected and approved by the Project Representative.
 - b. The Contractor's Supervisor shall perform daily inspections of the site and generate a written daily quality control report.
2. Site Security:
 - a. The work area is to be restricted only to authorized, trained, and protected personnel. These may include the Contractor's employees; employees of subcontractors; County employees and representatives; federal, state, and local inspectors; and other authorized or designated individuals.
 - b. Provide site security during PCB-Bulk Product and Remediation Waste removal operations.
3. Preparation of Work Area:
 - a. Prior to PCB removal work, establish and maintain a PCB control area that prevents unauthorized entry of personnel. Food, drink and smoking shall not be permitted in areas where PCBs are handled or PCB wastes are stored.
 - b. Provide warning signs at approaches to PCB control areas in conformance with 29 CFR 1910.145. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area.
 - c. Prior to PCB removal work, block or otherwise protect storm drain inlets in or near the work areas in a manner that prevents contaminated sediment or dust from discharging into a drain. The catch basins shall remain blocked during removal activities.
 - d. All electrical conduits, junction boxes and other electrical equipment in or adjacent to the work areas shall be protected from water. Wire in conduit that passes through the work area shall be assumed to be energized at all times. The Contractor is responsible for all electrical safety.
 - e. Decontaminate contaminated tools, containers, etc., after use by rinsing three times with an appropriate solvent or by wiping down three times with a solvent wetted rag, or as indicated in 40 CFR 761.79. .

B. Removal Procedures:

1. Workers removing and handling PCB Bulk Product, Remediation, and Cleanup Waste shall be provided with PPE and other protection equipment described in the PCB Abatement Plan.
2. Select PCB removal procedure to minimize contamination of work areas with PCB Bulk Product and Remediation Waste. Handle PCBs such that no skin contact occurs. PCB Bulk Product and Remediation Waste removal process will be described in the PCB Abatement Plan.
3. The PCB control area shall be, at no time, left unattended after work procedures have been implemented, and shall be attended until all PCB Bulk Product, Remediation, and Cleanup Wastes have been sealed in approved containers.
4. Maintain an access log of employees working in a PCB control area and provide a copy to the County upon completion of the operation.
5. Apply water while removing PCB Bulk Product Waste as necessary to prevent fugitive dust. Do not allow excessive water to accumulate in the work area. Vent HEPA filter exhaust to the outside where appropriate. At a minimum, the use of a HEPA vacuum shall be part of each removal activity.
6. Aspiration of dust (i.e., vacuum equipped with a HEPA filter) at the source shall be utilized when cleaning residual bulk product waste by mechanical methods.
7. Minimize waste to the extent practicable.
8. Capture and store wastewater generated during removal, mopping, wet cleaning, or misting. At no time shall liquids be allowed to escape the work area or discharged down any drain.
9. Place all PCB Bulk Product and Remediation Waste and Cleanup Waste into County approved containers. Solid/non-aqueous and non-saturated wastes may be placed in the roll-off containers.
10. Affix labels to PCB waste containers. Label with the following:
 - a. "Solid (or Liquid) Waste Polychlorinated Biphenyls".
 - b. The PCB Caution Label, paragraph entitled "PCB Caution Label".

- c. The date the PCB Bulk Product or Remediation Waste was removed and placed in storage.
- 11. Containers shall not be overfilled and shall be kept closed except when actively adding materials to the container.
- 12. The Contractor may move the County approved containers around the Project Site to accommodate different work areas; however, the containers shall be stored in the designated temporary PCB Waste Storage Area while not in immediate use.

C. Cleanup:

- 1. Upon completion of PCB work, all tools and equipment used in the work shall be decontaminated as indicated in 40 CFR 761.79, and properly stored for disposal or reuse. PPE may not be reused.
- 2. All exterior surfaces of PCB Bulk Product and Remediation Waste and Cleanup Waste containers shall be thoroughly cleaned with a HEPA-filtered vacuum and wet wiping/mopping to ensure that they are free of dust and debris before leaving the work area.
- 3. All interior surfaces of the work area enclosure shall be thoroughly cleaned by HEPA vacuuming and wet wiping prior to the visual clearance inspection by the County. Re-cleaning and inspection will continue until no visible suspect material remains.

D. Work Area Clearance:

- 1. The County will perform a visual clearance inspection of each work area.
- 2. Work area clearance is achieved when:
 - a. The work area has been thoroughly cleaned (i.e., HEPA-vacuumed and wet-wiped).
 - b. The work area has passed visual clearance.
 - c. All PCB Bulk Product, Remediation, and Cleanup Waste have been removed from the area, contained in County approved containers, and transported to the appropriate disposal facility.

E. Disposal:

- 1. The Contractor is responsible for soliciting a waste service provider and any cost negotiations regarding disposal.
- 2. The Contractor shall notify the Project Representative and indicate which permitted facility will accept the PCB waste.
- 3. The characterization of the PCB waste shall be conducted prior to transportation off-site.
- 4. PCB Bulk Product and Remediation Waste will be shipped using a waste manifest, as required in 40 CFR 761.
- 5. Aqueous Cleanup Waste will be disposed as indicated in 40 CFR 761.79.
- 6. Non-aqueous Cleanup Waste that contains less than 50 ppm PCBs will be disposed as non-TSCA waste at a County approved landfill.
- 7. Waste profiles and manifests shall be signed by a representative from the County or their authorized representative.
- 8. Alternative disposal methods or facilities shall be approved by the Project Representative.
- 9. Invoices for disposal will be paid by the Contractor. However, the County will be listed as the generator of the waste on all profiles, manifests, or bills of lading.
- 10. Submit the Certificate of Disposal to the County within 30 days of the date that the disposal or destruction of the PCB Bulk Product and Remediation Waste identified on the manifest was completed. Certificate for the PCBs Bulk Product and Remediation Waste disposed shall include:
 - a. The identity of the disposal facility, by name, address, and EPA identification number.
 - b. The identity of the PCB waste affected by the Certificate of Disposal including reference to the manifest number for the shipment.
 - c. A statement certifying the fact of disposal of the identified PCB waste, including the date(s) of disposal, and identifying the disposal process used.
- 11. Payment will not be made until the certificate of disposal has been furnished to the County.

END OF SECTION

SECTION 03 01 32
CONCRETE SURFACE REPAIR SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies concrete surface repair systems to repair damage to or defects in old or in new construction.
- B. This Section specifies concrete surface repair systems for restoring concrete, exposed by pedestal, housekeeping or equipment pad removal to match the surrounding concrete profile and surface texture.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AASHTO T277	Standard Method of Test for Rapid Determination of the Chloride Permeability of Concrete
ASTM A82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A185	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C348	Standard Test Method for Flexural Strength of Hydraulic Cement Mortars
ASTM C496	Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C596	Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C1202	Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetration
ASTM E699	Criteria for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Samples: Mesh reinforcement and mesh anchor.
- C. Polymer-modified repair mortar system:
 - 1. Manufacturer's installation bulletin.
 - 2. Manufacturer's recommended fabric size for mesh reinforcement.
 - 3. Product data sheet for each material.
- D. Mesh manufacturer's installation instructions and allowable load criteria.
- E. Written description of equipment proposed for hydrodemolition surface preparation.
- F. Certificates:
 - 1. Certificate of Compliance that proposed product systems meet or exceed specified performance criteria when tested as specified within this Section.
 - 2. Polymer-modified repair mortar system manufacturer's Certificate of Proper Installation.

- G. Statements of qualification:
 - 1. Independent testing laboratory.
 - 2. Polymer-modified repair mortar system manufacturer's representative.
- H. Polymer-modified repair mortar system manufacturer's proposed modified test procedures for ASTM C109 and ASTM C882 test methods.
- I. Independent testing laboratory test report of all laboratory and field testing.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Independent testing laboratory: Based on evaluation of laboratory submitted criteria in accordance with ASTM E699.

PART 2 PRODUCTS

2.01 POLYMER-MODIFIED REPAIR MORTAR

- A. Polymer-modified, cementitious based, chloride resistant, flowable, gray in color, working time of 15 minutes minimum, surface renovation mortar having an integral corrosion inhibitor, conforming to the following properties:
 - 1. Slant Shear Bond Strength: 2,000 psi in 28 days in accordance with ASTM C882 test method modified with no bonding agent.
 - 2. Compressive strength, ASTM C109 at 28 days: Minimum 6,000 psi.
 - 3. Flexural strength, ASTM C348 at 28 days: Minimum 1,200 psi.
 - 4. Rapid chloride permeability, ASTM C1202 or AASHTO T277: 1100 coulombs maximum.
 - 5. Splitting tensile strength. ASTM C496 at 28 days: 500 psi minimum.
 - 6. Drying shrinkage, ASTM C596 at 28 days: Maximum 0.12 percent.
 - 7. Freeze thaw resistance, ASTM C666, at 300 cycles: 90 percent RDF.
 - 8. Recommended by the manufacturer for vertical or overhead use for vertical or overhead repairs.
 - 9. Recommended by the manufacturer for horizontal use for horizontal repairs.
 - 10. Suitable for the required repair depth. Extension with aggregates as recommended by the manufacturer is permitted.

2.02 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.03 ACCESSORIES

- A. Mesh reinforcement: Welded wire fabric with spacing of wires, and wire size in accordance with ASTM A185 and ASTM A82, and mortar system manufacturer's recommendations:
 - 1. Size: 4x4 - W1.4xW1.4, unless noted otherwise.
- B. Tie wire: 16 gauge galvanized.
- C. Mesh anchors:
 - 1. Stainless steel Type 304 tie wire anchors.
 - 2. Acceptable manufacturers:
 - a. Hilti, Inc.; HHDCA Concrete Ceiling Anchor..
 - b. Dewalt; Power-Stud SD1 Tie Wire Wedge Expansion Anchor.
 - c. UCAN Fastening Products; UCAN Tie Wire Wedge Anchor.
 - d. Approved Equal.
- D. Stainless steel helical anchors:

1. Prosoco, Inc.: PROSOCO Concrete Patch-Tie.
2. HeliFix, Inc.: PatchPin.
3. Approved Equal.

2.04 PRIMING/BONDING AGENT

- A. As recommended by the Polymer-Modified Repair Mortar manufacturer.

2.05 CURING COMPOUNDS

- A. As recommended by the Polymer-Modified Repair Mortar manufacturer.

PART 3 EXECUTION

3.01 GENERAL

- A. The color of the polymer-modified repair mortar shall be adjusted to match background surface where the repair is to be exposed and not painted.

3.02 PREPARATION

- A. Remove unsound and deteriorated concrete from Work by high pressure water blasting machines capable of removing concrete surfaces to minimum amplitude roughness of 3/16-inch or as shown. Remove to provide for thickness recommended by the repair mortar manufacturer.
- B. Square edges of patch areas by sawing and chipping to a minimum depth of ½-inch.
- C. High pressure water blasting machines with 16,000 to 20,000-psi minimum.
- D. Collect and dispose of water from removal operations in manner and location acceptable to Project Representative.
- E. Do not use power-driven jackhammers and chipping hammers, unless water blasting is prohibited due to potential damage to installed equipment.
- F. Remove concrete minimum of 1-inch clearance around rebar for application and bonding of new mortar to entire periphery of exposed rebar if the following surface conditions exist:
 1. 50 percent or more of periphery around rebar is exposed during removal of concrete.
 2. 25 percent or more of periphery around rebar is exposed during removal of concrete and corrosion has eventuated to the extent that loss of section has occurred.
 3. Bond between existing concrete and reinforcement has deteriorated.
- G. Clean exposed reinforcing bars of rust and concrete, and coat with primer as recommended by the polymer-modified repair mortar manufacturer.
- H. Maintain surface areas free of slurry where concrete has been removed. Remove slurry from prepared areas before new polymer-modified repair mortar is applied.
- I. Clean surface areas to be filled with new repair mortar of laitance and contamination by high-pressure water blasting not more than 24 hours before applying bonding agent. Ensure saturated surface dry (SSD) existing concrete at time of application of repair mortar unless otherwise recommended by the polymer-modified repair mortar manufacturer.

3.03 INSTALLATION OF MESH REINFORCEMENT

- A. Provide reinforcement when mortar application is more than 3 inches deep unless otherwise shown and when existing reinforcement is not exposed.

- B. Install mesh anchors in accordance with mesh manufacturer's instructions.
- C. Fasten reinforcement to mesh anchors with tie wire.
- D. Lap reinforcement a minimum of one mesh spacing and secure with tie wire at intervals no less than 12 inches.
- E. Install stainless steel helical anchors at 6" (maximum) on center in each direction in accordance with the manufacturer's recommendations. Anchors may be installed at an angle or may be bent to ensure that the pin has at least ¾" of cover.

3.04 POLYMER-MODIFIED REPAIR MORTAR APPLICATION

- A. Apply Priming or Bonding Agent to prepared surface as recommended by the polymer-modified repair mortar manufacturer .
- B. Place Polymer-Modified Repair Mortar as recommended by the manufacturer.
- C. Finish repair polymer-modified repair mortar flush to the plane of the surrounding existing concrete.
- D. Finish to same texture as existing concrete around patch.

3.05 FINISHING

- A. In accordance with the manufacturer's recommendations.

3.06 CURING

- A. In accordance with the manufacturer's recommendations.

3.07 FIELD QUALITY CONTROL

- A. Independent testing laboratory shall be retained by the Contractor and approved by the Project Representative, and shall perform the following:
 - 1. Secure production samples of mixed materials during construction and test for compliance with the Specifications.
 - 2. Obtain actual core samples from the completed repair Work and test.
 - 3. Perform "modified" ASTM C109 and ASTM C882 test methods in accordance with manufacturer's approved modifications of testing procedures.
- B. Construction testing:
 - 1. Production samples:
 - a. Provide minimum of three samples each test.
 - 2. Core samples of in-place repair:
 - a. Obtain two core samples and test samples for each repair work.
 - b. Cores shall be either 2-1/2 inches or 3 inches in diameter and shall be cored through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness.
 - c. Sawcut the cores after removal to trim base concrete thickness to same thickness as mortar so that bond line is at center of repaired sample.
 - d. Samples shall be epoxy bonded to steel plates at each end using a bonding agent to prevent failure in bond to steel plates.
 - e. Sustain bond line without failure or movement with a minimum of 300 psi in direct tension. The tension test shall use eyebolts or threaded connectors tapped and threaded into baseplate so that tension load is concentric with center of core sample.

- C. Repair and fill holes where core samples have been removed using same polymer-modified repair mortar used in repair.

END OF SECTION

SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies formwork for cast-in-place concrete, with shoring, bracing and anchorage, openings for other work, form accessories, and form stripping.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ACI 117	Specification for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	Specifications for Concrete Construction
ACI PRC-303	Guide to Cast-in-Place Architectural Concrete Practice – American Concrete Institute
ACI 318	Building Code Requirements for Reinforced Concrete and Commentary
ACI PRC 347.3	Guide to Formed Concrete Surfaces
NIST PSI	Structural Plywood

- B. Perform work of this Section in accordance with the Referenced Standards:

1. Maintain one copy of standards on project site.

- C. Design formwork under direct supervision of a Professional Engineer experienced in design of concrete formwork and licensed in the state of Washington.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data: Provide data on concrete formwork, void form materials and installation requirements.

1.04 DESIGN REQUIREMENTS

- A. Design, engineer, and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for design, fabrication, erection and removal of formwork.

1.06 MOCK-UP

- A. Construct a mock-up of formwork to be used for all concrete surfaces exposed to view on the Raw Sewage Pump Building, 4 feet long by 4 feet wide for each mock-up:
1. Include reinforcement, ties, and accessories specified in Section 03 20 00.

2. Provide concrete in accordance with provisions of Section 03 30 00.
3. Cure concrete in accordance with provisions of Section 03 30 00.

- B. Locate mock-up where directed by Project Representative.
- C. Mock-up may not remain as part of the Work.
- D. Mock-up will become the property of the Contractor and shall be removed from the site when directed by the Project Representative.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver void forms and installation instructions in manufacturer's packaging.
- B. Store void forms off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Forms for concrete exposed to view (Architectural Concrete):
 1. Materials selected to offer optimum smooth, stain-free final appearance and minimum number of joints.
 2. Provide materials with sufficient strength to resist the pressure of the fluid concrete without deflection in excess of allowable tolerances provided herein or within the referenced standards, whichever is more stringent.
 3. Steel, Medium Density Overlay (MDO) panels or High Density Overlay (HDO) panels.
 4. Provide special edges or sealant to provide grout-tight joints between form panels.
 5. Strength, stiffness, and quality as necessary to provide the concrete surface finish specified in Section 03 30 00.
- B. Forms for concrete not exposed to view (below grade, interior or not exposed to view):
 1. Plywood, hard plastic finished plywood, overlaid waterproof wood panels (OSB and similar) or steel forms.
 2. Sufficient strength to resist the pressure of the fluid concrete without deflection in excess of allowable tolerances provided herein or within the referenced standards.
 3. Strength, stiffness, and quality as necessary to provide the concrete surface finish specified in Section 03 30 00.

2.02 FORMWORK ACCESSORIES

- A. Form Ties: Removable type, galvanized metal, fixed length, cone type, with neoprene water resistant washer, 1 inch break back dimension, free of defects that could leave holes larger than 1 inch in concrete surface.
- B. Form Tie Plugs: Hard rubber or plastic. Configured to fit form tie holes with exterior face of plug $\frac{1}{2}$ " to $\frac{3}{4}$ " below the surface of concrete. Form tie plugs shall be bonded with the adhesive recommended by the manufacturer.
- C. Form Release Agent:
 1. Material:
 - a. Shall not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatments of the concrete surfaces.
 - b. A ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents.
 - c. Environmentally safe and shall meet the requirements of the referenced standards.

2. Acceptable manufacturers:
 - a. Master Builders: MasterFinish RL 211.
 - b. Cresset Chemical Company: Crete-Lease 20-VOC.
 - c. US Mix Products Company: Ezkote Green.
 - d. Approved Equal.
- D. Corners: Filleted, rigid plastic type; 3/4 x 3/4 inch size; maximum possible lengths.
- E. Dovetail Anchor Slot: Type 316 Stainless steel, 22 gage thick, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- F. Flashing Reglets: Type 316 Stainless steel, 22 gage thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- G. Nails, Spikes, Lag Bolts, She-Bolts, Through Bolts, and Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete. Provide plastic cones and plugs similar to Form Ties and Form Tie Plugs. She-bolts shall have tapered noses.
- H. Waterstops:
1. Polyvinyl Chloride (PVC):
 - a. Manufactured from virgin polyvinyl chloride conforming to the Corps of Engineers Specification No. CRD-C572.
 - b. Unless otherwise specified or noted on the Drawings, waterstops shall be 6-inch flat center/ribbed sides/0.375 inch thick.
 - c. Acceptable manufacturer:
 - 1) Greenstreak 679.
 - 2) Vinylex R638.
 - 3) Durajoint Type 11.
 - 4) Approved Equal.
 2. Expanding Hydrophilic:
 - a. Bentonite-free and made from unvulcanized rubber.
 - b. Used only where indicated on the Drawings or accepted in writing by the Project Representative.
 - c. Provide adhesive approved by the waterstop manufacturer.
 - d. Unless otherwise shown on the Drawings, use 3/8" x 3/4" waterstops.
 - e. Placed between two mats of reinforcing steel.
 - f. Acceptable manufacturer:
 - 1) Vinylex, SikaSwell A.
 - 2) Adeka, Ultra Seal MC-2010MN.
 - 3) Greenstreak Hydrotite.
 - 4) Approved Equal.
 3. Expanding Hydrophilic Caulking:
 - a. Single component polyurethane sealant.
 - b. Used only where indicated on the Drawings or accepted in writing by the Project Representative.
 - c. Acceptable manufacturer:
 - 1) Sika, Duroseal Quellpaste Type E Paste.
 - 2) Adeka, Ultra Seal P-201.
 - 3) Sika Leakmaster LV-Z.
 - 4) Approved Equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with Drawings.

3.02 EARTH FORMS

- A. Earth forms are not permitted.
- B. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.03 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with the most stringent requirements of ACI 301 and ACI 318 and the recommendations of ACI PRC 347. Exposed to view concrete (Architectural Concrete) shall also meet the recommendations of ACI PRC 303R.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of shoring and placement of reshoring in accordance with the most stringent requirements of the Referenced Standards.
- D. Align joints and make watertight. Keep form joints to a minimum.
- E. Obtain approval before framing openings in structural members that are not indicated on Drawings.
- F. Provide fillet strips on external corners of beams, joists, and columns.
- G. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- H. Coordinate this Section with other Sections of work that require attachment of components to formwork.
- I. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Project Representative before proceeding.

3.04 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are adversely affected by the form release agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in or passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.

- C. Coordinate with work of other Sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement. Heat splice joints so they are watertight.
- F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete:
 - 1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
 - 2. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.07 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 117 and ACI 301.
- B. Camber slabs and beams $\frac{1}{4}$ inch per 10 feet (2mm/m).
- C. In addition to the requirements of ACI 117 and ACI 301, construct formwork for exposed to view concrete (Architectural Concrete) to maintain the tolerances recommended by ACI PRC 303R where they are more stringent. Camber slabs and beams in accordance with ACI 301.

3.08 FIELD QUALITY CONTROL

- A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.
- B. Do not reuse MDO or HDO formwork more than two times for concrete surfaces to be exposed to view unless otherwise approved by the project representative. Do not patch formwork.

3.09 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads. Forms for elevated structural slabs and beams shall not be removed until the concrete has attained at least 90 percent of its specified minimum design strength.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

3.10 SCHEDULES

- A. Formed Surface Not Exposed to View: Comply with materials specified in this Section.
- B. Formed Surface Exposed to View: Comply with materials specified in this Section.

END OF SECTION

SECTION 03 15 19

CAST-IN CONCRETE ANCHORS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies cast-in anchorage to concrete, complete with washers and nuts.
- B. Cast-in concrete anchorage systems required to secure the various parts together and provide a complete installation are generally indicated on the Drawings. Where the anchorage design is absent, or insufficiently detailed to complete the installation, provide the anchorage design and submit for approval.
- C. The tabulation of items herein is not intended to be all inclusive, and it shall be the Contractor's responsibility to provide all metalwork and castings shown, specified, or which can reasonably be inferred as necessary to complete the project.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1525	Standard Test Method for Vicat Softening Temperature of Plastics
ASTM F436	Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F2329	Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's product data.
 - 2. Design calculations and details showing the required diameter, length, embedment, edge distance, confinement, and other conditions, stamped and signed by a structural engineer, licensed in the State of Washington, for all anchor bolts and concrete anchors not conforming to the configurations shown on the Drawings and all concrete anchors required for the bracing and anchoring designs required by Section 01 73 00.

1.04 QUALITY ASSURANCE

- A. The diameter and capacity of cast-in concrete anchors shall be as recommended or required by the equipment or machinery manufacturer, including any requirements for seismic bracing and anchorage required in the design in Section 01 73 00. In case of conflicting or ambiguous recommendations or requirements, the most stringent shall apply. Verify that the capacities and configurations conform to the Drawings or as required for the bracing and anchoring design required by Section 01 73 00.

1.05 EXPOSURE CONDITIONS

- A. Dry: indoor spaces not subject to moisture, washdown, hydrogen sulfide gas or chemicals.
- B. Wet and/or corrosive: outdoor areas, or indoor areas subject to moisture, washdown, hydrogen sulfide gas or chemicals.
- C. Submerged: at or below a point 1.5 foot above maximum fluid surface.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Unless otherwise specified, materials shall conform to the following:
 - 1. Anchor bolts and anchor rods:
 - a. Carbon steel: ASTM F1554 Grade 36 or Grade 55, as specified.
 - b. Stainless steel: ASTM F593G or F593H as required by size.
 - c. Galvanized: ASTM F1554 Grade 36 or Grade 55, hot-dip zinc coated per ASTM F2329.
 - 2. Threaded rod:
 - a. Carbon steel: ASTM F1554 Grade 36 or Grade 55, as specified.
 - b. Stainless steel: ASTM F593G or F593H as required by size.
 - c. Galvanized: ASTM F1554 Grade 36 or Grade 55, hot-dip zinc coated per ASTM F2329.
 - 3. Nuts: (Heavy Hex)
 - a. Carbon steel: ASTM A563A for Grade 36 and 55 rods.
 - b. Stainless steel: ASTM F594G or ASTM F594H as required by size .
 - c. Galvanized: ASTM A563A, hot-dip zinc coated per ASTM F2329.
 - 4. Washers:
 - a. Carbon steel: ASTM F436.
 - b. Stainless steel: Type 316.
 - c. Galvanized: ASTM F436, hot-dip zinc coated per ASTM F2329.
 - 5. Anchor Bolt Sleeve: high density polyethylene plastic.
 - a. Plastic: high-density polyethylene.
 - b. Density: ASTM D1505, 0.956 grams per cubic centimeter minimum .
 - c. Vicat softening point: ASTM D1525, 256° minimum.
 - d. Brittleness Temperature: ASTM D746, -180° maximum .
- B. Fasteners: all components of mating fasteners, bolts, nuts and washers, of the same material and coated by the same process.

2.02 ANCHOR BOLTS

- A. Unless shown otherwise on the Drawings, provide 3/4-inch minimum diameter with 10-inch embedment into concrete with bolt head or nut at the embedded end.
- B. Provide a minimum of two nuts and a washer of the same material for each bolt at the top of the bolt.
- C. Provide sleeves as shown on the Drawings for location adjustments.

- D. Provide anchor bolt material for the exposure conditions as noted below unless noted otherwise on the Drawings:
 - 1. Equipment and machinery:
 - a. Dry exposure: stainless steel.
 - b. Wet, corrosive or submerged exposure: stainless steel.
 - 2. Fabricated metalwork or structural building or frame components:
 - a. Dry Exposure:
 - 1) Steel anchoring: galvanized steel.
 - 2) Other metal anchoring: stainless steel.
 - b. Wet, corrosive or submerged exposure: stainless steel.
- E. Anchor Bolt Sleeve:
 - 1. Single unit construction with deformed sidewalls such that the concrete and grout lock in place.
 - 2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
 - 3. Anchor bolt sleeves shall provide minimum anchor bolt movement of 1/2" in all horizontal directions. The minimum sleeve length shall be 8 times the bolt diameter.
 - 4. Anchor bolt sleeves shall have a minimum internal diameter 1" greater than bolt diameter and a maximum internal diameter 3" greater than anchor bolt diameter. Sleeves shall be filled with nonshrink grout after bolts aligned.
- F. Nonshrink Grout: comply with the requirements of Section 03 60 00.
- G. Coated concrete anchors shall be coated by fusion bonding. Coating of threads is not required. Where threads are covered with a fusion bonded coating, provide the nut of proper size to fit and provide a connection of equal strength to the embedded anchor.

2.03 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZE)

- A. Where stainless steel nuts and threaded fasteners are used, apply anti-seize lubricant to the threads prior to making up the connections. Lubricant shall be manufactured and labeled for use with stainless steel and shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper.

PART 3 EXECUTION

3.01 GENERAL

- A. Install per manufacturer's recommendations.
- B. Cutting and welding: not permitted.
- C. After anchors have been embedded, protect threads with grease or anti-seizing lubricant and install the nuts.
- D. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators.
- E. Provide beveled washers where mating surface is not square with the anchor bolt.

3.02 ANCHOR BOLT HOLES IN EQUIPMENT

- A. Shall not exceed the bolt diameters by more than:
 - 1. Bolts smaller than 1-inch: 25 percent
 - 2. Bolts 1-inch and larger: 1/4-inch.

3.03 ANCHOR INSTALLATION

- A. Place anchor bolts to be embedded-in concrete accurately and hold in correct position while the concrete is placed or, if specified, form recesses or blockouts in the concrete and grout the metalwork in place in accordance with Section 03 60 00.
- B. Thoroughly clean the surfaces of metalwork in contact with concrete.
- C. Anchor bolts shall have sufficient exposed length for leveling the machinery while maintaining a minimum of ½-inch clearance between the baseplate and the foundation.
- D. The annular space around the anchor bolt below the foundation surface and the machinery baseplate shall be filled with non-shrink grout in accordance with Section 03 60 00. Completely fill all voids. The anchor bolt leveling nuts shall be blocked out of the grout.
- E. After the grout has attained its designed strength, the anchor bolt leveling nuts shall be backed off and the grout patched after the primary anchor bolt nuts are tightened

3.04 GALVANIZING REPAIR

- A. Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired in accordance with the recommendations of ASTM A780 as required by the Project Representative.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies reinforcing steel for use in reinforced concrete. Epoxy coated reinforcing steel is not included in this Section.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
PRC-303	Guide to Cast-in-Place Architectural Concrete Practice – American Concrete Institute
ACI 318	Building Code Requirements for Structural Concrete
ASTM A82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706	Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ACI	Manual of Standard Practice
AWS D1.4	Structural Welding Code— Reinforcing Steel
CRSI-PRB	Placing Reinforcing Bars
CRSI-MSP	Manual of Standard Practice

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Shop Drawings and Product Data:
1. Technical data of reinforcing bars including mill certificates, dowel bars, tie bars, bar supports and mechanical couplers.
 2. Reinforcing bar shop and placement drawings.
 3. Bar lists and bending details.
 4. Bar tags.
 5. Welder performance qualification records in accordance with Section 05 05 20.
 6. Welding Procedure Specification in accordance with Section 05 05 20.
 7. Mechanical Threaded Connections: Current International Code Council (ICC) Evaluation Report and Manufacturer's Instructions

PART 2 PRODUCTS

2.01 MATERIALS

- A. Bar Reinforcement: Deformed billet steel conforming to ASTM A615, Grade 60, including supplementary requirements except No. 2 bars.
- B. Bar Reinforcement to be welded: Deformed billet steel conforming to ASTM A706, Grade 60. Welding reinforcing shall not be permitted unless shown on the Drawing or permitted in writing by the Project Representative. Existing reinforcement to be welded shall be preheated and maintained at the required interpass temperature required by AWS D1.4.
- C. Do not use reinforcement having any of the following defects:
 - 1. Bar lengths, depths, or bends exceeding the specified fabricating tolerances.
 - 2. Bends or kinks not indicated on the Drawings or required for this work.
 - 3. Bars with cross-section reduced due to excessive rust or other causes.
- D. Tie Bars: Deformed billet steel bars conforming to the requirements of ASTM A615, Grade 60.
- E. Spiral Ties: Spiral ties shall conform to the requirements of ASTM A82.
- F. Mechanical Couplers, Form Savers, Terminators or Splices:
 - 1. Mechanical couplers, form savers, terminators or splices shall meet the requirements of a Type 2 mechanical splice of ACI 318.
- G. Bar Supports, Tie Wire and Trim Steel:
 - 1. Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI MSP and placed in accordance with CRSI PRB. Concrete block supports shall be provided for footing and slabs on grade. Stainless steel or plastic protected supports shall be provided for all other work.
 - 2. Locate in accordance with CRSI Manual of Standard Practice.
 - 3. Show all reinforcing steel required on the shop drawings.
 - 4. Tie wire shall be black, soft-annealed 16 gage wire.
 - 5. Unless otherwise indicated, use standard steel supports for other work.
 - 6. Non-corrosive, non-rusting material where bar supports will be exposed to air, soil, water or sewage.
- H. Welded Wire Fabric conforming to ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fabrication:
 - 1. Reinforcing steel:
 - a. Do not bend or straighten in a manner that will damage the material.
 - b. Do not use bars with kinks or with bends not shown.
 - c. Fabricate in accordance with CRSI MSP-1.
 - 2. Heating or welding bars shall only be permitted where shown on the Drawing or permitted in writing by the Project Representative. Unless otherwise indicated:
 - a. Perform in accordance with Section 05 05 20.
 - b. Welders shall meet the requirements of Section 05 05 20.
 - c. Do not weld bars at the bend.
 - d. Tack welding of cross bars is not acceptable.

- B. Placement:
1. Place reinforcing steel in accordance with CRSI- PRB, the Drawings, and the applicable shop drawing per the reinforcing steel supplier.
 2. Include all reinforcing steel as required by CRSI-MSP or CRSI-PRB when not shown specifically on the Drawings or explicitly referred to in the Specifications.
 3. Unless otherwise indicated, provide concrete cover as shown on the Drawings.
 4. Position reinforcing steel accurately and secure against displacement at intersections with tie wire and support by concrete or metal chairs, spacers or metal hangers.
 5. Support reinforcing steel on rock foundations with steel rods and pegs.
 6. Unless otherwise indicated, do not place reinforcing steel on fresh concrete or force the steel into fresh concrete.
 7. When moisture-proofing is used, support reinforcing steel or mesh with supports designed with flat bases to protect the membrane at all times.
- C. Splicing:
1. Lap splice reinforcing steel a Class B Lap Splice as provided by ACI 318 unless otherwise shown on the Drawings, or 40 bar diameters if not shown.
 2. In slabs, beams, girders, and walls subject to lateral pressure, do not splice reinforcing steel in areas of maximum stress.
 3. Stagger splices of adjacent bars as shown in the Typical Details of the Drawings or as required by ACI 318 if not otherwise shown.
- D. Mechanical Splices, including splices, couplers, terminators and form savers:
1. Mechanical Splices (ACI 318 Type 2) may be substituted for Lap Splices at the contractor's discretion.
 2. Mechanical Splices (ACI 318 Type 2) shall be substituted for Lap Splices at any location where a Class B Lap Splice cannot be placed due to congestion or conflicts of any kind.
 3. Mechanical Splices and terminators shall be installed in accordance with the manufacturer's recommendations.
- E. Additional reinforcement around openings: Additional reinforcement shall be placed around all openings in concrete construction as provided in the Drawings. If no reinforcing is shown in a slab or wall, the Typical Opening Reinforcing shown in the Structural Standard Details shall be required. In the event that the Typical Details do not apply, additional reinforcing equivalent to the cross sectional area of the steel cut by the opening shall be added, equally distributed on all sides. The additional steel shall be extended beyond the limits of the opening a minimum of one development length (straight or hooked).
- F. Minimum reinforcement: If no reinforcing is shown in a slab or wall, the minimum reinforcing shown in the Minimum Wall Reinforcement or Minimum Slab Reinforcement Schedule in the Structural Standard Details shall be required.
- G. Cleaning:
1. Clean steel of mill rust scale, dried concrete, or other coatings that may reduce bond.
 2. Reinforcement reduced in section is not acceptable.
 3. Remove all debris in the placement area prior to concrete placement.
 4. When concrete placement is delayed, special cleaning of reinforcement may be required by the Project Representative.

3.02 TESTING

- A. Demonstrate conformance with the specified requirements for concrete reinforcement and welded rebar by an independent testing laboratory that complies with the requirements of ASTM E329.
- B. The County may elect to also test concrete reinforcement per Section 01 15 00.
- C. The Contractor shall test all welded reinforcement in accordance with Section 05 05 20.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the requirements for cast-in-place reinforced concrete including embedded materials.
- B. This Section specifies the repair of holes, voids, cracks or other defects in existing or new cast-in-place concrete.
- C. All concrete construction shown on the Drawings are to be cast-in-place unless specifically designated as precast, shotcrete, or other.
- D. The requirements specified herein are minimum requirements only and shall not be interpreted as all inclusive. It is the responsibility of the Contractor to employ the necessary practices based on the referenced ACI Standards to ensure the completion of quality concrete construction, of the strengths specified, and free of cracks.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
SPEC 117	Specification for Tolerances for Concrete Construction and Materials and Commentary – American Concrete Institute
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	Specifications for Structural Concrete
ACI 302.1R	Guide for Concrete Floor and Slab Construction
ACI 304.2R	Guide to Placing Concrete by Pumping Methods
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308.1	Specification for Curing Concrete
ACI 309R	Guide for Consolidation of Concrete
ACI 318	Building Code Requirements for Structural Concrete and Commentary
ACI PRC 347.3	Guide to Formed Concrete Surfaces
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C157	Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete

Reference	Title
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1059	Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete
ASTM E1155	Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D4783	Standard Test Methods for Resistance of Adhesive Preparations in Container to Attack by Bacteria, Yeast, and Fungi

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Quality Control Plan.
- C. Qualifications.
- D. Concrete Mix design and verification of mix strength with laboratory testing. Submittal to include proposed weight of each type of fine and course aggregates per cubic yard of concrete, including aggregate gradations for each type selected for a particular concrete mix design, as well as shrinkage test results when shrinkage limitations are specified for particular elements of the structure.
- E. Drawings showing concrete pour layout and lift plans. All construction joints are to be indicated on Drawings.
- F. Submit manufacturer's data on specified products showing compliance with requirements.
- G. Submit manufacturers' data on contractor selected products showing quality and suitability for the application. Contractor selected products are to be standards typically used in the industry for similar applications.
- H. Submit an Environmental Product Declaration (EPD) for each cast-in-place concrete mix design.
- I. Samples: Submit samples of materials as specified.
 - 1. Provide Section 07 44 56 GFRC Fabricator two 12" x 12" samples, cut from job site mockups of cast-in-place concrete panels for color and texture coordination.
- J. Concrete Test Records.
- K. Manufacturer's Installation Instructions: Submit installation procedures and interface required with adjacent construction for concrete accessories.
- L. Defective Concrete Repair Plan.

- M. Project Record Documents per Section 01 78 39, including photos showing all concealed or embedded conduits and other utilities and components.
- N. On a project-wide basis, provide the following:
 - 1. Total cement used, in pounds.
 - 2. Total cement substitutes used, in pounds.

1.04 QUALITY ASSURANCE

- A. Be responsible for controlling the quality of the materials and work.
- B. Obtain services of an independent testing laboratory to perform required tests to document compliance with the Contract requirements.
- C. Perform work of this Section in accordance with the Referenced Standards.
- D. Maintain one copy of each document, including all test reports, on site.
- E. In hot weather follow requirements of ACI 305.1 during placement and finishing of fresh concrete.
- F. In cold weather follow recommendations of ACI 306.1 during placement and finishing of fresh concrete.
- G. Be responsible for results of the cured concrete specified and placed per the requirements of this Section, and perform required repair and remediation to meet the Contract Documents.
- H. Qualifications:
 - 1. Concrete Installer: Experienced in installing and placing concrete for at least two similar Water-Tight Concrete projects in the last five years.
 - 2. Concrete Plant: Concrete plant shall have National Ready Mixed Concrete Association certification.
 - 3. Independent Testing Laboratory shall be certified by Washington Association of Building Officials (WABO).

1.05 MOCK-UP

- A. Construct and erect mock-up panels for all exposed to public view (Architectural Concrete):
 - 1. Panel Size:
 - a. Sufficient to illustrate full range of treatment.
 - b. Otherwise Panel Size to be 6 feet x 6 feet.
- B. Construct and erect mockup of jacketed columns and beams:
 - 1. The mockups shall match the cross sectional dimensions of the existing concrete column or beam, including any slab above the beam, and the reinforcing, including dowels drilled into the existing concrete, that will be used in the jacketed column or beam.
 - 2. The column mockup shall be vertical and at least 15 feet tall and the concrete shall be pumped into a port near the bottom of the jacket form.
 - 3. The beam mockup shall be horizontal and at least 15 feet long and the concrete shall be pumped from a port at one end at the underside of the jacket formwork.
- C. Number of Panels: One panel for each type of formed surface that will be exposed to public view.
- D. Number of column jacket mockups: One mockup.
- E. Number of beam jacket mockups: One mockup.
- F. Locate as directed by the Project Representative.

- G. The mock-up panels and jacketed beam and column sections shall not be incorporated into the finished work. The mock-up shall be properly connected or isolated, as required.
- H. The mock-up panels that are determined to be acceptable by the Project Representative shall be considered the basis for the nature and quality of the finished work. Keep the mock-up panels exposed to view for the duration of the concrete work.
- I. If requested by Project Representative, cast other special concrete mock-up panel. Obtain acceptance of resulting surface finish prior to erecting formwork.

PART 2 PRODUCTS

2.01 FORMWORK

- A. Comply with requirements of Section 03 10 00.

2.02 REINFORCEMENT

- A. Comply with requirements of Section 03 20 00.
- B. Do not use reinforcement having any of the following defects:
 - 1. Bar lengths, depths, or bends exceeding the specified fabricating tolerances.
 - 2. Bends or kinks not indicated on the Drawings or required for this work.
 - 3. Bars with cross-section reduced due to excessive rust or other causes.
- C. Fiber reinforcement when specified: Synthetic fiber shown to have long-term resistance to deterioration when exposed to moisture and alkalis; 1/2 inch length. Submit samples for review and acceptance.

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C595, Type IL – Portland-Limestone.
- B. Normal Weight Fine and Coarse Aggregates: ASTM C33.
- C. Fly Ash: ASTM C618, Class C or F.
- D. Ground Granulated Blast Furnace Slag (GGBF) Slag: ASTM C989, Grade 100 or 120.
- E. Calcined Pozzolan: ASTM C618, Class N.
- F. Water: Clean, free of silts, organics and other compounds detrimental to concrete.

2.04 ADMIXTURES

- A. Air Entrainment Admixture: ASTM C260.
- B. Chemical Admixtures, as required: ASTM C494:
 - 1. Type A - Water Reducing.
 - 2. Type C – Accelerating.
 - 3. Type F – High Range Water Reducing (HRWR) admixture.
 - 4. Type G - Water Reducing, High Range and Retarding.
 - 5. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- C. Shrinkage-compensating/reducing admixture:

1. The following portions of the concrete structure shall be cast with concrete containing the Shrinkage-compensating/reducing admixture:
 - a. Concrete placed around the Formed Suction Inlets.
 - b. Concrete placed in the Morning Glory Weir reconstruction.
 - c. Concrete used as concrete jacketing of beams or columns.
 - d. Concrete used to close or fill openings in wall or slabs.
 - e. Concrete used to abandon any existing sumps.
 - f. Concrete described as infill concrete in the Drawings.
 2. The admixture shall provide the following characteristics:
 - a. Expands at a rate that closely compensates for the shrinkage of the concrete mix.
 - b. Reduces the capillary surface tension of the concrete pore water.
 - c. Provides at least 80% shrinkage reduction at 28 days as measured and documented by field performance.
 - d. Formulated for use in freezing and thawing weather.
 - e. Shall be certified by NSF/ANSI Standard 61: Drinking Water System Components – Health Effects.
 3. Mixing sequence shall be per manufacturer's recommendations.
 4. Minimum Dosage Rate (on a weight basis) of the admixture shall be equal to 5 percent of the weight of Portland-Limestone cement contained in the mix.
 5. Acceptable Manufacturers:
 - a. Premier CPG: PREVent-C.
 - b. Approved Equal.
- D. Antimicrobial Additive:
1. Liquid antimicrobial additive shall be an EPA registered material and the registration number shall be submitted for approval prior to use.
 2. Dosage rate and mixing sequence shall be per manufacturer's recommendations. Include this amount in the total water content of the concrete mix design.
 3. Mix the additive into the concrete mix water to obtain even distribution of the additive throughout the concrete mixture.
 4. Retain two labeled specimens from each production run. One set shall be retained by the Contractor and the other sent to an independent laboratory with experience in the required testing for verification of performance. See Test for Antimicrobial Additive in this Section for Test Procedure to be used to determine if sufficient protection has been achieved with the addition of the antimicrobial additive.
 5. Acceptable Manufacturers:
 - a. Conshield Technologies Inc: ConMICShield.
 - b. ConSeal: ConBlock MIC.
 - c. Approved Equal.
 6. Additive shall be added to structural concrete used for and in the following structures:
 - a. Concrete placed in the Morning Glory Weir reconstruction.

2.05 CONCRETE ACCESSORIES

- A. Reglets: Galvanized steel, 22 gage thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- B. Latex Bonding Agent: Latex Bonding Agent may be used where approved by the Project Representative. Latex Bonding Agent shall comply with the requirements of ASTM C1059, Type II acrylic non-redispersable type.
- C. Epoxy Bonding System: Epoxy resin bonding compounds shall be used for bonding all fresh concrete to hardened concrete unless otherwise noted on the Drawings. Epoxy Bonding Systems shall comply with ASTM C881, Type IV or V as required by project conditions.

- D. Chemical Hardener: Fluosilicate solution or lithium silicate solution designed for densification of cured concrete slabs. The chemical hardener product and applications shall be in accordance with the requirements of ACI 301 Chapter 11 and the manufacturer's recommendations. Submit product data. Acceptable Product: US Spec Permalith, or approved equal.
- E. Curing Materials: Contractor selected method and materials shall be in conformance with the requirements of ACI 301 Section 5.
- F. Evaporation Retardant:
 - 1. Fluorescent color tint that disappears completely upon drying.
 - 2. Manufacturers and Products:
 - a. Master Builder; MasterKure ER 50.
 - b. Euclid Chemical Co., Cleveland, OH; Eucobar.
 - c. Approved Equal.

2.06 JOINT DEVICES AND MATERIALS

- A. Joint Filler: Non-extruding, resilient asphalt impregnated fiberboard or felt, complying with ASTM D1751, 1/4 inch thick and 4 inches deep unless noted otherwise on the Drawings; tongue and groove profile. Submit product data.
- B. Construction Joint Devices: Integral galvanized steel, formed to tongue and groove profile, with removable top strip exposing sealant trough, knockout holes spaced at 6 inches, ribbed steel spikes with tongue to fit top screed edge.
- C. Sealant and Primer: Contractor selected. Submit product data.

2.07 CONCRETE MIX DESIGN

- A. Proportioning Concrete: Comply with ACI 211.1 recommendations.
- B. Required Concrete Class for this Project: (Normal Weight Concrete)
 - 1. All cast-in-place structural concrete unless otherwise indicated: Class 5000 per Table 1.
 - 2. Concrete used for jacketing columns or beams: Class 5000P per table 1.
 - 3. Concrete placed around and below the Formed Suction Inlets: Class 5000P per Table 1.
 - 4. Concrete placed by pumping into any formwork: Class 5000P per Table 1.
 - 5. Electrical Conduit Encasement and Concrete Fill: Class 2500 per Table 1.
 - 6. Sidewalks: Class 5000 per Table 1.
- C. Verification of Concrete Strength: Verify required average strength for each type of concrete on the basis of trial mixtures, as specified in ACI 301:
 - 1. For trial mixtures method, employ an experienced independent testing agency acceptable to Project Representative for testing and reporting proposed mix designs.
 - 2. Admixtures to be used in the concrete mix shall be incorporated into the mix design. For concrete containing the PREVent-C shrinkage reducing admixture, it shall be added in powder form (do not premix with water) after all other admixtures have been added.
- D. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer. Submit product data.
- E. Fiber Reinforcement: If specified, add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions. Submit product data.
- F. Shrinkage Limits: For all Concrete Class 5000 and Class 5000P, the concrete mix shall be proportioned to limit the 28-day (dry-age) shrinkage of the concrete to not exceed 350 micro strain as determined by ASTM C157 prism tests.

1. For concrete mixes containing a shrinkage compensating/reducing admixture, the prism tests may be modified as recommended by the admixture manufacturer if approved by the Project Representative.

G. Concrete Mix Proportions:

Table 1: Concrete Mix Proportions

Concrete Class ^a	Maximum Coarse Aggregate Size (inches)	Minimum Cementitious Material Content ^f (lbs/cubic yard)	Maximum Water to Cementitious Material Ratio	Option 1 ^b Pozzolan (Percent by Weight of Portland-Limestone cement)	Option 2 ^b GGBF Slag (Percent by Weight of Portland-Limestone cement)	Total Air Content ^d (Percent)	Minimum 28 ^{a,c} -day, Design Compressive Strength (psi)	Slump Working Limit Min-Max ^e (inches)
5000	3/4	564	0.40	15-25	15-25	4-6	5,000	2-4
2500	3/4	As designed	0.55	0	0	1-6	2,500	3-5
5000P ^h	3/8	658	0.35	15-25	15-25	1-6	5,000	6-8

Notes:

- a. All course and fine aggregates to be normal weight aggregates. Determine compressive strength at the end of 28 days based on test cylinders made and tested in accordance with ASTM C39. If pozzolan or GGBF slag are utilized, compressive strengths shall be determined at the end of 28 days. Provide admixtures as required by Specification Section 03 30 00, 2.04.
- b. The Contractor has the option of providing concrete with Pozzolan or GGBF Slag as a cement replacement within the limits prescribed on the table.
- c. All concrete shall contain the specified water-reducing admixture or water-reducing-retarding admixture and/or the specified high range water-reducing admixture (superplasticizer). Concrete slabs placed at air temperatures below 50 °F shall contain the specified non-corrosive, non-chloride accelerator. Concrete required to be air entrained shall contain an air-entraining admixture.
- d. Do not air entrain concrete for trowel-finished interior floors and suspended slabs, or exterior base mat or slabs of liquid containing structures. Do not allow entrapped air content to exceed three percent. Exterior concrete surfaces exposed to freezing and thawing or exposed to deicing chemicals shall contain an air entraining agent. Air content shall be measured at the discharge end of the placing nozzle. Air content shall be tested in accordance with ASTM C173.
- e. Slump limits shown are prior to the addition of superplasticizer.
- f. Cementitious material content equals combined weight of Portland-Limestone cement plus either pozzolan or slag.
- g. Concrete mix shall be proportioned to contain a "well graded" combined aggregate package.
- h. Class 5000P shall be used for a pumpable, self-consolidating mix used to pump concrete into wall forms where Class 5000P is indicated on the drawings, column and beam jacketing forms and around and below the new FSIs. Cast-in-place concrete and/or shotcrete shall not be substituted where Class 5000P concrete is required by the specifications or the drawings. A retarding admixture is required for Class 5000P. Class 5000P shall be capable of being pumped, and of flowing through steel reinforcing bar dowels and cages without segregation or buildup of differential head inside or outside of the steel reinforcing cage. Class 5000P shall be capable of flowing within forms and below and along all sides of the FSIs.

2.08 MIXING

- A. Transit Mixers: Comply with ASTM C94. Concrete mixing shall be in accordance with ACI 301.

2.09 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor. Submit product data to Project Representative.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this Section. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.
- B. Place no concrete until all embedded conduits, utilities and other components are recorded on the Record Drawings and a photographic image made to document the item's presence. Submit photographs.

3.02 PREPARATION

- A. Formwork:
 - 1. Verify reveals and other design elements are properly laid out.
 - 2. Verify that forms are clean and free of rust before applying release agent.
 - 3. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.
 - 4. Rigidly close openings in formwork.
 - 5. Support formwork against movement during placement of concrete.
 - 6. Wet wood forms sufficiently to tighten up cracks; wet other material sufficiently to maintain workability of the concrete.
- B. Roughen previously placed concrete to ICRI CSP-5 To CSP-8 and apply bonding agent in accordance with manufacturer's instructions.
- C. Roughen existing concrete to ICRI CSP-5 To CSP-8 and apply bonding agent in accordance with manufacturer's instructions.
- D. In locations where new concrete is doweled to existing work, drill holes of the approved diameter and depth in existing concrete, insert steel rebar dowels and fill annular space with approved epoxy adhesive.

3.03 CONVEYING

- A. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Allow no cold joints to form.
- B. Except for concrete that is pumped into jacketed columns or beams, deposit concrete as nearly as practicable in its final location so as to avoid separation due to dropping, rehandling and flowing.
- C. Do not use concrete which becomes non-plastic and unworkable, or does not meet required quality control limits, or has been contaminated by foreign materials.
- D. Remove concrete from the work site that does not meet specifications.
- E. Unless otherwise noted herein or by any of the Referenced Standards, convey all concrete in accordance with the requirements of ACI 301.

3.04 PLACING AND CONSOLIDATING CONCRETE

- A. Place all concrete in accordance with ACI 301 and ACI 304.2.
- B. Place concrete for floor slabs in accordance with ACI 301 as modified by ACI 302.1R. Unless indicated otherwise, floor slabs shall be placed in alternating sections at each level, with a minimum 7-day delay between the placement of adjoining sections to allow for a portion of drying shrinkage to occur.
- C. Notify Project Representative not less than 24 hours prior to commencement of placement operations.
- D. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement. Ensure all blockouts for openings have been properly located.
- E. Install joint devices in accordance with manufacturer's instructions.
- F. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- G. Apply sealants in joint devices in accordance with Section 07 92 00.
- H. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- I. Place concrete continuously between predetermined expansion, control, and construction joints. Locations of joints shall be as indicated on the Drawings or as approved by the Project Representative. Locations of construction joints proposed by the Contractor shall be submitted for review by the Project Representative. Joints shall be detailed as indicated on the Drawings.
- J. Class 5000P concrete shall be pumped into the formwork at the lowest elevation practicable and shall be pumped to entirely fill the formwork and any voids. External vibration shall be applied to facilitate placement and consolidation around reinforcing.
- K. Screed floors level unless otherwise indicated in the Drawings. Maintain surface flatness complying with ASTM E1155. Minimum requirements are F_F 35/ F_L 25.
- L. Do not interrupt successive placement; do not permit cold joints to occur. If cold joints are required, prepare them with forms, keyway, and waterstop.
- M. Walls exceeding 40 feet in length shall be cast in panels not to exceed 30 feet in length. Where the number of wall panels is three or more, the panels shall be cast in an alternating pattern. A minimum of 7 days shall have elapsed prior to casting of adjoining panels. Joints are not allowed within the lesser of 10 feet or 25 percent of the wall length from any corner unless specifically identified on the Drawings.
- N. Slab panels shall be cast in checkerboard patterns not to exceed 40 feet in length and not to exceed 900 square feet in area, unless indicated otherwise on the Drawings. The ratio of the long side length to the short side length of any panel shall not exceed $1\frac{1}{2}$ to 1. Allow a minimum of 96 hours to elapse between placing adjacent panels unless otherwise approved by the Project Representative.
- O. Reinforcing steel and welded wire fabric shall be continued across construction joints, unless indicated otherwise on the Drawings. Beams, girders and slabs shall not be constructed over columns or walls until at least 72 hours have elapsed to allow for shrinkage and settlement of the concrete in the column or wall. Joints shall be perpendicular to the reinforcement. Waterstops shall be provided in all construction joints below grade and where indicated on the Drawings.
- P. Consolidating Concrete:

1. Consolidate concrete in accordance with ACI 301 and ACI 309R, Chapters 8 and 9. Internal vibration is not required for Class 5000P concrete placed as a self-consolidating concrete in walls, column jackets or beam jackets. External vibration is required for Class 5000P concrete placed in walls, column jackets or beam jackets.
2. Suspend concrete placing if proper consolidation is not being achieved until proper consolidation can be achieved.
3. During and immediately after placing concrete, consolidate the concrete by means of high frequency mechanical internal vibrators.
4. The number of vibrators and size of vibrator heads shall be in accordance with the manufacturer's recommendations for the conditions of the work.
5. Provide a minimum of two, 2-1/2-inch diameter vibrators with the following:
6. Minimum 9,000 impulses per minute; maximum of 12,000 impulses per minute.
7. Minimum amplitude of not less than 0.040-inch; maximum of not less than 0.075-inch.
8. Keep spare vibrators of each size and type at the Site during concrete placing operations.
9. Do not use vibrators to transport concrete within the forms.
10. Insert and withdraw vibrators vertically at 18 to 30 inches apart or between each set of wall ties.
11. Do not place vibrators between reinforcing and form in columns.
12. At each insertion, use sufficient duration to consolidate the concrete, but not to cause segregation or bleeding.
13. Work concrete thoroughly around reinforcement and embedded fixtures and into the corners of forms, eliminating air or aggregate pockets, which may cause honeycombing, pitting, or planes of weakness.
14. If, during placing operation, there is a delay of more than 15 minutes, vibrate into previous lift just prior to placing new concrete.
15. Use and type of vibrator shall conform to ACI 309R.

Q. Tolerances:

1. Walls: In accordance with the requirements of ACI SPEC 117 Section 4.
2. Beams: In accordance with the requirements of ACI SPEC 117 Section 4.
3. Columns: In accordance with the requirements of ACI SPEC 117 Section 4.
4. Slab and Mat Finish Tolerances and Slope Tolerances:
 - a. Floor flatness and Floor levelness measurements shall be made the day after the floor is finished and before shoring is removed to eliminate effects of shrinkage, curing, and deflection.
 - b. Comply with ASTM E1155. Tests shall meet FF and FL values specified in this Section.
 - c. Areas displaying defective conditions shall be repaired as soon as possible in a manner acceptable to the Project Representative.

3.05 CONCRETE FINISHING

- A. Apply evaporation retardant to the exposed surface of concrete slabs that are constructed exterior to the building.
 1. Apply in accordance with the manufacturer's recommendations, do not work into the surface of the concrete.
- B. Repair surface defects, including voids, projections, holes, rock pockets, tie holes and similar defects, that exceed the limits of ACI 301, Section 5.3.3 for Unexposed Form Finish or ACI PRC 347.3 for Exposed Form Finish, immediately after removing formwork.
- C. Unexposed Form Finish: Provide an as-cast finish in accordance with ACI 301, Section 5.3.3 with a Surface Finish SF-2.0.
- D. Interior or Exterior Exposed Form Finish: Provide a finish that meets the following properties as defined in ACI PRC 347.3:
 1. Surface Category: CSC3
 2. Texture: T3
 3. Surface Void Ratio: SVR3
 4. Color Uniformity: CU2

5. Surface Irregularities: SI3
6. Construction and Facing Joint: CJ3
7. Form Facing Category: FC2

E. Concrete Slabs:

1. Steel Trowel finish for concrete slabs:
 - a. Conform to ACI 301, Section 5.3.4.2(c).
 - b. Unless otherwise indicated, provide on floors.
 - c. Finish slabs to the following tolerances:
 - 1) Maintain surface flatness complying with ASTM E 1155. Minimum requirements are F_F 35/ F_L 25.
 - d. Floor surfaces shall not vary more than $\pm 1/8$ -inch from the elevation indicated on the Drawings anywhere on the floor surface, except in areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal, unless otherwise indicated in the Drawings.
 - e. Immediately after final troweling, cure and protect the surface as specified.

F. Fine-broomed Finish shall be applied to all walking surface exterior to the building and where otherwise specified on the Drawings:

1. Conform to ACI 302,1R Section 8.3.11, Guide for Concrete Floor and Slab Construction.
2. Finish slab to the tolerances specified in this Section.
3. Immediately after final troweling, a soft-bristled broom shall be drawn over the surface to create a fine-broomed surface finish. The fine-broomed finish shall match the finish characteristics that were demonstrated in the approved mock-up panel. Following the brooming operation, cure and protect the surface as specified.
4. A minimum of 2 weeks prior to placing any concrete for the slab, provide a mock-up panel demonstrating the fine-broomed finish to be applied to the surface of the slab. Size of the mock-up panel shall be as required by the Project Representative. Minimum size shall be at least 2 feet by 4 feet.

3.06 CURING AND PROTECTION

- A. Comply with requirements of ACI 301 and ACI 308.1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete:
 1. Normal concrete: Not less than 7 days.
 2. High early strength concrete: Not less than 4 days.
- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:
 1. Start initial curing as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 2. Begin final curing after initial curing but before surface is dry.
- E. After completion of curing process, finished surface where indicated shall be protected by use of protection boards from workman, equipment, scaffolding, and any other form of damage throughout subsequent construction. Size, thickness, and material of board shall be determined by Contractor. Contractor is responsible for maintaining integrity of slab finish throughout construction.

3.07 FIELD QUALITY CONTROL

- A. Be responsible for Quality Control of Work for materials, placement, curing, and finishing.

- B. Perform tests of concrete and concrete materials to ensure conformance with specified requirements per ACI 318 and ACI 350. County may perform spot checks. County testing does not relieve the Contractor for quality control and documentation of its Work.
- C. Compressive Strength Tests:
1. ASTM C39.
 2. For each test, mold and cure five concrete test cylinders. Test one cylinder at 7 and 14 days. Test two cylinders at 28 days. Hold one cylinder in reserve.
 3. Obtain test samples for every 100 cu yd or less of each class of concrete placed per day.
 4. Take one additional test cylinder during cold weather concreting cured on the Site under same conditions as concrete it represents.
- D. Air entrainment: Test for entrained air to document compliance with the Specifications; test once for each mix design delivered per day.
- E. Slump Test: Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143.
- F. Test for Antimicrobial Additive: Standard Test Method for Resistance of Treated Cementitious Materials to Attack by Bacteria (Modified ASTM D4783 Standard Test Method for Resistance of Adhesive Preparations in Container to Attack by Bacteria, Yeast and Fungi).
1. Scope:
 - a. This test method is used to determine the resistance of treated cementitious materials, either concrete or mortars, to microbial attack by challenging the test specimen with a bacterial culture.
 2. Summary of Test Method:
 - a. The concrete or mortar specimen is challenged by inoculation with a culture of bacteria. The inoculated specimen is then placed in a closed container and stored at 30 degrees Centigrade for 24 hours. At any point in a series of challenges, if the inoculated specimen shows microbial growth on the streak plate or test surface after 72 hours, the test is discontinued, and the sample specimen is reported as not resistant to attack. If the culture shows no growth, it is reported as resistant to attack and positive for the presence of the anti-microbial agent.
 3. Significance and Use:
 - a. This test method is used to demonstrate whether a cementitious material is sufficiently protected with ConShield® anti-bacterial additive to resist attack by bacteria. This method is patterned after methods cited in ASTM D4783 used by biological laboratories.
 - b. The resistance of Serratia Marcescens bacteria is similar in nature to Thiobacillus Thiooxidans bacteria; however, growth is more rapid and visible without magnification.
 4. Precautions:
 - a. This test method uses live cultures of bacteria. Laboratory personnel should be trained in correct microbiological techniques in order to perform this test in a safe manner.
 5. Sterilization of Equipment and Media:
 - a. Follow accepted microbiological practices for sterilizing equipment and media used for the tests. Sterilize all cultures and contaminated specimens in an approved manner.
 6. Bacterial Cultures:
 - a. The test Microorganism is a twenty-four (24) hour culture of Serratia Marcescens, grown in a nutrient broth at 30 degrees Centigrade to produce an approximate cell count at least 1 times 10⁷ per milliliter (ml). Serratia Marcescens produces a red pigmented colony making it easy to differentiate it from any other contaminating bacteria.
 7. Sample Preparation:
 - a. Test specimens treated with ConShield® anti-bacterial additive and a control sample without ConShield® anti-bacterial additive are washed with water, dried and placed in a closed container with dry ice overnight to adjust the pH of the specimens to create an environment conducive to rapid growth of Serratia Marcescens bacteria.
 8. Test Procedure:
 - a. After the carbon dioxide treatment, a magic marker is used to encircle a test site on a test specimen and on the control sample.

- b. Bacterial preparation: 24 hour *Serratia marcescens* grown on nutrient agar at 30 degrees C.
 - c. A cell suspension is made in distilled water estimated at 1×10^7 .
 - d. A 0.2-0.3 ml cell suspension is placed on the sample surface using a 1 ml pipette and allowed to dry. The samples are then placed in a closed chamber that maintains humidity and is then incubated for 24 hours at 30 degrees C.
 - e. Cell recovery: 0.2-0.3 ml of sterile water is washed over the surface, stirred with a pipette, and then the water is removed and placed on a nutrient agar plate. A sterile cotton swab is brushed over the surface and then used to streak a nutrient agar plate. The plates are incubated for 48 hours at 30 degrees C.
9. Interpretation of the Results:
- a. A positive test results is when there is no growth of *Serratia Marcescens* on the agar plates within a 48 hour period. This demonstrates that the antimicrobial agent was present in the sample in sufficient quantity to kill the indicator microorganism within forty-eight (48) hours. If the culture shows no growth, it is reported as resistant to attack and positive for the presence of ConShield® antibacterial additive
 - b. A negative test is shown by the growth of red colonies of *Serratia Marcescens* on the agar plates. This demonstrates that the antimicrobial agent was not present in the sample in sufficient concentration to kill the indicator microorganism in forty-eight (48) hours. If the inoculated specimen shows microbial growth, the sample specimen is reported as not resistant to attack and negative for the presence of the ConShield® anti-bacterial additive.

3.08 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required surface finish, required lines, details, dimensions, tolerances or other specified requirements.
 - 1. Repair in accordance with the requirements of Section 03 01 32.
 - 2. Repair or replacement of defective concrete as required by the Project Representative. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
 - 3. Crack Repair: Cracks larger than 0.010 inches in width or any cracks allowing leakage shall be repaired using an epoxy injection grouting method and grout type approved by the Project Representative. The cost of Crack Repair shall be borne by the Contractor.
 - a. Remove all grout used to seal the crack for injection or install injection ports or any other grout on the surface, to bare concrete, prior to undertaking further surface preparation work.
 - 4. Submit a repair plan to the Project Representative for patch, fill, touch-up, repair, or replacement of defective concrete. For defects in concrete that may affect the load-carrying capacity of the structure, submit a repair plan for structural repairs to the Project Representative. Structural repairs shall not proceed until approval is obtained from the Project Representative for the proposed repair plan.

END OF SECTION

SECTION 03 37 13

SHOTCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies pneumatically applied shotcrete.
- B. The requirements specified herein are minimum requirements only and shall not be interpreted as all inclusive. It is the responsibility of the Contractor to employ the necessary practices based on the referenced ACI Standards to ensure the completion of quality shotcrete construction, of the strengths specified, and free of cracks.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
PRC-211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 506.2	Specification for Shotcrete
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C1141	Standard Specification for Admixtures for Shotcrete
ASTM C1604	Standard Test Method for Obtaining and Testing Drilled Cores of Shotcrete

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Quality Control Plan.
- C. Qualifications.
- D. Shotcrete Mix design and verification of mix strength with laboratory testing. Submittal to include proposed weight of each type of fine and coarse aggregates per cubic yard of shotcrete, including aggregate gradations for each type selected for a particular shotcrete mix design, as well as shrinkage test results when shrinkage limitations are specified for particular elements of the structure.

- E. Drawings showing shotcrete joint layout and lift plans. All construction joints are to be indicated on drawings.
- F. Method and equipment used to apply, finish, and cure the shotcrete.
- G. Submit manufacturer's data on specified products showing compliance with requirements.
- H. Submit manufacturers' data on contractor selected products showing quality and suitability for the application. Contractor selected products are to be standards typically used in the industry for similar applications.
- I. Samples: Submit samples of materials as specified.
- J. Shotcrete Test Records.
- K. Shotcrete Repair Plan.
- L. Shotcrete repair plan shall be in accordance with the requirements of ACI 506.2, Section 3.9.
- M. On a project-wide basis, provide the following:
 - 1. Total cement used, in pounds.
 - 2. Total cement substitutes used, in pounds.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Submit documentation of the experience and certification of each nozzle operator placing shotcrete:
 - a. All nozzle operators shall have had at least 1 year of experience in the application of shotcrete. Each nozzle operator will be qualified, by the Project Representative, to place shotcrete, after successfully completing one test panel for each shooting position and surface type which will be required for the project.
 - b. Qualification will be based on a visual inspection of the shotcrete density, void structure, and finished appearance of the finished surface, along with attaining the minimum 28-day compressive strength, determined from three cores taken from each test panel. The 28-day core compressive strength shall be tested by the Contractor in accordance with ASTM C1604 except that:
 - 1) The core diameter shall be at least 3.0 times the maximum aggregate size, but not less than 4 inches.
 - 2) The core length shall be a minimum of 2.0 times the core diameter.
 - 3) Cores shall be taken at a minimum distance of 1 inch from edge of core to edge of test panel and a minimum clear distance of 1 inch between them.
 - 4) Test panels shall be sized to meet the core spacing specified above, but in no case shall be smaller than 12 by 12 inch.
 - c. The Contractor shall notify the Project Representative not less than 2 days prior to the shooting of a qualification panel. The mix design for the shotcrete shall be the same as that slated for the wall being shot.
 - d. Shotcrete shall be placed only by personnel qualified by the Project Representative.
 - e. All shotcrete crew members, including the person performing the surface finishing, shall have completed at least three projects in the last 5 years where such finishing of shotcrete was performed.
 - 2. Submit documentation of the experience of the person performing the surface finishing of shotcrete.
- B. Perform Work, testing and repairs in accordance with ACI 506.2.
- C. Be responsible for controlling the quality of the materials and work.

- D. Obtain services of an independent testing laboratory to perform required tests to document compliance with the Contract requirements.

1.05 MOCK-UP

- A. Construct and erect mock-up panels for all shotcrete: Panel Size: Sufficient to illustrate full range of treatment but not less than 6 feet x 6 feet.
- B. Number of Panels: One panel for each type of formed surface that will be exposed to public view.
- C. Locate as directed by the Project Representative.
- D. The mock-up panels shall not be incorporated into the finished work.
- E. The mock-up panels that are determined to be acceptable by the Project Representative shall be considered the basis for the nature and quality of the finished work. Keep the mock-up panels exposed to view for the duration of the shotcrete work.

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Comply with requirements of Section 03 20 00.
- B. Do not use reinforcement having any of the following defects:
 - 1. Bar lengths, depths, or bends exceeding the specified fabricating tolerances.
 - 2. Bends or kinks not indicated on the Drawings or required for this work.
 - 3. Bars with cross-section reduced due to excessive rust or other causes.
- C. Fiber reinforcement:
 - 1. Fibers shall be macro synthetic fibers of deformed polyolefin Type 3 conforming to ASTM C1116.
 - 2. Length: 1 inch to 2.0 inches.
 - 3. Diameter: 0.02 to 0.04 inches.
 - 4. The fibers shall be of a type specifically manufactured for shotcrete.
 - 5. Fibers shall be added to the shotcrete materials at the time the materials are batched for the shotcrete at the rate of 1.5 to 2.0 pounds per cubic yard.
 - 6. Batching and mixing procedures shall be in accordance with the manufacturer's recommendations. Fibers shall be randomly oriented and uniformly distributed throughout the shotcrete.

2.02 SHOTCRETE MATERIALS

- A. Cement: ASTM C595, Type 1L – Portland-Limestone.
- B. Normal Weight Fine and Coarse Aggregates: ASTM C33. Maximum size: 3/8" inch.
- C. Fly Ash: ASTM C618, Class C or F.
- D. Water: Clean, free of silts, organics and other compounds detrimental to shotcrete.

2.03 ADMIXTURES

- A. All shotcrete admixtures: ASTM C1141.
- B. If wet mix process is used, shotcrete shall contain an air-entraining admixture. Admixture shall conform to ASTM C260.

- C. Water-reducing admixture: Conform to ASTM C494, Type A or Type D, except it shall contain no chlorides, and shall be compatible with the air-entraining admixtures. The amount of admixture added to the shotcrete shall be in accordance with the manufacturer's recommendations.
- D. Do not use any admixture that contains chlorides or other corrosive elements.

2.04 BONDING AGENT

- A. Compatible with substrate and subsequent materials.
- B. 28-day Slant Shear Bond Strength: A minimum of 400 psi when tested in accordance with ASTM C882.

2.05 CURING COMPOUND

- A. Membrane Curing Compound: Not detrimental to application of subsequent surface finish materials or coatings. Cure as required for Cast-in-Place Concrete in Section 03 30 00.

2.06 SHOTCRETE MIX DESIGN

- A. Proportioning Shotcrete: Comply with ACI 211.1 recommendations:
 - 1. Shotcrete shall consist of either dry mixed fine aggregate and Portland-Limestone cement pneumatically applied, to which mixture the water is added immediately previous to its expulsion from a nozzle, or mortar premixed by mechanical methods and pneumatically applied through a nozzle onto a prepared foundation.
 - 2. Add admixtures for wet mix process in the batching process. Batch admixtures for dry mix process into the drum or tank of mixing water.
 - 3. Dry mixture shall consist of one-part cement to not more than four and one-half parts of fine aggregate thoroughly mixed in a dry state.
 - 4. Shotcrete shall contain not less than 610 pounds of Portland-Limestone cement per cubic yard, fine aggregate, and water. A maximum of 30% pea gravel by weight may be substituted for the same weight of fine aggregate.
- B. Furnish wet or dry mix design that provides required compaction and low percentage of rebound, is stiff enough not to sag, and conforms to following requirements.
 - 1. Minimum 28-day Compressive Strength per ASTM C109: 5,000 psi.
 - 2. Maximum Aggregate Size: 3/8 inch.
 - 3. Air Entrainment: 5 percent +/- 1%.
 - 4. Chemical Admixture: Conform to ASTM C494.
 - 5. Pozzolan Mineral Admixture: Conform to ASTM C618.
 - 6. Slump: 1 inch, plus or minus 1/2 inch.

2.07 SHOTCRETE COLOR STAIN

- A. The finished shotcrete shall have penetrating stains applied for finishing the shotcrete to match the approved mock-up panel. The stain shall be a single component, water based, thermoplastic acrylic emulsion which carries its color and water repellent protection into the shotcrete.
- B. All shotcrete stains shall be of the same batch and lot and shall be delivered to the application site in original sealed containers clearly marked with the manufacturer's name, brand name, type of material, batch and lot numbers, date of manufacture, and color.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are acceptable and are ready to receive Work.
- B. Verify that field measurements are as indicated on the Drawings.
- C. Verify that fabricated forms are following:
 - 1. Set to line and dimension as indicated on Drawings.
 - 2. Adequately braced against vibration during placement.
 - 3. Constructed to permit escape of air during gunning operations.
 - 4. Constructed to minimize rebound during gunning operations.
- D. Ensure that placement of reinforcement is correct, and that sufficient clearance exists around reinforcement to permit complete encasement.
- E. Ensure easy access to shotcrete surfaces for screeding and finishing, and to permit uninterrupted application.

3.02 PLACING WIRE REINFORCEMENT

- A. Place reinforcement of the shotcrete as shown in the Drawings.
- B. Securely fasten wire reinforcement so that it will be located as shown in the Drawings.
- C. Lap wire reinforcement 1.5 squares in all directions, unless otherwise shown in the Drawings.

3.03 ALIGNMENT CONTROL

- A. Install non-corroding alignment wires and thickness control pins to establish thickness and plane surface. Install alignment wires at corners and offsets not established by formwork.
- B. Ensure that the alignment wires are tight, true to line, and placed to allow further tightening.
- C. Remove the alignment wires after shotcrete construction is complete.

3.04 PREWETTING

- A. Clean and wet cementitious or absorptive substrate surfaces prior to receiving shotcrete.
- B. Keep porous surfaces damp for several hours prior to placement of shotcrete.
- C. Apply bonding agent in accordance with the manufacturer's recommendations.

3.05 SHOTCRETE APPLICATION

- A. A clean, dry supply of compressed air sufficient for maintaining adequate nozzle velocity for all parts for the Work and for simultaneous operation of a blow pipe for cleaning away rebound shall be maintained at all times.
- B. Control thickness, method of support, air pressure, and rate of placement of shotcrete to prevent sagging or sloughing of freshly applied shotcrete.
- C. Apply shotcrete from the lower part of the area upwards. Surfaces to be shot shall be damp, but free of standing water.

- D. For subsequent layers of Shotcrete facia panels sandblast the underlying shotcrete facing to remove laitance and curing compound and then clean by pressure washing prior to application of the bonding agent.
- E. Do not apply shotcrete more than 45 minutes after adding Portland-Limestone cement to mix.
- F. The nozzles shall be held at an angle approximately perpendicular to the working face and at a distance that will keep rebound at a minimum and compaction will be maximized. Shotcrete shall emerge from the nozzle in a steady uninterrupted flow. If, for any reason, the flow becomes intermittent, the nozzle shall be diverted from the Work until a steady flow resumes.
- G. Immediately after placement, protect shotcrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- H. Surface defects:
 - 1. Repair as soon as possible after initial placement of the shotcrete.
 - 2. Remove and replace all shotcrete which lacks uniformity; which exhibits segregation, honeycombing, or lamination; or which contains any dry patches, slugs, voids, or sand pockets to the satisfaction of the Project Representative at no cost to the Owner.
- I. Construction joints:
 - 1. Taper uniformly over a minimum distance of twice the thickness of the shotcrete layer.
 - 2. Clean and thoroughly wet the surface of the joints before adjacent shotcrete is placed.
 - 3. Place shotcrete in a manner that provides a finish with uniform texture and color across the construction joint.
- J. Shotcrete curing:
 - 1. Cure by applying a clear curing compound immediately after final gunning.
 - 2. Apply two coats of curing compound immediately after finishing:
 - a. Application of the second coat shall run at right angles to that of the first.
 - b. The two coats shall total at least one-gallon curing compound per 150 square feet and shall obscure the original color of the Shotcrete.
 - c. Clean off any curing compound spills on construction joints or reinforcing steel before the next shotcrete placement.
 - 3. After placement, shotcrete surfaces shall be cured for at least 7 days.

3.06 SHOTCRETE FINISHING

- A. When the shotcrete facing is an interim coating to be covered by a subsequent shotcrete coating, strike off the surface of the shotcrete facing with a roughened surface. The grooves of the roughened surface shall be either vertical or horizontal.
- B. When the shotcrete facing provides the finished exposed final surface, the shotcrete face shall be finished as follows:
 - 1. Apply shotcrete in a thickness a fraction beyond the alignment wires and forms.
 - 2. The shotcrete shall stiffen to the point where the surface does not pull or crack when screed with a rod or trowel.
 - 3. Trim, slice or scrape excess material to true lines and grade.
 - 4. Remove alignment wires.
 - 5. Provide a Smooth Rubbed Finish as described in Specification Section 03 30 00, 3.05, C, 1.
 - 6. Surface tolerance: Match the surface tolerances for cast-in-place concrete as described in Specification Section 03 30 00, 3.04, P.

3.07 FIELD QUALITY CONTROL

- A. Be responsible for Quality Control of Work and testing for materials, conformance with the specifications, placement, curing, and finishing.
- B. Perform tests of shotcrete and shotcrete materials to ensure conformance with specified requirements. County may perform spot checks. County testing does not relieve the Contractor for quality control and documentation of its Work.
- C. Production Compressive Strength Tests:
 - 1. Test the 28-day core compressive strength in accordance with ASTM C1604 for each section of shotcrete facing shot, except that:
 - a. The core diameter shall be at least 3.0 times the maximum aggregate size, but not less than 4 inches.
 - b. The core length shall be a minimum of 2.0 times the core diameter.
 - c. Cores shall be taken at a minimum distance of 1 inch from edge of core to edge of test panel and a minimum clear distance of 1 inch between them.
 - d. Test panels shall be sized to meet the core spacing specified above, but in no case shall be smaller than 12 by 12 inch.
 - 2. For each test, take three cores. All three cores shall achieve the specified 28-day strength.
- D. Air entrainment: Test for entrained air to document compliance with the Specifications; test once for each mix design delivered per day.
- E. Repair or replace the section(s) of wall if the production shotcrete is found to be unsuitable based on the results of the test panels to the satisfaction of the Project Representative at no additional cost to the Owner.

END OF SECTION

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies non-shrink cementitious grout and epoxy grout for use in applications including but not limited to grouts for leveling machine bases to equipment pads, grouting blockouts for gate guides and grouting under base plates. Epoxy adhesives for concrete applications including, but not limited to pressure injection of cracks and reinforcing bar dowels.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C40	Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C595	Standard Specification for Portland-Limestone cement
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C882	Standard Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
CRD-C-621	Corps of Engineers Specification for Non-shrink Grout

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's Data for the following:
1. Non-shrink cementitious grout.
 2. Epoxy grout.
 3. Super low-viscosity epoxy resin
 4. Adhesive for pressure injection of cracks.
 5. Adhesive for doweling.
 6. Retardants.
 7. Bonding compounds.

- C. Certified Test Reports: Before delivery of materials or grout, submit certified reports of the tests specified herein. Accompany the certified reports on previously tested materials with the manufacturer's certified statement that the previously tested material is of the same type, quality, manufacture, and make as that proposed for use in this Contract. Certified test reports are required for all non-shrink cementitious grout constituents, including cement and aggregates.
- D. On a project-wide basis, provide the following:
 - 1. Total cement used, in pounds.
 - 2. Total cement substitutes used, in pounds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Grout mixes and admixtures shall not contain more than 0.05 percent chloride ions.
- B. Water for washing aggregate, for mixing, and for curing:
 - 1. Shall be free from oil and deleterious amounts of acids, alkalis, and organic materials.
 - 2. Shall not contain more than 1,000 mg/L of chlorides as Cl, nor more than 1,300 mg/L of sulfates as SO₄.
 - 3. Shall not contain an amount of impurities that may cause a change of more than 25 percent in the setting time of the cement nor a reduction of more than 5 percent in the compressive strength of the grout at 14 days when compared with the result obtained with distilled water.
 - 4. Water used for curing shall not contain an amount of impurities sufficient to discolor the grout.

2.02 GROUT

- A. Use grout specified on the Drawings or as specified in the equipment recommendations.
- B. Non-shrink cementitious grout:
 - 1. Non-shrink cementitious grout that conforms to ASTM C1107, CRD-C-621, "Corps of Engineers Specification for Non-Shrink Grout", and the following requirements:
 - a. Non-metallic nongas-liberating aggregate.
 - b. Prepackaged natural aggregate grout requiring only the addition of water.
 - c. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
 - d. Test in accordance with ASTM C1107/C1107M:
 - 1) Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
 - 2) Temperatures of 40 degrees F, 80 degrees F, and 90 degrees F.
 - e. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
 - f. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
 - g. Maintain fluid consistency when mixed in 1 yard to 9 yard loads in ready-mix truck.
- C. Epoxy Grout:
 - 1. Multi-component, 100 percent solids compound conforming to the following requirements:
 - a. Suitable for use on dry or damp surfaces.
 - b. Comply with ASTM C881:
 - 1) Grade 1: For low viscosity uses.
 - 2) Grade 2: For medium viscosity uses.
 - 3) Grade 3: For non-sag uses.
 - 4) Class A: For use below 40 degrees F.
 - 5) Class B: For use between 40-60 degrees F.
 - 6) Class C: For use above 60 degrees F.
 - 7) Type V: For bonding fresh concrete to hardened concrete.

- D. Admixtures:

1. Admixtures shall be compatible with the grout and shall conform to the following requirements:
 - a. Calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.
 - b. Use admixtures in accordance with the manufacturer's recommendations and add separately to the grout mix.
 - c. Chemical admixtures for flowing concrete grout shall comply with ASTM C1017.
 - d. Water reducing, retarding admixture:
 - 1) The admixture shall comply with ASTM C494 Type D requirements and not contain more chloride ions than are present in municipal drinking water.
 - 2) Lubricant for cement pressure grouting:
 - a) Acceptable manufacturer:
 - (1) Sika Corp.
 - (2) Specrete-IP, Inc.
 - (3) Muhu Construction Materials, Ltd.
 - (4) Approved Equal.

2.03 ADHESIVES

- A. Adhesive for pressure injection of cracks in concrete:
 1. A two-component, moisture tolerant, low viscosity, liquid epoxy adhesive conforming to ASTM C881 for load-bearing applications:
 - a. Grade 1: For low viscosity uses.
 - b. Class A: For use below 40 degrees F.
 - c. Class B: For use between 40-60 degrees F.
 - d. Class C: For use above 60 degrees F.
 - e. Type V: All pressure injection.
- B. Adhesive for filling space below and around the Morning Glory stainless steel insert.
 1. A two-component, moisture tolerant, super low viscosity, liquid epoxy resin conforming to ASTM C881 for load-bearing applications:
 - a. Grade 1
 - 1) Viscosity less than 200 CPS at 75 degrees F.
 - b. Class C (except for gel time)
 - c. Type I or II
 2. 28 day compressive strength greater than 10,000 psi at all temperatures above 40 degrees F.
 3. Tensile Adhesion Strength hardened concrete to steel, 1,500 psi minimum as determined in accordance with ASTM C882
 4. Tack-Free Cure Time: 2.5 hours minimum for all temperatures greater than 90 degrees F.
 5. Acceptable product:
 - a. Sikadur 55 SLV
 - b. Kemko 186
 - c. or approved equal.
- C. Adhesive for doweling reinforcing bars in concrete:
 1. Epoxy adhesive used for anchoring reinforcing bar dowels shall have an ICC Evaluation Service Report (ESR) indicating compliance with the requirements of IBC for use in cracked and uncracked concrete for the anchor type and concrete strength conditions for which the anchor will be used. The ESR shall indicate IBC compliance for use under seismic loading conditions. The basis of the ESR shall be Post-Installed Adhesive Anchors in Concrete Elements (AC308).
 2. Do not use where fire or elevated temperatures exceeding 150 degrees F can occur, unless specifically shown otherwise.
 3. Epoxy adhesive used for anchoring reinforcing bar dowels installed horizontally or upwardly inclined shall be qualified in accordance with ACI 355.4 requirements for sensitivity to installation direction.
 4. Epoxy Adhesive:
 - a. Meet ASTM C881, Type 1, Grade 3, Class A, B, or C.

- b. Two-component, 100 percent solids, non-sag, paste, insensitive to moisture, designed to be used in adverse freeze/thaw environments, and gray in color. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
- 5. Mixed Epoxy Adhesive: Non-sag paste consistency holding the following properties:
 - a. Slant Shear Strength, ASTM C881 and ASTM C882, No Failure in Bond Line, Dry/Moist Conditions: 5,000 psi.
 - b. Compressive Strength, ASTM D695: 14,000 psi minimum.
 - c. Tensile Strength, ASTM D695: 4,500 psi.
 - d. Heat Deflection Temperature, ASTM D648: 135 degrees F, minimum.
- 6. Epoxy Adhesive Packaging:
 - a. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio and fit into a manually or pneumatically operated caulking gun.
 - b. Dispense components through a mixing nozzle that thoroughly mixes components and places epoxy at base of predrilled hole.
 - c. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate sizes of anchor rods.
 - d. Cartridge Markings: Include manufacturer's name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- 7. Storage of Epoxy adhesive:
 - a. Store epoxy cartridges on pallets or shelving in a covered storage area.
 - b. Control temperature above 60 degrees F and dispose of cartridges if shelf life has expired. If stored at temperatures below 60 degrees F, test adhesive prior to use to determine if adhesive meets specified requirements.
- 8. Acceptable manufacturers:
 - a. Simpson Strong Tie, "Set-XP".
 - b. Hilti, "HIT-RE 500 V3".
 - c. DeWALT, "Pure110+".
 - d. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Mix, place and cure in accordance with the manufacturer's instructions.
- B. For grouting of equipment base plates, refer to manufacturer's instructions for appropriate procedures.
- C. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and all loose material or foreign matter likely to affect the bond or performance of grout or mortar.
- D. Inspect base plate and anchor systems for rust, oil, and other deleterious substances that may affect the bond or performance of grout.
- E. Confirm that newly placed concrete has been cured sufficiently to attain its design strength and limit further shrinkage.
- F. Verify that temperature of non-shrink cementitious or epoxy grout does not exceed manufacturer's recommendations.
- G. Non-shrink cementitious grout to be placed around and below the SST Morning Glory Discharge box shall be of a consistency and time of set that permits the grout to flow completely into place, filling all voids.

3.02 PREPARATION

- A. Surface Preparation:

1. Roughen all concrete surfaces by heavy sandblasting, chipping, or other mechanical means to ICRI CSP-5 To CSP-8 and apply bonding agent in accordance with manufacturer's instructions. Loose or broken concrete shall be removed.
 2. All grease, oil, dirt, curing compounds, laitance, and other deleterious materials that may affect bond that were identified in the inspection process shall be completely removed from concrete and bottoms of base plates. All metal surfaces should have a 2 to 3 mil peak-to-valley profile for epoxy grouts.
 3. For non-shrink cementitious grouts, concrete shall be saturated surface damp. Any standing water shall be removed prior to placing grouts.
 4. For epoxy grouts, do not wet concrete surfaces with water. Instead, where required, wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grouts.
- B. Forms and Headboxes for Non-Shrink Cementitious or Epoxy Grouts:
1. Forms for grouts shall be built of material with adequate strength to withstand the placement of grouts.
 2. Forms shall be rigid and liquid tight. All cracks and joints shall be caulked with an elastomeric sealant. All forms shall be lined with polyethylene for easy grout release. Forms carefully waxed with two coats of heavy-duty paste wax shall also be acceptable.
 3. Forms shall be 4 to 6 inches higher than the base plate on one side of the base plate configuration when using head pressure for placement.
 4. A sufficient number of headboxes shall be built to facilitate placement of grouts.
 5. Air relief holes a minimum 1/8 inch in diameter shall be provided when required by a base plate configuration to avoid entrapping air underneath.

3.03 NON-SHRINK CEMENTITIOUS GROUT

- A. Prepare concrete surfaces in accordance with the grout manufacturer's instructions.
- B. Do not retemper grout by adding more water after stiffening.

3.04 EPOXY GROUT

- A. Prime concrete in accordance with the grout manufacturer's instructions.
- B. Epoxy grouts shall be mixed in complete units. Do not vary the ratio of components or add solvent to change the consistency of the mix.
- C. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in the mix.

3.05 PRESSURE INJECTION OF CRACKS

- A. Design system to permit injection of adhesive resin at pressures up to 50 psi.
- B. Injection Equipment:
1. Include a mixer and holdover agitator tanks.
 2. Provide gages to indicate pressure used.
 3. Provide a meter capable of indicating the volume of grout used to 1/10 of a cubic foot.

3.06 DOWEL INSTALLATION

- A. Install per adhesive manufacturer's instructions.
- B. Obstructions in Drill Path:
1. Locate holes in existing concrete to miss existing reinforcing. Prior to drilling holes, field verify and mark the location of existing reinforcing using a pachometer or other approved locating equipment.

2. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction. Drill shall not be slanted more than 10 degrees. Where slanting the drill does not resolve the conflict the Contractor shall stop and notify the Project Representative and resolve the conflict to the satisfaction of the Project Representative. For threaded anchor rods intended to be installed plumb, drilled holes shall not be slanted unless approved by Project Representative prior to drilling the holes. For threaded anchor rods that encounter an obstruction, the solution shall be one approved by the Project Representative.
3. Abandoned dowel or anchor holes shall be completely filled with non-shrink grout and struck off flush with the adjacent surface.

3.07 CURING

- A. Non-Shrink Cementitious Grouts:
 1. Clean equipment and tools as recommended by the grout manufacturer.
 2. Cure Non-Shrink Cementitious Grouts in accordance with manufacturer's specifications and recommendations. Keep Non-Shrink Cementitious Grouts moist for a minimum of 3 days. The method needed to protect Non-Shrink Cementitious Grouts will depend on temperature, humidity, and wind. Wet burlap, a soaker hose, sun shading, ponding, and, in extreme conditions, a combination of methods shall be employed.
 3. Non-Shrink Cementitious Grouts shall be maintained above 40 degrees Fahrenheit until they have attained a compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for a minimum of 24 hours to avoid damage from subsequent freezing.
- B. Epoxy Grouts:
 1. Cure epoxy grouts in accordance with manufacturers' specifications and recommendations. Do not wet cure epoxy grouts.
 2. Consult the manufacturer for appropriate cure schedule. In no case should any surface in contact with epoxy grout be allowed to fall below 50 degrees Fahrenheit for a minimum of 48 hours after placement.

3.08 TESTING

- A. To ensure compliance with the specified requirements for grouts, provide the services of an independent testing laboratory that complies with the requirements of ASTM E329, ASTM C109, and ASTM C579, Method B. See Section 01 15 00.
- B. The testing laboratory will sample and test grout materials and submit results to the Project Representative.
- C. During the course of construction, the Project Representative may take separate field samples of the following materials for confirming tests:
 1. Cement.
 2. Aggregates.
 3. Cementitious grout mixture.
 4. Commercially manufactured grout products.

END OF SECTION

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies non-shrink cementitious grout and epoxy grout for use in applications including but not limited to grouts for leveling machine bases to equipment pads, grouting blockouts for gate guides and grouting under base plates. Epoxy adhesives for concrete applications including, but not limited to pressure injection of cracks and reinforcing bar dowels.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C40	Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C595	Standard Specification for Portland-Limestone cement
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C882	Standard Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
CRD-C-621	Corps of Engineers Specification for Non-shrink Grout

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's Data for the following:
1. Non-shrink cementitious grout.
 2. Epoxy grout.
 3. Super low-viscosity epoxy resin
 4. Adhesive for pressure injection of cracks.
 5. Adhesive for doweling.
 6. Retardants.
 7. Bonding compounds.
- C. Certified Test Reports: Before delivery of materials or grout, submit certified reports of the tests specified herein. Accompany the certified reports on previously tested materials with the

manufacturer's certified statement that the previously tested material is of the same type, quality, manufacture, and make as that proposed for use in this Contract. Certified test reports are required for all non-shrink cementitious grout constituents, including cement and aggregates.

- D. On a project-wide basis, provide the following:
1. Total cement used, in pounds.
 2. Total cement substitutes used, in pounds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Grout mixes and admixtures shall not contain more than 0.05 percent chloride ions.
- B. Water for washing aggregate, for mixing, and for curing:
1. Shall be free from oil and deleterious amounts of acids, alkalis, and organic materials.
 2. Shall not contain more than 1,000 mg/L of chlorides as Cl, nor more than 1,300 mg/L of sulfates as SO₄.
 3. Shall not contain an amount of impurities that may cause a change of more than 25 percent in the setting time of the cement nor a reduction of more than 5 percent in the compressive strength of the grout at 14 days when compared with the result obtained with distilled water.
 4. Water used for curing shall not contain an amount of impurities sufficient to discolor the grout.

2.02 GROUT

- A. Use grout specified on the Drawings or as specified in the equipment recommendations.
- B. Non-shrink cementitious grout:
1. Non-shrink cementitious grout that conforms to ASTM C1107, CRD-C-621, "Corps of Engineers Specification for Non-Shrink Grout", and the following requirements:
 - a. Non-metallic nongas-liberating aggregate.
 - b. Prepackaged natural aggregate grout requiring only the addition of water.
 - c. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
 - d. Test in accordance with ASTM C1107/C1107M:
 - 1) Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
 - 2) Temperatures of 40 degrees F, 80 degrees F, and 90 degrees F.
 - e. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
 - f. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
 - g. Maintain fluid consistency when mixed in 1 yard to 9 yard loads in ready-mix truck.
- C. Epoxy Grout:
1. Multi-component, 100 percent solids compound conforming to the following requirements:
 - a. Suitable for use on dry or damp surfaces.
 - b. Comply with ASTM C881:
 - 1) Grade 1: For low viscosity uses.
 - 2) Grade 2: For medium viscosity uses.
 - 3) Grade 3: For non-sag uses.
 - 4) Class A: For use below 40 degrees F.
 - 5) Class B: For use between 40-60 degrees F.
 - 6) Class C: For use above 60 degrees F.
 - 7) Type V: For bonding fresh concrete to hardened concrete.
- D. Admixtures:
1. Admixtures shall be compatible with the grout and shall conform to the following requirements:
 - a. Calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

- b. Use admixtures in accordance with the manufacturer's recommendations and add separately to the grout mix.
- c. Chemical admixtures for flowing concrete grout shall comply with ASTM C1017.
- d. Water reducing, retarding admixture:
 - 1) The admixture shall comply with ASTM C494 Type D requirements and not contain more chloride ions than are present in municipal drinking water.
 - 2) Lubricant for cement pressure grouting:
 - a) Acceptable manufacturer:
 - (1) Sika Corp.
 - (2) Specrete-IP, Inc.
 - (3) Muhu Construction Materials, Ltd.
 - (4) Approved Equal.

2.03 ADHESIVES

- A. Adhesive for pressure injection of cracks in concrete:
 - 1. A two-component, moisture tolerant, low viscosity, liquid epoxy adhesive conforming to ASTM C881 for load-bearing applications:
 - a. Grade 1: For low viscosity uses.
 - b. Class A: For use below 40 degrees F.
 - c. Class B: For use between 40-60 degrees F.
 - d. Class C: For use above 60 degrees F.
 - e. Type V: All pressure injection.
- B. Adhesive for filling space below and around the Morning Glory stainless steel insert.
 - 1. A two-component, moisture tolerant, super low viscosity, liquid epoxy resin conforming to ASTM C881 for load-bearing applications:
 - a. Grade 1
 - 1) Viscosity less than 200 CPS at 75 degrees F.
 - b. Class C (except for gel time)
 - c. Type I or II
 - 2. 28 day compressive strength greater than 10,000 psi at all temperatures above 40 degrees F.
 - 3. Tensile Adhesion Strength hardened concrete to steel, 1,500 psi minimum as determined in accordance with ASTM C882
 - 4. Tack-Free Cure Time: 2.5 hours minimum for all temperatures greater than 90 degrees F.
 - 5. Acceptable product:
 - a. Sikadur 55 SLV
 - b. Kemko 186
 - c. or approved equal.
- C. Adhesive for doweling reinforcing bars in concrete:
 - 1. Epoxy adhesive used for anchoring reinforcing bar dowels shall have an ICC Evaluation Service Report (ESR) indicating compliance with the requirements of IBC for use in cracked and uncracked concrete for the anchor type and concrete strength conditions for which the anchor will be used. The ESR shall indicate IBC compliance for use under seismic loading conditions. The basis of the ESR shall be Post-Installed Adhesive Anchors in Concrete Elements (AC308).
 - 2. Do not use where fire or elevated temperatures exceeding 150 degrees F can occur, unless specifically shown otherwise.
 - 3. Epoxy adhesive used for anchoring reinforcing bar dowels installed horizontally or upwardly inclined shall be qualified in accordance with ACI 355.4 requirements for sensitivity to installation direction.
 - 4. Epoxy Adhesive:
 - a. Meet ASTM C881, Type 1, Grade 3, Class A, B, or C.
 - b. Two-component, 100 percent solids, non-sag, paste, insensitive to moisture, designed to be used in adverse freeze/thaw environments, and gray in color. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
 - 5. Mixed Epoxy Adhesive: Non-sag paste consistency holding the following properties:

- a. Slant Shear Strength, ASTM C881 and ASTM C882, No Failure in Bond Line, Dry/Moist Conditions: 5,000 psi.
- b. Compressive Strength, ASTM D695: 14,000 psi minimum.
- c. Tensile Strength, ASTM D695: 4,500 psi.
- d. Heat Deflection Temperature, ASTM D648: 135 degrees F, minimum.
6. Epoxy Adhesive Packaging:
 - a. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio and fit into a manually or pneumatically operated caulking gun.
 - b. Dispense components through a mixing nozzle that thoroughly mixes components and places epoxy at base of predrilled hole.
 - c. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate sizes of anchor rods.
 - d. Cartridge Markings: Include manufacturer's name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
7. Storage of Epoxy adhesive:
 - a. Store epoxy cartridges on pallets or shelving in a covered storage area.
 - b. Control temperature above 60 degrees F and dispose of cartridges if shelf life has expired. If stored at temperatures below 60 degrees F, test adhesive prior to use to determine if adhesive meets specified requirements.
8. Acceptable manufacturers:
 - a. Simpson Strong Tie, "Set-XP".
 - b. Hilti, "HIT-RE 500 V3".
 - c. DeWALT, "Pure110+".
 - d. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Mix, place and cure in accordance with the manufacturer's instructions.
- B. For grouting of equipment base plates, refer to manufacturer's instructions for appropriate procedures.
- C. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and all loose material or foreign matter likely to affect the bond or performance of grout or mortar.
- D. Inspect base plate and anchor systems for rust, oil, and other deleterious substances that may affect the bond or performance of grout.
- E. Confirm that newly placed concrete has been cured sufficiently to attain its design strength and limit further shrinkage.
- F. Verify that temperature of non-shrink cementitious or epoxy grout does not exceed manufacturer's recommendations.
- G. Non-shrink cementitious grout to be placed around and below the SST Morning Glory Discharge box shall be of a consistency and time of set that permits the grout to flow completely into place, filling all voids.

3.02 PREPARATION

- A. Surface Preparation:
 1. Roughen all concrete surfaces by heavy sandblasting, chipping, or other mechanical means to ICRI CSP-5 To CSP-8 and apply bonding agent in accordance with manufacturer's instructions. Loose or broken concrete shall be removed.
 2. All grease, oil, dirt, curing compounds, laitance, and other deleterious materials that may affect bond that were identified in the inspection process shall be completely removed from concrete and

bottoms of base plates. All metal surfaces should have a 2 to 3 mil peak-to-valley profile for epoxy grouts.

3. For non-shrink cementitious grouts, concrete shall be saturated surface damp. Any standing water shall be removed prior to placing grouts.
 4. For epoxy grouts, do not wet concrete surfaces with water. Instead, where required, wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grouts.
- B. Forms and Headboxes for Non-Shrink Cementitious or Epoxy Grouts:
1. Forms for grouts shall be built of material with adequate strength to withstand the placement of grouts.
 2. Forms shall be rigid and liquid tight. All cracks and joints shall be caulked with an elastomeric sealant. All forms shall be lined with polyethylene for easy grout release. Forms carefully waxed with two coats of heavy-duty paste wax shall also be acceptable.
 3. Forms shall be 4 to 6 inches higher than the base plate on one side of the base plate configuration when using head pressure for placement.
 4. A sufficient number of headboxes shall be built to facilitate placement of grouts.
 5. Air relief holes a minimum 1/8 inch in diameter shall be provided when required by a base plate configuration to avoid entrapping air underneath.

3.03 NON-SHRINK CEMENTITIOUS GROUT

- A. Prepare concrete surfaces in accordance with the grout manufacturer's instructions.
- B. Do not retemper grout by adding more water after stiffening.

3.04 EPOXY GROUT

- A. Prime concrete in accordance with the grout manufacturer's instructions.
- B. Epoxy grouts shall be mixed in complete units. Do not vary the ratio of components or add solvent to change the consistency of the mix.
- C. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in the mix.

3.05 PRESSURE INJECTION OF CRACKS

- A. Design system to permit injection of adhesive resin at pressures up to 50 psi.
- B. Injection Equipment:
 1. Include a mixer and holdover agitator tanks.
 2. Provide gages to indicate pressure used.
 3. Provide a meter capable of indicating the volume of grout used to 1/10 of a cubic foot.

3.06 DOWEL INSTALLATION

- A. Install per adhesive manufacturer's instructions.
- B. Obstructions in Drill Path:
 1. Locate holes in existing concrete to miss existing reinforcing. Prior to drilling holes, field verify and mark the location of existing reinforcing using a pachometer or other approved locating equipment.
 2. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction. Drill shall not be slanted more than 10 degrees. Where slanting the drill does not resolve the conflict the Contractor shall stop and notify the Project Representative and resolve the conflict to the satisfaction of the Project Representative. For threaded anchor rods intended to be installed plumb, drilled holes shall not be slanted unless approved by Project Representative prior to drilling the holes. For threaded anchor rods that encounter an obstruction, the solution shall be one approved by the Project Representative.

3. Abandoned dowel or anchor holes shall be completely filled with non-shrink grout and struck off flush with the adjacent surface.

3.07 CURING

- A. Non-Shrink Cementitious Grouts:
 1. Clean equipment and tools as recommended by the grout manufacturer.
 2. Cure Non-Shrink Cementitious Grouts in accordance with manufacturer's specifications and recommendations. Keep Non-Shrink Cementitious Grouts moist for a minimum of 3 days. The method needed to protect Non-Shrink Cementitious Grouts will depend on temperature, humidity, and wind. Wet burlap, a soaker hose, sun shading, ponding, and, in extreme conditions, a combination of methods shall be employed.
 3. Non-Shrink Cementitious Grouts shall be maintained above 40 degrees Fahrenheit until they have attained a compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for a minimum of 24 hours to avoid damage from subsequent freezing.
- B. Epoxy Grouts:
 1. Cure epoxy grouts in accordance with manufacturers' specifications and recommendations. Do not wet cure epoxy grouts.
 2. Consult the manufacturer for appropriate cure schedule. In no case should any surface in contact with epoxy grout be allowed to fall below 50 degrees Fahrenheit for a minimum of 48 hours after placement.

3.08 TESTING

- A. To ensure compliance with the specified requirements for grouts, provide the services of an independent testing laboratory that complies with the requirements of ASTM E329, ASTM C109, and ASTM C579, Method B. See Section 01 15 00.
- B. The testing laboratory will sample and test grout materials and submit results to the Project Representative.
- C. During the course of construction, the Project Representative may take separate field samples of the following materials for confirming tests:
 1. Cement.
 2. Aggregates.
 3. Cementitious grout mixture.
 4. Commercially manufactured grout products.

END OF SECTION

SECTION 03 83 00

CONCRETE BREAKING, CUTTING AND PATCHING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the requirements and limitations for breaking, cutting, drilling, core drilling, hydrodemolition, and patching of work, including but not limited to the following:
1. Saw-cutting new rectangular openings in existing concrete slabs and walls.
 2. Core drilling new circular openings in existing concrete slabs and walls.
 3. Chipping existing concrete to provide for construction of new concrete and/or placement of new patching material for building up or resurfacing of existing concrete.
 4. Breaking concrete by means of non-explosive expansive demolition grout.
 5. Breaking concrete by means of hydraulic concrete splitters.
 6. Breaking concrete by means of jackhammers.
 7. Removal of concrete by high pressure hydrodemolition.
 8. Providing support for the cored and/or sawcut concrete, and removal and disposal of the broken, cored and/or sawed concrete, control of drilling water and cleaning all slurry and debris that results from the operations.
 9. Protecting existing reinforcing bars that are beyond the limits of the intended removal.
 10. Protecting existing reinforcing bars that are to be incorporated into new construction by embedment, splicing or coupling with new reinforcing bars.
 11. Cutting of existing reinforcing bars and/or anchors and patching over locations where bars have been cut.
 12. Preparation of concrete surface to receive new patching material and installation of new patching material.
 13. Breaking concrete by explosive means, of any type, is not permitted.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ACI 117	Standard Tolerances for Concrete Construction and Materials
International Concrete Repair Institute (ICRI)	110.1 - Guide Specifications for Structural Concrete Repairs

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Submit written request in advance of breaking, cutting, drilling, coring or altering elements which affects the following:
1. Structural integrity of the element.
 2. Integrity of weather exposed or moisture-resistant elements.
 3. Visual qualities of elements exposed to sight.
 4. Operations of the facility.
 5. County staff ability to access areas and operate and maintain equipment.
- C. Breaking, cutting, coring, drilling, hydrodemolition, and patching proposal:
1. Submit a proposal describing procedures at least 2 weeks before the time the work will be performed, requesting approval to proceed. Include the following information:

- a. Extent: At each occurrence indicated on the Drawings, describe the work, show how they will be performed, and indicate what construction equipment will be employed to complete the work, and equipment to be used to locate embedded reinforcing bars, pipe, and conduits.
- b. Products: List products to be used and firms or entities that will perform the work.
- c. Dates: Indicate when the work will be performed.
- d. Utility services and mechanical/electrical systems: List services/systems that the work will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
- e. Method to contain and control water, spoils and debris.
- f. Method to contain, control, and dispose of rebound and spray from hydrodemolition.
- g. Method to support and remove concrete and debris.
- h. Project Representative's review: Obtain review of proposal before undertaking the work.

1.04 QUALITY ASSURANCE

- A. Qualifications: Employ skilled and experienced installer to perform breaking, cutting, drilling, coring, hydrodemolition and patching work. Contractor performing the work shall have at least 3 years prior experience performing similar work.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Acceptable products for patching and/or resurfacing of damaged surface areas on existing concrete slabs and/or defective and non-conforming work:
 - 1. Concrete surface repair products identified in Section 03 01 32.
 - 2. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Execute breaking, cutting, coring, drilling, hydrodemolition, and patching to complete the work and to:
 - 1. Fit several parts together, to integrate with other work.
 - 2. Provide openings in elements of work for new penetrations.
 - 3. Provide openings in existing concrete for removal of existing and installation of the new Formed Suction Inlets.
 - 4. Remove and replace existing concrete at the Morning Glory Discharge Structure Top Slabs.
 - 5. Remove existing equipment or housekeeping pads.
 - 6. Restore existing surfaces exposed by removal of work.
 - 7. Uncover work to install or replace ill-timed work.
 - 8. Remove and replace defective and non-conforming work.
 - 9. Sawcut completely through at locations where existing reinforcement is not shown to be incorporated into or spliced with new reinforcement of new construction.
 - 10. Sawcut $\frac{3}{4}$ " deep on both faces, to provide a neat straight edge at limits of new construction shown on the contract drawings where the existing reinforcement is to be incorporated into new construction by embedment, splicing or coupling with new reinforcing bars. Expose existing reinforcement to be incorporated into the new construction by chipping or hydrodemolition.
- B. Execute work by methods which will avoid damage to other work, avoid excessive vibration (excessive vibration is vibration that interferes with the operation of existing plant equipment or operation), prevent microcracking of remaining concrete, and provide proper surfaces to receive patching and finishing. Inspect all cut surfaces to ensure that no electrical conduits or other piping (air, water, etc.) has been cut during the cutting operation. Report any issues to the Project Representative immediately. For patching of existing concrete surfaces, comply with applicable recommendations of patching material manufacturer and ICRI 110.1 Guide Specifications for Structural Concrete Repair, including preparation

and roughening of the surface to receive the new material, and curing of the new material after it has been placed. As a minimum, conform to tolerances listed in ACI 117.

1. Jackhammers shall not exceed 60 lb weight class.
- C. Cut and remove rigid materials using concrete saw, core drill, expansive grout or hydrodemolition. When cutting rectangular openings in concrete slabs and walls, use method that will not overcut the opening dimensions at the corners of the opening. Acceptable methods may include the following:
 1. Cut the opening with a concrete chain saw and avoid any overcut at the corners.
 2. Prior to cutting the opening, core drill each corner and sawcut only up to the cored opening and chip the remaining concrete at each corner.
- D. Break concrete using expansive demolition grout or hydraulic splitters. Acceptable methods may include the following:
 1. Core drill a line of holes along the intended line of the break of the size, spacing and depth recommended by the manufacturer of the expansive demolition grout or hydraulic splitter.
 2. Core drill relief holes of the size, spacing and depth recommended by the manufacturer of the expansive demolition grout or hydraulic breaker to provide an open face or free space necessary to permit proper expansion of the grout and fracturing of the concrete.
- E. Hydrodemolition:
 1. Hydrodemolition waterjets shall be able to produce 35,000 psi.
- F. Restore work with new products in accordance with requirements of Contract Documents.
- G. Completely seal annular spaces around pipes, circular ducts and conduits and voids around non-circular ducts. Use firestopping as required in Specification Section 07 84 00 or as shown on the drawings. Seal around other penetrations as required in Specification Section 07 92 00.
- H. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to the nearest intersection; for an assembly, refinish the entire unit.
- I. Water, spray, slurry and debris from the hydrodemolition, core drilling, and saw-cutting shall not be permitted to flow or spray away from the immediate area of the work, nor into sumps or drains. Provide watertight barriers to contain all water, spray, slurry, and debris and prevent it from contacting any equipment, electrical panels or devices.
- J. Cut cores and sawed concrete sections shall be supported on scaffolding or similar means of support placed beneath the work. The cut sections shall not be permitted to drop free.
- K. The concrete cores debris shall be removed and disposed of offsite without damage to existing facilities.
- L. The concrete slurry and debris shall be removed and disposed of offsite without damage to existing structures, paving, utilities, plantings or other improvements at the site.

3.02 PROTECTING EXISTING REINFORCING BARS

- A. Existing reinforcing bars shall be located and avoided to the greatest degree possible by adjusting the location of the penetration, subject to the approval of the Project Representative.
- B. Existing reinforcing bars below equipment pad removals shall be located and avoided to the greatest degree possible by controlling the depth of concrete removal to the limits shown on the contract drawings.

- C. Existing reinforcement that is to be incorporated into new construction by embedment, splicing or coupling with new reinforcing bars shall be protected to permit the required embedment, splicing or coupling for the new construction.

3.03 CUTTING OF EXISTING REINFORCING BARS

- A. Existing reinforcing bars that become exposed due to demolition and/or removal of portions of existing concrete shall be treated as follows depending on the applicable condition:
 - 1. Existing reinforcing bars to be incorporated into new concrete pours shall be located and protected from damage. Bars that are cut or damaged shall be repaired to the satisfaction of the Project Representative. Bars shall not be field bent from their existing configuration in order to facilitate concrete removal unless approved by the Project Representative or noted on the Drawings.
 - 2. Projecting reinforcing bars that are not to be incorporated into new concrete pours shall be cut off one-half inch below the concrete surface and the hole patched with epoxy grout.
 - 3. Reinforcing bars that are cut through by saw-cutting operations and are flush with the cut surface of the concrete shall have the cut ends coated with two coats of an approved liquid epoxy coating material to prevent corrosion except for the following condition. If the cut ends of the bars are exposed on the top surface of a slab or on the exposed face of a wall, then the bars shall be cut or ground down one-half inch below the finished concrete surface and the hole filled with epoxy grout.

3.04 EXISTING ANCHOR BOLTS OR ANCHOR RODS

- A. Existing anchor bolts or anchor rods projecting from the finished face of concrete due to removal of existing equipment or other installations and no longer needed shall be cut off one-half inch below the finished face of concrete and the hole filled with epoxy grout.

END OF SECTION

SECTION 05 05 19

POST-INSTALLED CONCRETE ANCHORS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies post-installed anchorage to concrete, complete with washers and nuts.
- B. Post-installed concrete anchorage systems required to secure the various parts together and provide a complete installation are generally indicated on the Drawings. Where the anchorage design is absent, or insufficiently detailed to complete the installation, provide the anchorage design and submit for approval.
- C. The tabulation of items herein is not intended to be all inclusive, and it shall be the Contractor's responsibility to provide all metalwork and castings shown, specified, or which can reasonably be inferred as necessary to complete the Contract.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
ASTM D648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM F436	Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F2329	Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
AC 193	Acceptance Criteria for Mechanical Anchors in Concrete Elements
AC 308	Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
ACI 355.2	Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:

1. Manufacturer's product data.
2. Manufacturer's information showing the recommended installation equipment and procedures for the following:
 - a. Mechanical anchors (expansion, undercut, screw etc.).
 - b. Adhesive anchor shall include instructions for the safe handling of adhesives.
3. Design calculations and details showing the required diameter, length, embedment, edge distance, confinement, and other conditions, stamped and signed by a Professional Structural Engineer currently licensed State of Washington, for post-installed anchors exceeding the capacities or not conforming to the configurations shown on the Drawings and as required by Section 01 73 00.

1.04 QUALITY ASSURANCE

- A. The diameter and capacity of post-installed concrete anchors shall be as recommended or required by the equipment or machinery manufacturer, including any recommended or required adjustment for seismic conditions listed in Section 01 73 00. In case of conflicting or ambiguous recommendations or requirements, the most stringent shall apply. Verify that the capacities and configurations conform to the Drawings.

1.05 EXPOSURE CONDITIONS

- A. Dry: indoor spaces not subject to moisture, washdown, hydrogen sulfide gas or chemicals.
- B. Wet and/or corrosive: outdoor areas, or indoor areas subject to moisture, washdown, hydrogen sulfide gas or chemicals.
- C. Submerged: at or below a point 1.5 foot above maximum fluid surface.
- D. Unless otherwise indicated, all non-submerged surfaces shall be considered wet or corrosive.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Unless otherwise specified, materials shall conform to the following:
 1. Anchor bolts and anchor rods:
 - a. Carbon steel: ASTM F1554 Grade 36 or Grade 55, hot-dip zinc coated per ASTM F2329.
 - b. Stainless steel: ASTM F593G or F593H as required by size.
 2. Threaded rod:
 - a. Carbon steel: ASTM F1554 Grade 36 or Grade 55, hot-dip zinc coated per ASTM F2329.
 - b. Stainless steel: ASTM F593G or F593H as required by size.
 3. Nuts: (Heavy Hex):
 - a. Carbon steel: ASTM A563DH, hot-dip zinc coated per ASTM F2329.
 - b. Stainless steel: ASTM F594G or ASTM F594H as required by size.
 4. Washers:
 - a. Carbon steel: ASTM F436, hot-dip zinc coated per ASTM F2329.
 - b. Stainless steel: Type 316.
- B. Fasteners: all components of mating fasteners, bolts, nuts and washers, of the same material and coated by the same process.

2.02 CONCRETE ANCHORS

- A. Mechanical anchors:
 1. Mechanical anchors shall have an ICC Evaluation Service Report (ESR) indicating compliance with the requirements of IBC for use in cracked and uncracked concrete for the anchor type and

- concrete strength conditions for which the anchor will be used. The ESR shall indicate IBC compliance for use under seismic loading conditions. The basis of the ESR shall be Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193).
2. Acceptable Manufacturers:
 - a. Simpson Strong-Tie Company, Inc., "STRONG-BOLT 2" (expansion), and Torq-Cut (undercut).
 - b. Hilti, Inc., Kwik-Bolt KB-TZ (expansion), and HAD (undercut).
 - c. DeWALT, "Power-Stud+ SD2" carbon steel anchors and "Power-Stud+ SD6" stainless steel anchors (expansion), and Atomic+Undercut.
 - d. Approved Equal.
- B. Concrete Screws anchors:
1. Concrete Screw anchors shall have an ICC Evaluation Service Report (ESR) indicating compliance with the requirements of IBC for use in cracked and uncracked concrete for the anchor type and concrete strength conditions for which the anchor will be used. The ESR shall indicate IBC compliance for use under seismic loading conditions. The basis of the ESR shall be Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193).
 2. Acceptable Manufacturers:
 - a. Simpson Strong-Tie Company, Inc., "Titen HD" Type 316 SST.
 - b. Hilti, Inc., KH-EZ Type 316 SST.
 - c. Approved Equal.
- C. Adhesive Anchors:
1. Adhesive anchors shall have an ICC Evaluation Service Report (ESR) indicating compliance with the requirements of IBC for use in cracked and uncracked concrete for the anchor type and concrete strength conditions for which the anchor will be used. The ESR shall indicate IBC compliance for use under seismic loading conditions. The basis of the ESR shall be Post-Installed Adhesive Anchors in Concrete Elements (AC308).
 2. Do not use where fire or elevated temperatures exceeding 150 degrees F can occur, unless specifically shown otherwise.
 3. Adhesive anchors installed horizontally or upwardly inclined shall be qualified in accordance with ACI 355.4 requirements for sensitivity to installation direction.
 4. Epoxy Adhesive:
 - a. Meet ASTM C881, Type 1, Grade 3, Class A, B, or C.
 - b. Two-component, 100 percent solids, non-sag, paste, insensitive to moisture, designed to be used in adverse freeze/thaw environments, and gray in color. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
 5. Mixed Epoxy Adhesive: Non-sag paste consistency holding the following properties:
 - a. Slant Shear Strength, ASTM C881 and ASTM C882, No Failure in Bond Line, Dry/Moist Conditions: 5,000 psi.
 - b. Compressive Strength, ASTM D695: 14,000 psi minimum.
 - c. Tensile Strength, ASTM D695: 4,500 psi.
 - d. Heat Deflection Temperature, ASTM D648: 135 degrees F, minimum.
 6. Epoxy Adhesive Packaging:
 - a. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio and fit into a manually or pneumatically operated caulking gun.
 - b. Dispense components through a mixing nozzle that thoroughly mixes components and places epoxy at base of predrilled hole.
 - c. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate sizes of anchor rods.
 - d. Cartridge Markings: Include manufacturer's name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
 7. Storage of Epoxy adhesive:
 - a. Store epoxy cartridges on pallets or shelving in a covered storage area.
 - b. Control temperature above 60 degrees F and dispose of cartridges if shelf life has expired. If stored at temperatures below 60 degrees F, test adhesive prior to use to determine if adhesive meets specified requirements.

- 8. Acceptable manufacturers:
 - a. Simpson Strong Tie, "Set-XP".
 - b. Hilti, "HIT-RE 500 V3".
 - c. DeWALT, "Pure110+".
 - d. Approved Equal.
- D. Post-installed anchors shall be qualified for earthquake loading in accordance with ACI 355.2 or ACI 355.4.
- E. Provide concrete anchors for the exposure conditions as noted below:
 - 1. Equipment and machinery:
 - a. Dry exposure: stainless steel.
 - b. Wet or submerged exposure: stainless steel.
 - 2. Fabricated metalwork or structural building or frame components:
 - a. Dry Exposure:
 - 1) Steel anchoring: galvanized steel.
 - 2) Other metal anchoring: stainless steel.
 - b. Wet or submerged exposure: stainless steel.
- F. Coated concrete anchors shall be coated by fusion bonding. Coating of threads is not required. Where threads are covered with a fusion bonded coating, provide the nut of proper size to fit and provide a connection of equal strength to the embedded anchor.

2.03 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZE)

- A. Where stainless steel nuts and threaded fasteners are used, apply anti-seize lubricant to the threads prior to making up the connections. Lubricant shall be manufactured and labeled for use with stainless steel and shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper.

PART 3 EXECUTION

3.01 GENERAL

- A. Install per manufacturer's recommendations.
- B. All machinery or equipment with moving parts and all structural steel shall be anchored using adhesive or cast-in anchor bolts.
- C. Cutting and welding: not permitted.
- D. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators.
- E. Provide beveled washers where mating surface is not square with the anchor bolt.

3.02 ANCHOR BOLT HOLES IN EQUIPMENT

- A. Shall not exceed the bolt diameters by more than:
 - 1. Bolts smaller than 1-inch: 25 percent.
 - 2. Bolts 1-inch and larger: 1/4-inch.

3.03 ANCHOR INSTALLATION

- A. Installation shall not begin until the concrete or masonry receiving the anchors has attained its design strength.
- B. Install in strict conformance with manufacturer's written instructions.

- C. Use manufacturer's recommended drills and equipment.
- D. Unless otherwise specified, embedded length shall not include housekeeping pads or fill grout.
- E. Adhesive anchors shall not be installed when the temperature of the concrete is below 35 degrees F or above 110 degrees F.
- F. Installation of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be performed by personnel certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program, or equivalent.
- G. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by an inspector specially approved for that purpose by Project Representative. The special inspector shall furnish a report to the licensed design professional and Project Representative that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved construction documents and the Manufacturer's Printed Installation Instructions (MPII).
- H. Furnish manufacturer's representative, for each type of concrete anchor used, to the jobsite to conduct jobsite training for proper installation, handling, and storage of each anchor system for personnel as required. Notify Project Representative of training session schedule.

3.04 GALVANIZING REPAIR

- A. Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired in accordance with the recommendations of ASTM A780 as required by the Project Representative.

END OF SECTION

SECTION 05 05 20

WELDING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies welding and testing requirements for all shop and field welding.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME BPVC SEC V	Nondestructive Examination
ASME BPVC SEC IX	Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders, Brazers, and Welding, Brazing and Fusing Operators
ASME B31.3	Process Piping
ASNT SNT-TC-IA	Personnel Qualification and Certification in Non-destructive Testing
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
AWS A2.4	Standard Symbols for Welding, Brazing, and Nondestructive Examination
AWS A3.0	Standard Welding Terms and Definitions; Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting and Thermal spraying
AWS D1.1	Structural Welding Code - Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.3	Structural Welding Code – Sheet Steel
AWS D1.4	Structural Welding Code – Reinforcing Steel
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D18.2	Guide to Weld Discoloration Levels on Inside of Austenitic Stainless Steel Tube.
AWS QC 1	Standard for AWS Certification of Welding Inspectors

1.03 SUBMITTALS

- A. Procedure: 01 33 00.
- B. Provide the following submittals:
1. Shop drawings:
 - a. Welding data (shop and field):
 - 1) Show on a weld map complete information regarding base metal ASTM specifications, and the location, type, size, and length of all welds.
 - 2) Identify the WPS to be used and NDE requirements in the tail of each welding symbol. See AWS A2.4 for guidance if needed.
 - 3) Clearly distinguish between shop and field welds.
 - 4) Indicate by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings.
 - 5) Welding and NDE symbols in accordance with AWS A2.4.
 - 6) Welding terms and definitions in accordance with AWS A3.0.
 2. Shop and field WPSs and PQRs.

3. Nondestructive Testing (NDT) procedure specifications prepared in accordance with ASME BPVC SEC V.
4. Welder Performance Qualification records and Welder Logs.
5. CWI credentials.
6. Testing agency personnel credentials.
7. CWI and NDT reports.
8. Welding documentation: Submit on appropriate forms in referenced welding codes.
9. Pickling products and procedures for stainless steel welding.

1.04 DEFINITIONS

- A. CJP: Complete Joint Penetration.
- B. CWI: Certified Welding Inspector.
- C. MT: Magnetic Particle Testing.
- D. NDE: Nondestructive Examination.
- E. NDT: Nondestructive Testing.
- F. PJP: Partial Joint Penetration.
- G. PQR: Procedure Qualification Record.
- H. PT: Liquid Penetrant Testing.
- I. RT: Radiographic Testing.
- J. UT: Ultrasonic Testing.
- K. VT: Visual Inspection/Testing.
- L. WPQ: Welder/Welding Operator Performance Qualification Record.
- M. WPS: Welding Procedure Specification.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. WPSs: In accordance with AWS D1.1 (Annex J Forms) or referenced AWS code (shop or field welding); or ASME BPVC SEC IX (Forms QW-482 and QW-483) for shop welding.
 - a. Welding procedures for duplex stainless steel shall be qualified by testing, as required by AWS D1.6/D1.6M.
 2. WPQs: In accordance with AWS D1.1 (Annex J Forms) or referenced AWS code (shop or field welding); or ASME BPVC SEC IX (Form QW-484) for shop welding:
 - a. Performance qualifications must be conducted by, or on behalf of, the Contractor. Performance qualifications conducted by Others are not acceptable.
 3. Contractor's CWI: Certified in accordance with AWS QC 1, and having prior experience with the welding codes specified.
 4. Independent Testing Agency: Personnel performing nondestructive tests shall be ASNT SNT-TC-1A, Level II.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

- A. The Contractor's CWI shall be present whenever shop welding is performed. The CWI shall perform inspection at suitable intervals prior to assembly, during assembly, during welding, and after welding. CWI duties include:
 - 1. Verifying conformance of specified job material and proper storage.
 - 2. Monitoring conformance with approved WPS.
 - 3. Monitoring welder performance and conformance with WPQs.
 - 4. Inspecting joint preparation, joint fit-up and in-process welder technique.
 - 5. Providing 100 percent visual inspection of welds.
 - 6. Coordinating with nondestructive testing personnel and evaluating test results.
 - 7. Maintaining records and preparing reports confirming that the results of inspection and testing comply with the Work.
- B. Nondestructive Weld Testing: as specified in this Section.
- C. Stainless steel welds shall be fully pickled and passivated in accordance with ASTM A380.

PART 3 EXECUTION

3.01 GENERAL

- A. Welding and fabrication by welding: Conform to governing welding codes referenced in the Welding and Nondestructive Testing Table included in this Section.
- B. Use matching filler metals and low hydrogen electrodes.

3.02 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

- A. Quality control inspection:
 - 1. All welds: 100 percent VT by Contractor's CWI.
 - 2. Acceptance criteria:
 - a. Structural pipe and tubing: AWS D1.1/D1.1M, Paragraph 10.24, or referenced welding code.
 - b. All other structural steel: AWS D1.1/D1.1M, Paragraph 8.9 and Table 8.1, Statically Loaded Nontubular Connections, or referenced AWS code.
 - c. Stud connections: AWS D1.1/D1.1M, Paragraph 9.8.1, or referenced AWS code.
 - 3. Weld discoloration levels for stainless steel welds shall not exceed Level 3 as defined by AWS D18.2.
- B. NDT frequency shall be as specified in this Section, as required by referenced welding codes, or as specified in the Welding and Nondestructive Testing Table included in this Section. In case there is a conflict, the higher frequency level of NDT shall apply:
 - 1. Nontubular Connections:
 - a. CJP Butt Joint Groove Welds: 10 percent random RT of each weld. Use UT for CJP butt joint groove welds that cannot be readily radiographed.
 - b. All Other CJP Groove Welds: 10 percent random UT of each weld.
 - c. Fillet Welds and PJP Groove Welds: 10 percent random PT or MT of each weld.
 - 2. Tubular Connections:
 - a. CJP butt joint groove welds made from one side without backing: 100 percent RT or UT in accordance with AWS D1.1/D1.1M, Paragraph 10.25.2 requirements.
 - b. CJP Butt Joint Groove Welds made with back-gouging: 10 percent random RT of each weld.
 - c. CJP Butt Joint Groove Welds made with backing and other butt joint groove welds that, in the opinion of the Project Representative, cannot be readily radiographed: 10 percent random UT.
 - d. All Other CJP Groove Welds: 10 percent random UT of each groove weld.

- e. Fillet Welds and PJP Groove Welds: 10 percent random PT or MT of each groove weld.

C. NDT Procedures and Acceptance Criteria:

1. Nontubular Connections:
 - a. RT: Perform in accordance with AWS D1.1/D1.1M, Clause 8, Part E. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.12.1.
 - b. UT: Perform in accordance with AWS D1.1/D1.1M, Clause 8, Part F. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.13.1.
 - c. PT and MT:
 - 1) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 8.14.4 and Paragraph 8.14.5.
 - 2) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.9, Visual Inspection, Statically Loaded Nontubular Connections.
2. Tubular Connections:
 - a. RT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 10, Paragraph 10.27 and Paragraph 10.28.
 - b. UT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 10, Paragraph 10.26 and Paragraph 10.29.
 - c. PT and MT:
 - 1) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 8.14.4 and Paragraph 8.14.5.
 - 2) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 10.24.

3.03 FIELD QUALITY CONTROL

- A. The Contractor's CWI shall be present whenever field welding is performed. The CWI shall perform inspection at suitable intervals prior to assembly, during assembly, during welding, and after welding. CWI duties include:
1. Verifying conformance of specified job material and proper storage.
 2. Monitoring conformance with approved WPS.
 3. Monitoring welder performance and conformance with WPQs.
 4. Inspecting weld joint preparation, fit-up, and in-process welder technique.
 5. Providing 100 percent visual inspection of welds.
 6. Coordinating with nondestructive testing personnel and evaluating test results.
 7. Maintaining records and preparing reports confirming that the results of inspection and testing comply with the Work.

3.04 WELD DEFECT REPAIR

- A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

3.05 WELDING AND NONDESTRUCTIVE TESTING TABLE

SECTION	GOVERNING WELDING CODES OR STANDARDS	SUBMIT WPS	SUBMIT WPQ	CWI REQUIRED	SUBMIT WRITTEN NDT PROCEDURE SPECIFICATIONS	NDT REQUIREMENT
03 20 00	AWS D1.4/D1.4M, Structural Welding Code - Reinforcing Steel	Yes	Yes	Yes	Yes	100% VT and 100% RT of all rebar splices; also see Section 03 20 00
05 12 00	AWS D1.1/D1.1M, Structural Welding Code - Steel	Yes	Yes	Yes	Yes	100% VT and 10% UT or RT of all groove welds; 10% MT of all fillet welds; also see Section 05 12 00

SECTION	GOVERNING WELDING CODES OR STANDARDS	SUBMIT WPS	SUBMIT WPQ	CWI REQUIRED	SUBMIT WRITTEN NDT PROCEDURE SPECIFICATIONS	NDT REQUIREMENT
05 31 00	AWS D1.1/D1.1M, Structural Welding Code - Steel or AWS D1.3/D1.3M, Structural Welding Code - Sheet Steel	Yes	Yes	Yes	No	100% VT; also see Section 05 31 00
05 41 00	AWS D1.1/D1.1M, Structural Welding Code - Steel or AWS D1.3/1.3M, Structural Welding Code - Sheet Steel	Yes	Yes	Yes	No	100% VT; also see Section 05 41 00
05 50 00	AWS D1.1/D1.1M, Structural Welding Code-Steel or AWS D1.2/D1.2M, Structural Welding Code - Aluminum or AWS D1.6/D1.6M, Structural Welding Code - Stainless Steel	Yes	Yes	Yes	No	100% VT and 10% UT or RT of all groove welds; 10% MT of all fillet welds; also see Section 05 50 00
05 52 00	AWS D1.1/D1.1M, Structural Welding Code - Steel	No	No	Yes	No	100% VT; also see Section 05 52 00
05 53 00	AWS D1.1/D1.1M, Structural Welding Code - Steel	No	Yes	Yes	No	100% VT; also see Section 05 53 00
05 58 01	AWS D1.1/D1.1M, Structural Welding Code – Steel	Yes	Yes	Yes	No	100% VT; also see Section 05 58 01
40 05 01	ASME BPV Code, Section IX; and ASME B31.3 Normal Fluid Service Category	Yes	Yes	Yes	Yes	100% VT and 10% RT of all groove welds; also see Section 40 05 01
40 05 23	ASME BPV Code, Section IX; and ASME B31.3 Normal Fluid Service Category	Yes	Yes	Yes	Yes	100% VT and 10% RT of shop groove welds and 25% RT of field groove welds, and 10% PT of all fillet welds; also see Section 40 05 23
40 05 24	ASME BPV Code, Section IX	Yes	Yes	Yes	Yes	100% VT and 20% random RT or UT of groove welds, and 10% MT or PT of fillet welds; and as specified in Section 40 05 24
40 05 40	ASME BPV Code, Section IX; ASME B31.3 Normal Fluid Service Category, or AWS D1.1/D1.1, Structural Welding Code – Steel	Yes	Yes	Yes	Yes	100% VT; also see Sections 40 05 01 and 40 05 24.

END OF SECTION

SECTION 05 05 23

METAL FASTENINGS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies all metal fastenings, complete with washers and nuts, except cast-in concrete anchors and post-installed anchors.
- B. Metal fastening systems required to secure the various metal parts together and provide a complete installation are generally indicated on the Drawings. Where the fastening design is absent, or insufficiently detailed to complete the installation, provide the fastening design and submit for approval.
- C. The tabulation of items herein is not intended to be all inclusive, and it shall be the Contractor's responsibility to provide all metalwork and castings shown, specified, or which can reasonably be inferred as necessary to complete the Contract.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM F436	Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
ASTM F959	Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
ASTM F2329	Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
ASTM F3125	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength
RCSC	Specification for Structural Joints Using High-Strength Bolts

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Detailed shop drawings.
 - 2. Preparation and installation or application instructions, as appropriate.
 - 3. Certificates of Compliance that products meet chemical and mechanical requirements of standards specified.
 - 4. Manufacturer's inspection test report results for production lot(s) provided, to include:
 - a. Tensile strength.
 - b. Yield strength.

- c. Reduction of area.
 - d. Elongation and hardness.
- 5. Certified mill test reports for bolts and nuts:
 - a. Name and address of manufacturer.
 - b. Bolts correctly marked.
 - c. Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.
- 6. Direct tension indicators (DTIs): Provide manufacturer's test report meeting requirements of ASTM F959.
- 7. Tension control (TC) bolts: Provide manufacturer's test report meeting requirements of ASTM F3125.

1.04 DELIVERY AND STORAGE

- A. Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.

PART 2 PRODUCTS

2.01 MATERIALS

- A. High-Strength Bolts:
 - 1. Conventional bolts: ASTM F3125 Grade A325.
 - 2. Twist-off-type tension-control bolts: ASTM F3125, Grade F1852 hot dip galvanized per ASTM F2329.
 - 3. Stainless bolts: ASTM F593G or F593H as required by size.
- 4. Nuts: (Heavy Hex):
 - a. Carbon steel: ASTM A563DH hot dip galvanized per ASTM F2329.
 - b. Stainless steel: ASTM F594G or ASTM F594H as required by size .
- 5. Washers:
 - a. DTIs or load indicator washers for conventional bolts: ASTM F959.
 - b. Hardened steel washers: ASTM F436 hot dip galvanized per ASTM F2329.
 - c. Stainless steel washers: Type 316.

2.02 FABRICATION

- A. Bolt assembly furnish:
 - 1. A325 bolt assemblies: hot-dip zinc coated per ASTM F2329.
 - 2. Twist off bolt assemblies: ASTM F3125, Grade F1852 hot dip galvanized per ASTM F2329.
 - 3. Galvanize components of bolted assemblies separately before assembly.
- B. Slip critical bolted connections:
 - 1. Mask faying surfaces of slip critical (SC) bolted connections to be shop painted as specified in Section 09 90 00.
 - 2. Do not roughen galvanized faying surfaces with hand wire brushing (Chapter 3.2.2, (3) Specification for Structural Joints Using High-Strength Bolts, RCSC, 2020).

2.03 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZE)

- A. Where stainless steel nuts and threaded fasteners are used, apply anti-seize lubricant to the threads prior to making up the connections. Lubricant shall be manufactured and labeled for use with stainless steel and shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper.

PART 3 EXECUTION

3.01 GENERAL

- A. Install high-strength bolts per Specification for Structural Joints Using High-Strength Bolts.

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- B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators.
- C. Provide beveled washers where mating surface is not square with the bolt.

3.02 INSTALLATION OF HIGH-STRENGTH BOLT

- A. Tighten in accordance with AISC Specification for Structural Joints Using High-Strength Bolts.
- B. Hardened washers:
 - 1. Provide at locations required by Washer Requirements section of AISC Specification for Structural Joints Using High-Strength Bolts, to include slip-critical connections using slotted or oversized holes or Grade A490 bolts.
 - 2. Use beveled style and extra thickness where required by AISC Specification.
 - 3. Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.
 - 4. Do not substitute DTIs for hardened flat washers required at slotted and oversized holes.
- C. Bearing-type connections not fully tensioned (N, X): Tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.
- D. Fully tensioned bolted connections:
 - 1. Use DTIs or TC bolts at slip-critical (SC) and fully tensioned bearing-type connections.
 - 2. DTIs:
 - a. Position within bolted assembly in accordance with ASTM F959.
 - b. Install bolts, with DTIs plus hardened washers as required, in all holes of an assembly and tighten until plies are in firm contact and fasteners are uniformly snug tight.
 - 3. Final tighten bolts, beginning at most rigid part of bolted connection and progressing toward free edges, until final twist-off of TC bolts or until DTIs have been compressed to an average gap equal to or less than shown in Table 2, ASTM F959.

3.03 MISFITS AT BOLTED CONNECTIONS

- A. Where misfits in erection bolting are encountered, immediately notify Project Representative for approval of one of the following methods of corrections:
 - 1. Ream holes that shall be enlarged to admit bolts and use oversize bolts.
 - 2. Plug weld misaligned holes and redrill holes to admit standard size bolts.
 - a. Plug welding shall be performed in accordance with the requirements of Section 05 05 20.
 - 3. Drill additional holes in connection, conforming to AISC Standards for bolt spacing and end and edge distances, and add additional bolts.
 - 4. Reject member containing misfit, incorrect sized, misaligned holes and fabricate new member to ensure proper fit.
- B. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

3.04 FIELD QUALITY CONTROL

- A. Inspect:
 - 1. Marking identification and conformance to ASTM standards.
 - 2. Alignment of bolt holes.
 - 3. Placement, type, and thickness of hardened washers.
 - 4. Tightening of bolts.
- B. Bearing-type connections not fully tensioned (N, X): Snug tight condition with piles of joint in firm contact.
- C. Fully tensioned bearing and slip critical connections:

1. Conduct pre-installed test.
 2. Monitor installation and tightening of DTIs or TC bolts.
 3. Monitor condition of faying surfaces for slip critical connections.
- D. Pre-installation test:
1. Conduct jobsite test prior to start of work using a bolt tension measuring device.
 2. Select representative sample of not less than three bolts of each diameter, length, and grade.
 3. Include DTIs and flat hardened washers as required to match actual connection assembly.
 4. Conduct test in accordance with Specification for Structural Joints Using High-Strength Bolts.
- E. Nondestructive testing (NDT) report: Prepare and submit a written NDT report identifying location of inspected bolted connections and summary of corrections as required to meet code acceptance criteria.
- F. Defective connections: Correct and re-inspect defective and improperly tightened high-strength bolted connections. Retest fully tensioned bolts as necessary to demonstrate compliance of completed work.

3.05 GALVANIZING REPAIR

- A. Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired in accordance with the recommendations of ASTM A780 as required by the Project Representative.

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies structural steel framing, base plates, structural frame accessories and shop finishing.
- B. All steel members (except crane rails), fabrications, framing, base plates, assemblies, connections and accessories shall be hot dip galvanized.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AISC	Code of Standard Practice for Steel Buildings and Bridges, excluding Sections 3, 4, 7.11.2, 7.11.3, 7.11.4, and 7.11.5
AISC	Erector Certification Program
AISC	Steel Construction Manual
AISC	Quality Certification Program
ASTM A1	Standard Specification for Carbon Steel Tee Rails
ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143	Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement
ASTM A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Shop Drawings:
 - 1. Erection plans.
 - 2. Members and their connections.
 - 3. Anchor bolt layouts.
 - 4. Weld types, sizes, and locations including joint details for complete joint penetration welds.
 - 5. Schedules for fabrication procedures.
 - 6. Primer and other coatings.
- C. Name and address of manufacturer(s) for products used.
- D. Product specifications.
- E. Manufacturer's testing procedures and standards.
- F. Preparation and installation or application instructions, as appropriate.
- G. Mill Certificates of tests made in accordance with ASTM A6.
- H. High-strength bolts, as specified in Section 05 05 23.
- I. Methods proposed to resolve misalignment between anchor bolts and bolt holes in steel members.
- J. Welding data and weld inspection reports, as specified in Section 05 05 20 Welding.
- K. Hot-dip galvanizing: Certificate of compliance signed by galvanizer with description of material processed and ASTM standard used for coating.
- L. AISC quality certification: AISC certificate showing name and address of certified firm, effective date, and category of certification; or, for erectors, documentation of similar project experience to include project name, location, date of completion, and name and phone number of owner's contact person.
- M. Fabricator Certification: AISC Conventional Steel Building Structures (SBD).
- N. Certified Steel Erector (CSE), or documented experience in erection of at least 10 years in lieu of AISC certification.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.
- B. Storage:
 - 1. Protect structural steel members and packaged materials from corrosion and deterioration.
 - 2. Store in dry area and not in direct contact with ground.
 - 3. Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.
- C. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Rolled plates, shapes except W-shapes, and bars: ASTM A36 or ASTM A572, unless indicated otherwise.
- B. W-shapes: ASTM A992.
- C. Steel pipe: ASTM A53, Type E or S, Grade B.
- D. Round hollow structural sections (HSS): ASTM A500, Grade C.
- E. Square and rectangular hollow structural sections (HSS): ASTM A500, Grade C.
- F. Crane rails: ASTM A1

2.02 FASTENERS

- A. Anchors: As specified in Section 03 15 19 or 05 05 19 and as indicated on the contract drawings.
- B. High-strength bolt assemblies: As specified in Section 05 05 23.
- C. Welded Anchor Studs: As specified in Section 05 50 00.

2.03 FINISH

- A. As specified in Section 09 06 90 and Section 09 90 00. Primer used on structural steel shall conform to the requirements of Section 09 90 00 and shall be compatible with the final finish coats required in Section 09 90 00 and Section 09 06 90. Contractor to submit technical data on primers.
- B. Grout: As specified in Section 03 60 00.

2.04 FABRICATION

- A. General:
 - 1. Fabricate as shown and in accordance with AISC Specification for Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges.
 - 2. Columns shall be full length members without splices, unless shown otherwise or approved by Project Representative.
 - 3. Mark and match mark materials for field assembly.
 - 4. Complete assembly, including bolting and welding of units, before start of finishing operations.
 - 5. Fabricate to agree with field measurements.
 - 6. Provide camber as indicated on Drawings.
- B. Connections:
 - 1. Shop connections: Weld or bolt, as shown.
 - 2. Meet requirements of AISC Manual of Steel Construction tables for bolted double-angle shear connections, unless indicated otherwise.
 - 3. Meet OSHA requirements for bolting at beams framing into column web connections.
 - 4. Provide oversized holes for anchor bolts in column base plates in accordance with AISC Manual of Steel Construction, unless indicated otherwise.
- C. Welded construction:
 - 1. As specified in Section 05 05 20 and as shown on the approved shop drawings.
 - 2. Groove and butt joint welds: Complete joint penetration, unless otherwise indicated.

- D. Interface with other work:
1. Holes:
 - a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.
 - b. No flame-cut holes will be permitted without prior approval of Project Representative.
 2. Weld threaded nuts to framing, and other specialty items as shown to receive other Work.
- E. Shop paint primer:
1. All structural steel requiring painting shall be shop primed and field finished as specified in Section 09 90 00 and Section 09 06 90.
 2. Surface preparation and painting as specified in Section 09 90 00.
 3. Do not shop prime the following surfaces, unless indicated otherwise:
 - a. Faying surfaces of slip critical bolted connections.
 - b. Within 2 inches of field-welded connections.
 - c. Steel members to be completely encased in reinforced concrete or coated with cementitious fireproofing.
 4. Apply shop primer to top flange surfaces of composite steel beams unless indicated otherwise.
- F. Galvanizing:
1. Fabricate steel to be galvanized in accordance with ASTM A143, A384, and A385. Avoid fabrication techniques that could cause distortion or embrittlement of steel.
 2. Provide venting and drain holes for tubular members and in accordance with ASTM A385.
 3. Remove welding slag, spatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
 4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
 5. Hot-dip galvanize all structural steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123 (except do not galvanize crane rails.)
 6. Galvanize components of bolted assemblies separately before assembly.
- G. Slip critical bolted connections: As specified in Section 05 05 23.

PART 3 EXECUTION

3.01 ERECTION

- A. Meet requirements of AISC Specification for Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges, with exceptions as specified.
- B. Install Contractor-designed temporary construction bracing to provide necessary support until components are in place and construction is complete.
- C. Establish permanent benchmarks necessary for the accurate erection of structural steel.
- D. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar items, before erection proceeds.
- E. High-strength bolted connections: As specified in Section 05 05 23.
- F. Welded connections:
1. As specified in Section 05 05 20 and as shown on the approved shop drawings.
 2. Groove and butt joint welds: Complete joint penetration, unless otherwise indicated.

3.02 ANCHOR BOLTS

- A. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in-place work.
- B. Provide templates and other devices for presetting bolts and other anchors to accurate locations.
- C. Projection of anchor bolts beyond face of concrete and threaded length shall be adequate to allow for full engagement of all threads of hold-down nuts, adjustment of leveling nuts, washer thicknesses, and construction tolerances, unless indicated otherwise.
- D. Placement tolerances:
 - 1. As required by AISC Code of Standard Practice for Steel Buildings and Bridges, unless indicated otherwise.
 - 2. Embedded anchor bolts shall not vary from the dimensions as shown on Drawings by more than the following:
 - a. Center to center of any two bolts within an anchor group: 1/8 inch.
 - b. Center to center of adjacent anchor bolt groups: 1/4 inch.
 - c. Variation from perpendicular to theoretical bearing surface: 1:50.

3.03 SETTING BASES AND BEARING PLATES

- A. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.
- B. Clean bottom surface of base and bearing plates.
- C. Set loose and attached base plates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices. Use leveling plates where indicated.
- D. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout. Weld plate washers to base plates where indicated.
- E. Grout under base plates: As specified in Section 03 60 00, prior to placing loads on structure.

3.04 FIELD ASSEMBLY

- A. Set structural frames accurately to lines and elevations shown.
- B. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.
- C. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.
- D. Level and plumb individual members of structure within tolerances shown in AISC Code of Standard Practice for Steel Buildings and Bridges.
- E. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.
- F. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.
- G. Do not field cut or alter structural members without approval of Project Representative.

- H. Provide additional field connection material as required by AISC Code of Standard Practice for Steel Buildings and Bridges.
- I. Splice members only where indicated and accepted on shop drawings.

3.05 MISFITS AT ANCHOR BOLTS

- A. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved submittal.
- B. Do not flame cut to enlarge holes without prior approval of Project Representative.

3.06 GAS CUTTING

- A. Do not use gas-cutting torches for correcting fabrication errors in structural framing.
- B. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by Project Representative.
- C. Finish flame-cut sections equivalent to sheared and punched appearance.

3.07 REPAIR AND CLEANING

- A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop primer.
- B. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.
- C. Remove weld backing bars and grind smooth where indicated on Drawings.
- D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09 90 00.

3.08 REPAIR OF DAMAGED HOT-DIP GALVANIZED COATING

- A. Conform to ASTM A780.
- B. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780.
- C. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780.
- D. Use magnetic gauge to determine that thickness is equal to or greater than base galvanized coating.

3.09 FIELD QUALITY CONTROL

- A. High-strength bolted connections: As specified in Section 05 05 23.
- B. Welded connections visual inspection and nondestructive weld testing: As specified in Section 05 05 20 Welding.

END OF SECTION

SECTION 05 31 00

STEEL DECKING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies fabrication and erection of steel roof and floor deck.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AISI	Cold-Formed Steel Design Manual
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
IBC	International Building Code as adopted by the authority having jurisdiction
UL	Fire Resistance Directory
FM	Factory Mutual
FMRC	Factory Mutual Research Center
SDI RD	Standard for Steel Roof Deck
SDI NC	Standard for Non-Composite Steel Floor Deck
SDI QA/QC	Standard for Quality Control and Quality Assurance for Installation of Steel Deck
SDI COSP	Code of Standard Practice
SDI MOC	Manual of Construction with Steel Deck

- B. General: For metal decking section properties, meet requirements of AISI Specifications for Design of Cold-Formed Steel Structural Members.
- C. Mechanical Fasteners: Packing containers shall show name of manufacturer and product and FMRC approval mark.
- D. Qualifications for Field Welding: As specified in Section 05 05 20.
- E. Erector Qualifications: Minimum of three years of experience on comparable steel deck projects.
- F. Install steel deck to meet requirements of the IBC as adopted by the authority having jurisdiction.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Shop Drawings:
1. Plan view layout of decking, showing type and section properties of deck panels, reinforcing channels, pans, special jointing, and accessories.
 2. Location of openings, deck laps, and deck attachment details.
 3. Details of accessories, showing sump pans, ridge and valley plates, and closure strips.

- 4. Location of temporary shoring for placement of concrete topping when used.
- C. Decking manufacturer's installation requirements.
- D. Welding data and weld inspection reports, as specified in Section 05 05 20 Welding.
- E. Operation manuals for mechanical fastener installation tools.
- F. Manufacturer's Certificate of Compliance.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store deck bundles on platforms or pallets, with one end elevated to provide drainage.
- C. Protect bundles against condensation with a ventilated waterproof covering.
- D. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage.
- E. Architecturally exposed deck shall be appropriately packaged and protected to prevent damage during shipment.

PART 2 PRODUCTS

2.01 METAL DECKING

- A. Provide metal deck with depth, gauge, and type as shown on the Drawings. All structural metal deck shall be galvanized unless noted otherwise.
- B. Materials and Finishes:
 - 1. Galvanized Deck:
 - a. Sheet steel for galvanized deck and accessories shall conform to ASTM A653, SS, Grade 50.
 - b. Galvanizing shall conform to ASTM A924 with coating class of G90 as defined in ASTM A653.
- C. Manufacturers:
 - 1. Vulcraft Division of Nucor Co., Brigham City, UT.
 - 2. Verco Manufacturing, Inc., Phoenix, AZ.
 - 3. ASC Steel Deck, West Sacramento, CA.
 - 4. Approved Equal.

2.02 SHOP PRIMER

- A. Not Used.

2.03 ACCESSORIES

- A. Provide pour stops, column closures, end closures, edge closures, cover plates, girder fillers, ridge and valley plates, finish strips, reinforcing channels, and other accessories as indicated for complete installation.
- B. Accessories shall comply with requirements of SDI and deck manufacturer.

2.04 MECHANICAL FASTENERS

- A. Self-Drilling Screws:
 - 1. Self-drilling, self-tapping screws with hexagonal washer head and corrosion-resistant finish.
 - 2. Manufacturers and Products:
 - a. ITW Buildex, Itasca, IL; Teks Self-Drilling Fasteners with Climaseal Coating.
 - b. Hilti, Inc., Tulsa, OK; S-MD-HWH KC Self-Drilling Screws with Kwik-Cote Treatment.
 - c. Approved Equal.

2.05 FIELD FINISH

- A. Steel deck requiring field finish shall be in accordance with Section 09 90 00 and Section 09 06 90.

2.06 ROOF INSULATION

- A. As specified in Section 07 22 00.

2.07 FABRICATION

- A. Form deck units in lengths to span 3 or more supports, with 2" minimum end laps and interlocking sidelaps formed with standing seam allowing top seam welds or other specified methods for side lap connections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.
- B. Verify that surfaces to receive steel deck are free of debris.
- C. Do not proceed with installation until defects are corrected.
- D. Coordinate work with requirements of mechanical equipment installation requirements.

3.02 INSTALLATION

- A. Install deck units and accessories in accordance with manufacturer's recommendations and shop drawings
- B. Locate deck bundles to prevent overloading of support framing members.
- C. Install at right angles to supporting members in a three span minimum lay-up, unless shown otherwise, and in accordance with Specification and manufacturer's installation recommendation.
- D. Bearing at end supports: 2 inches, minimum.
- E. End laps minimum of 2 inches and located over supports.
- F. Mark supports at regular intervals to maintain alignment and proper spacing of deck units.
- G. Do not stretch side laps.
- H. Closure Plates:
 - 1. Install closure and cover plate accessories as recommended by SDI.

2. Form Deck Closures:
 - a. Fasten column closures, cell closures, and zee closures to deck to provide tight fitting closures at open ends of ribs and sides of decking.
 - b. Fasten cell closures at changes of direction of deck units unless otherwise indicated.
- I. Holes and Openings:
 1. Cut and fit roof deck units and accessories around projections through roof decking.
 2. Make cuts neat, square, and trim.
 3. Cut openings in roof deck true to dimensions using metal saws or drills.
 4. Do not use cutting torches if neat appearance is required.
 5. Locate holes and openings as shown to clear structural framing and bracing members.
 6. Reinforcement Around Openings:
 - a. Roof Deck: For hole sizes of at least 6 inches across, but not more than 12 inches across in roof deck, reinforce with 0.0474-inch design thickness steel plate, painted or galvanized to match deck coating. Extend plate at least 12 inches beyond opening in all directions and attach to top of roof deck with No. 10 self-drilling screws at 6-inch spacing and at all corners. For openings larger than 12 inches across, reinforce roof deck with framing as shown on Drawings.
 - b. Composite Floor Deck and Form Deck: Reinforce openings as indicated on Drawings
- J. Protect deck areas from heavy concentrated loads or wheel traffic with planking or other approved means.
- K. Completed Deck: Free from buckles and irregularities, and in accordance with FM and UL requirements.

3.03 DECK ATTACHMENT

- A. Fasten panels as shown on Drawings.
- B. Welded Connections at roof decking: Weld roof deck sidelaps with 1-1/2" long top seam welds spaced 8-inches maximum on center unless noted otherwise. Weld roof deck to supports at end bearing locations and end lap locations with 5/8" effective diameter arc spot welds. Provide a minimum of 7 spot welds per 36-inch width of deck units at each fastening location unless noted otherwise. Provide 5/8" effective diameter arc spot welds at 6-inches on center along supports parallel to roof deck flutes unless noted otherwise.
- C. Mechanical Fasteners:
 1. Self-Drilling Screws:
 - a. Install screws in accordance with manufacturer's written instructions and with special installation tool. Do not over-torque. Spacings of screw connections shall be as indicated on the Drawings and as indicated on approved shop drawings.
 - b. Remove and redrive screws at side laps where upper sheet is not drawn tightly against lower sheet.

3.04 TOUCHUP PAINTING

- A. Immediately following erection, remove unused deck edge trimmings, screws, fasteners, welding washers, butt ends of welding rods, and debris from completed installation.
- B. Clean field welds, bolted connections, rust spots, and abraded areas.
- C. Repair damaged galvanized surfaces in accordance with Section 05 50 00.
- D. Use magnetic gauge to determine that thickness of repair is equal to or greater than base galvanized coating.

3.05 PROTECTION

- A. Do not use deck units for storage or working platforms until permanently secured in position.
- B. Assure that construction loads do not exceed carrying capacity of deck.
- C. Replace damaged or warped panel.

3.06 FIELD QUALITY CONTROL

- A. Inspect:
 - 1. Welded connections visual inspection and nondestructive weld testing: As specified in Section 05 05 20 Welding.
 - 2. Mechanical Fasteners: Visually inspect, in accordance with manufacturer's instructions, for each type of fastener.
- B. Repair or replace defective welds and fasteners.

END OF SECTION

SECTION 05 41 00

COLD-FORMED STEEL FRAMING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies cold-formed steel framing. Contractor is responsible for design of cold-formed steel framing unless design of framing is shown on the Drawings. Unless otherwise noted, all cold-formed steel framing members and accessories shall be the product of the same manufacturer.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AISI S240	North American Standard for Cold-Formed Steel Structural Framing
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot- Dip Galvanize Coating
ASTM A1003	Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members
ASTM C955	Standard Specification for Cold-Formed Steel Structural Framing Members

- B. Standard Specifications: Comply with the requirements of the following standard specifications except as supplemented and modified hereinafter:
1. Cold-Formed Steel Structural Framing: ASTM A955, ASTM A1003, and AISI S240.
- C. Qualifications for Welding: As specified in Section 05 05 20.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer Data: Submit manufacturer's data, specifications and installation instructions for cold-formed metal framing.
- C. Shop Drawings:
1. Plan and elevation views of all metal framing systems, including location and framing of all openings.
 2. Material specifications, member sizes, and properties.
 3. Details of track, web stiffeners, stud bracing, blocking, bridging, and other members as required to provide a complete installation.
 4. Details of connections including welding, mechanical fasteners, and accessory items.
 5. Design loads for cold-form steel framing as shown on the Drawing or as required by IBC. Calculations stamped by a professional engineer registered in the State of Washington. Calculations shall indicate critical stresses and connections for steel framing members.
- D. Operation manuals for mechanical fastener installation tools.

1.04 WELDING

- A. Welding data and weld inspection reports, as specified in Section 05 05 20 Welding.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to Site in bundles marked with name of manufacturer, section type, thickness, grade of material, and length.
- B. Store bundles on wood blocking, flat and off ground, to keep clean and to prevent any damage or permanent distortion.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Scafco Corp., Seattle, WA.
- B. Clark Dietrich, West Chester, OH; Steel Framing Systems.
- C. Marino/Ware, South Plainfield, NJ; Stud-Rite Lightweight Steel Framing Systems.
- D. Steeler, Inc., Seattle, WA; Steel Framing Systems.
- E. Approved Equal.

2.02 MATERIALS

- A. Provide size and type of framing members and accessories as indicated on Drawings.
- B. Cold-formed metal framing shall be formed from steel sheets complying with ASTM A1003, with G-90 hot-dip galvanized coating.
- C. Cold-Formed Members and Accessories shall conform to ASTM C955.

2.03 TRACK

- A. Galvanized steel track sections with:
 - 1. Track width as required for the Studs
 - 2. Track Flange: 2"
 - 3. Thickness: Match Stud thickness

2.04 STUDS

- A. Galvanized steel C studs with ½" minimum stiffening lips of size and thickness as indicated in the contract drawings. Fabricated with knurled surface on outside face; punched to receive mechanical and electrical work.
- B. Provide double studs at door jambs, typical.

2.05 SLOTTED DEFLECTION TRACK

- A. Galvanized steel slotted track sections with:
 - 1. Track width as required for the Studs
 - 2. Track Flange: 2"
 - 3. Slot size and spacing: ¼" x 1 ½" @ 1" o.c.

- 4. Thickness: Match Stud thickness

2.06 JOISTS

- A. Galvanized steel C Joist sections with ½" minimum stiffening lips of size and thickness as indicated in the contract drawings. Fabricated with knurled surface on outside face; punched to receive mechanical and electrical work.

2.07 FURRING CHANNELS

- A. Z shaped, 18 mils galvanized steel with knockouts for conduit installation; 1 inch wide flange x 1-5/8 inches deep, suitable to receive wallboard attached with self-drilling drywall screws at furred walls to receive insulation or concealed electrical conduit.
- B. Hat shaped sections of not less than 18 mils galvanized steel; hemmed flanges; 2-3/4-inch wide x 1 5/8 inch deep; suitable to receive wallboard attached with self-drilling drywall screws.

2.08 BRIDGING, BLOCKING, AND FIRE TRACK BLOCKING

- A. Same depth as studs or joists, 54 mils minimum design thickness, unpunched.

2.09 ACCESSORY MATERIAL

- A. Bracing Straps, Angle Bracing, Clip Angles: 54 mils, size as indicated on Drawings.
- B. Notched Track: 6" web, 1 ½" flange, 54 mils minimum
- C. Mounting Plates: 54 mils minimum design thickness by 8 inches by 18 inches.
- D. All incidental and accessory materials, methods, tools and equipment are required for the satisfactory fabrication and erection of framing, as indicated on the Drawings, including fasteners, attachments and anchorages to building construction. All incidental and accessory materials shall be the product of the manufacturer of the studs and joists.

2.10 MECHANICAL FASTENERS

- A. Self-Drilling Screws:
 - 1. Self-drilling, self-tapping screws with hexagonal washer head and corrosion-resistant finish.
 - a. #10 x 9/16" unless noted otherwise
 - 2. Manufacturers and Products:
 - a. ITW Buildex, Itasca, IL; Teks Self-Drilling Fasteners with Climaseal Coating.
 - b. Hilti, Inc., Tulsa, OK; Kwik-Pro HWH Self-Drilling Screws with Kwik-Cote Treatment.
 - c. Approved Equal.

2.11 CONCRETE ANCHORS

- A. Drilled anchors, size and type as shown on Drawings and as specified in Section 05 05 19.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect all prefabricated assemblies and repair any damage.
- B. Examine bearing support surfaces for compliance with requirements for installation tolerances and other conditions affecting performance of metal framing systems.

- C. Provide smooth level bearing surfaces for bottom track of load bearing walls.
- D. Clean all member and bearing surfaces that will be in contact after assembly.

3.02 ERECTION OF STUDS AND JOISTS

- A. Install tracks in accurate alignment in accordance with approved layouts and manufacturer's recommendations; secure to building construction, as indicated on the Drawings; where not indicated on the Drawings, provide minimum 5/16-inch diameter power-driven fasteners at 16 inches on center. Position studs in tracks and secure, as indicated on the Drawings. Space studs and joists no more than 16 inches on center.
- B. Provide jack studs to support headers and cripple studs above and below openings. Locate jack studs and cripple studs no more than two inches from all abutting partitions, partition corners, door frames, jambs and other interrupting construction.
- C. At door jambs and at free ends of partitions, provide double studs placed back to back. Above and below openings, provide cut studs, as necessary to maintain the specified stud spacing.
- D. Install framing in true line, plumb, level, and in proper alignment.
- E. Cut ends of framing members with saw or shear to bear uniformly against abutting members. Flame cutting is not permitted.
- F. All structural framing members shall be full-length without splices, unless indicated otherwise.
- G. Immediately install bridging and solid blocking to support joists. Maximum spacing of bridging shall be 4 feet.
- H. Install web stiffeners at joists all joist supports.
- I. Web Penetrations: Drilled holes for other trades shall be limited to the middle 1/3 of the joist depth within the middle 1/3 of the span, unless indicated otherwise. Minimum spacing between drilled holes shall be 1-1/2 times the joist depth. Notching of joist flanges and flame cutting of holes are not permitted.

3.03 HORIZONTAL BRACING

- A. Provide horizontal bracing consisting of hot or cold-rolled channels inserted through cutouts in the web of each stud and secured to each stud with tie wire. Provide 1 row of channels at mid-height for partitions up to 10 feet between runners, and 2 rows at 1/3 points for partitions over 10 feet between runners. Use 1-1/2-inch channels for partitions higher than 14 feet between runners and longer than 1-1/2 times the height, and 3/4-inch channel above the header of doors and other large openings. Extend bracing to engage first stud beyond each jamb stud.

3.04 BLOCKING AND REINFORCING FOR WALL-HUNG ITEMS

- A. Provide cut sections or runner channel, zinc coated steel backing plates, doubled and nested studs, load bearing studs and other items, as required, for the support of wall-hung fixtures, shelving, cabinets, hand rails and toilet accessories. Cut ends of runner and backing plates to each stud. Fasten studs carrying the weight of wall-hung items to the bottom runner channel.

3.05 FASTENERS

- A. Self-Drilling Screws:
 - 1. Install in accordance with manufacturer's written instructions and with special installation tool.

2. Screw type, diameter, and length shall be in accordance with AISI, Fasteners for Residential Steel Framing, minimum two screws per connection unless indicated otherwise.
 3. Use clamp to hold members together. Drive screw from lighter to heavier gauge, to allow plies to be pulled together without stripping metal. Do not over torque. A minimum of three exposed threads shall extend through steel.
 4. Minimum screw spacing, end distance, and edge distance shall be 3 diameters.
- B. Welded Connections:
1. As specified in Section 05 05 20.
 2. Repair galvanized surfaces damaged by welding with zinc-rich spray paint in accordance with ASTM A780.
- C. Concrete Anchors: Install in accordance with Section 05 05 19.

3.06 FIELD QUALITY CONTROL

- A. Perform the following inspections.
1. Welded connections visual inspection and nondestructive weld testing: As specified in Section 05 05 20 Welding.
 2. Mechanical Fasteners: Visually inspect, in accordance with manufacturer's instructions, for each type of fastener.
- B. Repair or replace defective welds and fasteners.
- C. Prepare and repair damaged galvanized coatings on fabricated and installed cold-form steel framing with galvanizing repair paint according to ASTM A780 and the manufacturer's instructions.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies fabricated metal items and other miscellaneous metalwork, stainless steel, galvanized steel, or metals with coating systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Specification for Structural Steel Buildings
AISC DG27	Design Guide 27/Structural Stainless Steel
ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A312	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1069	Standard Specification for Laser and Laser Hybrid Welded Stainless Steel Bars, Plates, and Shapes
ASTM F436	Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F2329	Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

Reference	Title
ASTM F3125	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength
IBC	International Building Code (as adopted by the Authority Having Jurisdiction)
SSPC	Association for Materials Protection and Performance

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's product data showing conformance to the specifications.
 - 2. Detailed shop drawings.
 - 3. Welding data and weld inspection reports, as specified in Section 05 05 20 Welding.

1.04 QUALITY ASSURANCE

- A. Shop and field welding shall conform to the requirements of: Section 05 05 20.
- B. The use of salvaged, reprocessed or scrap materials will not be permitted.
- C. Observation of Work: The Project Representative shall have access to any fabrication site or shop for the purpose of observing fabrication of items, structures, equipment, piping, electrical and other components which will be used in or incorporated in the work.
- D. Notification of Start of Work: Notify the Project Representative in advance of the start of fabrication. For fabrication sites within 50 miles of the project site, provide 48 hours notice. For fabrication sites greater than 50 miles from the project site, provide 7 days notice.
- E. Notification of Finish Work: Notify the Project Representative in advance of applying finish. For fabrication sites within 50 miles of the project site, provide 48 hours notice. For fabrication sites greater than 50 miles from the project site, provide 7 days notice.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Steel:
 - 1. Rolled plates, shapes except W-shapes, and bars: ASTM A36, unless indicated otherwise.
 - 2. W-shapes: ASTM A992.
 - 3. Steel pipe: ASTM A53, Type E or S, Grade B.
 - 4. Round hollow structural sections (HSS): ASTM A500, Grade C.
 - 5. Square and rectangular hollow structural sections (HSS): ASTM A500, Grade C.
 - 6. Headed Anchor Studs: ASTM A108.
 - 7. Deformed anchor bars: ASTM A615 or A1064.
 - 8. Nuts: ASTM A563 DH hot dip galvanized per ASTM F2329.
 - 9. Washers: ASTM F436 hot dip galvanized per ASTM F2329.
 - 10. High-strength Bolts: ASTM F3125, Grade A325, Type 1, hot dip galvanized per ASTM F2329, unless noted otherwise.
- B. Stainless Steel:
 - 1. Sheets and plates: ASTM A240, Type 316 or 316L except where noted to be AISI Type 2205.
 - 2. Sheets and plates: AISI 2205 at the Morning Glory Discharge Structure fabrications.
 - 3. Shapes, bars, and similar items: ASTM A276, Type 316 or 316L or ASTM A1069 for laser-fused shapes.

4. Pipe: ASTM A312, Type 316 or 316L.
5. Headed Anchor Studs: ASTM A276 or A493, Type 316L.
6. Bolts: ASTM F593G or F593H as required by size.
7. Nuts: ASTM F594G or ASTM F594H as required by size.
8. Washers: ASTM A240, Type 316.

C. Welding Materials: As specified in Section 05 05 20.

2.02 ANCHORAGE

- A. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication. Anchorage to concrete: in accordance with Section 05 05 19 and Section 03 15 19.

2.03 LIFTING LUGS

- A. Individual equipment and/or each field disassemblable part weighing in excess of 50 pounds: fitted with lifting lugs for easy handling.

2.04 FASTENERS

- A. As listed in Section 05 50 00.
- B. Finish: unless otherwise indicated, carbon steel bolts, screws, nuts, washers and all other steel fasteners: hot-dip zinc coated per ASTM F2329.
- C. Thread lubricant for stainless steel fasteners: where stainless steel bolts and threaded fasteners are used, apply anti-seizing lubricant to the threads prior to making up the connections. Lubricant: manufactured and labeled for use with stainless steel and shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc or copper.

2.05 WELDED ANCHOR STUDS

- A. Headed anchor studs (HAS) or threaded anchor studs (TAS), as indicated in the Drawings. Weld using an automatic stud gun.
- B. Type 316L where attached to AISI 2205 stainless steel.

2.06 PIPE SLEEVES

- A. ASTM A53, Schedule 40 steel pipe sleeves with continuously welded 3/16" thick seep ring with an outside diameter 3 inches greater than the sleeve outside diameter. Hot-dip galvanize in accordance with ASTM A123.

2.07 FINISH

- A. Unless otherwise indicated:
1. Steel items: hot dip galvanize, ASTM A123, ASTM A153 or ASTM F2329 as applicable.
 2. Steel items: after galvanizing, coat as indicated in Section 09 90 00.
 3. Stainless steel: none.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Verify measurements at the site.

- B. Verify that field conditions are acceptable and are ready to receive work.
- C. Make provisions for erection loads with temporary bracing. Keep work in alignment.
- D. Supply items required to be cast into concrete or embedded in masonry with setting templates.

3.02 FABRICATION

- A. All carbon steel fabrications: conform to AISC 303 and AISC 360 and as specified in Section 05 05 20.
- B. All stainless steel fabrications: conform to AISC 360 and AISC DG27 and as specified in Section 05 05 20.
- C. ASTM A1069 laser-fused SST shapes may be substituted for the equivalent ASTM A6 rolled shapes profiles.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt-tight, flush, and hairline. Remove all burrs and weld spatter. Ease exposed edges to small uniform radius.
- E. Punch holes 1/16-inch larger than the nominal size of the bolts, unless otherwise indicated. Whenever needed because of the thickness of the metal, subpunch and ream or drill holes.
- F. Perform fabrication including cutting, drilling, punching, threading and tapping required for miscellaneous metal or adjacent work prior to hot-dip galvanizing.
- G. Welded connections visual inspection and nondestructive weld testing: As specified in Section 05 05 20 Welding

3.03 FINISH

- A. Welds and adjacent surfaces:
 - 1. Weld profiles shall be uniform with a smooth transition from the weld toe to the adjacent base metal.
 - 2. No weld spatter on or adjacent to the weld or any other area to be painted.
 - 3. No sharp peaks or ridges along the weld bead.
- B. All embedded pieces of electrode or wire and the adjacent weld: removed and replaced with new welds.
- C. Obtain Project Representatives approval before applying finish.

3.04 INSTALLATION

- A. Install items plumb, level and square, accurately fitted, and free from distortion or defects.
- B. Allow for erection loads and provide temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.
- D. Protect encased or embedded dissimilar metals (both metals shall be encased or embedded) from galvanic corrosion by means of pressure tapes, coatings or isolators.
- E. Place metalwork to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if indicated, form recesses or blockouts in the concrete. Thoroughly clean the surfaces of

metalwork in contact with or embedded in concrete. If accepted, recesses may be neatly cored in the concrete after it has attained its design strength and the metalwork grouted in place.

- F. Seat angles, supports and guides: Set seat angles for grating and supports for floor plates so that they maintain the grating and floor plates flush with the floor.
- G. Pipe Sleeves:
 - 1. Provide a pipe sleeve wherever a pipe or similar item passes through concrete.
 - 2. If not otherwise shown in the Drawings provide a caulking sealant or a mechanical seal to form a watertight seal of the annular space between pipes and pipe sleeves.
- H. U-Channel Concrete Embeds: Provide as indicated for pipe and equipment supports and where otherwise shown on the Drawings.

3.05 FIELD REPAIR OF COATINGS

- A. Galvanized:
 - 1. Maximum area to be repaired: no more than 1/2 of 1 percent of the surface area or 36 sq. in. per ton of piece weight, whichever is less. Damage in excess of this requirement: repaired by stripping and recoating entire piece.
 - 2. Clean damaged areas to SSPC-SP10 Near White Wet Blast. Repair with zinc-rich paint in accordance with the manufacturer's instructions and with ASTM A780, Annex A2. Minimum thickness requirements: in accordance with ASTM A123, Paragraph 6.2.3, but not less than 3 mils Dry Film Thickness.
 - 3. Use zinc-rich repair paint.
 - 4. Acceptable manufacturers:
 - a. ZRC Galviline.
 - b. LPS Cold Galvanize.
 - c. CRC Zinc-It Instant Cold Galvanize
 - d. Approved Equal.
- B. Painted: after installation, clean and touch up damaged areas of with the same materials used for the shop coat.

3.06 ELECTROLYTIC CORROSION PROTECTION

- A. Coat all surfaces of aluminum that are to be in contact with concrete, grout or dissimilar metals as specified in Section 09 90 00.

END OF SECTION

SECTION 05 52 00

METAL RAILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies prefabricated hot dip galvanized steel guardrail and handrail railing systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A53	Pipe, Steel, Black, and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless for Ordinary Uses
ASTM A123	Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
ASTM A501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
SBC	Seattle Building Code

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Certified test reports: before fabrication of handrail, provide certificates which attest to their material complying with this Section.
 2. Layout or installation shop drawings.
 3. Calculations prepared and stamped by a Professional Engineer, registered in the state of Washington for each guardrail height and all guardrail and handrail layouts and anchorage types. Calculations shall include the design of all connections and anchorages.

1.04 DESIGN REQUIREMENTS

- A. Guardrails and handrails shall meet the requirements of the standards of the Washington State Department of Labor and Industries - Division of Occupational Safety & Health and the SBC.
1. Design for each guardrail height and all guardrail and handrail layouts and anchorage types.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Cushion wrap complete rails, modules and components to prevent scratching and denting during shipment, storage, and installation. Leave wrap intact, insofar as possible, until railing is completely installed.

1.06 FIELD MEASUREMENTS

- A. Before fabrication verify that field measurements are as indicated on the Drawings, report deviations to the Project Representative.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide hot dip galvanized toeboards at guardrails of materials matching the guardrails except where concrete curbs are indicated.
- B. System shall accommodate field cutting of posts to fit, prior to installation or attachment to base connections.

2.02 STEEL RAILING SYSTEM

- A. Materials:
 - 1. Rails and posts: Steel tubing, ASTM A501, Grade A or Grade B, or steel pipe, ASTM A53, Type E or S, Grade B.
 - 2. Wall Brackets: Malleable iron, round top, galvanized, as manufactured by:
 - a. R & B Wagner, No 1765.
 - b. Julius Blum, No. 1382.
 - c. Hollaender Manufacturing.
 - d. Thompson Fabricating Co.
 - e. Approved Equal.
- B. Finishes: Hot-dip galvanized steel per ASTM A123 Grade 75 minimum, after fabrication and welding.

2.03 FABRICATION

- A. Fit and assemble components in largest practical sizes, for delivery to the site.
- B. Pipe cuts shall be clean, straight, square, and accurate for minimum joint gap. Perform work in conformance with the handrail manufacturer's instructions. Work shall be free from blemishes, defects, and misfits that can affect durability, strength, or appearance.
- C. Unless otherwise indicated, punch holes 1/16 inch larger than the nominal size of the bolts. Whenever needed because of the thickness of the metal, subpunch and ream or drill holes. Replace pieces with mismatched holes. No drifting of bolts or enlargement of holes will be allowed to correct misalignment.
- D. Unless otherwise indicated, supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication.
- E. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt-tight, flush and hairline. Ease exposed edges to small, uniform radius.
- F. Welded connections visual inspection and nondestructive weld testing: As specified in Section 05 05 20.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify measurements at the site.
- B. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Supply items required to be cast into concrete or embedded in masonry with setting templates.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators.
- C. Protect aluminum in contact with concrete or grout with a heavy coat of bituminous paint.
- D. Install components plumb and level, accurately fitted, free from distortion or defects.
- E. Place metal to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if specified, form recesses or blockouts in the concrete and grout the metalwork in place after concrete has attained its design strength in accordance with Section 03 30 00. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete.
- F. Unless otherwise indicated, no field welding of handrails shall be permitted. Where field welding is specified, grind, weld smooth to match adjacent pipe and coat:
 - 1. All welding shall be as specified in Section 05 05 20.
 - 2. Coat all field welds and damaged areas as specified in Section 05 50 00.

3.04 TOLERANCES

- A. Maximum variance from plumb: 1/4-inch per story.
- B. Maximum offset from true alignment: 1/4-inch.

END OF SECTION

SECTION 05 55 00
METAL STAIR NOSINGS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies metal stair nosings.

1.02 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Certified test reports: Before fabrication of stair nosings, provide certificates which attest that all material complies with this Section.
 - 2. Shop drawings: include a plan layout, appropriate sections, and installation details for each item provided.

1.03 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Safety Stair Nosings: 4 inches wide.
 - 1. Acceptable manufacturer:
 - a. Wooster Products Alumogrit Type 101.
 - b. American Abrasive Metals, Alumalum.
 - c. Safe-T-Metal Company, Style AX.
 - d. Approved Equal.

2.02 FABRICATION

- A. Fabricate to sizes indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that opening sizes and dimensional tolerances are acceptable.

3.02 INSTALLATION

- A. Perform no drilling of bolts or enlargement of holes to correct misalignment.
- B. Protect encased or embedded dissimilar metals (both dissimilar metals shall be encased or embedded) from galvanic corrosion by means of pressure tapes, coatings, or isolators.

- C. Place metalwork to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if specified, form recesses or blockouts in the concrete after it has attained its design strength and grout the metalwork in place as specified in Section 03 30 00.
- D. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete. If accepted, recesses may be neatly cored in the concrete.
- E. Safety stair nosings:
 - 1. Install on concrete stairs as indicated in the Drawings.
 - 2. Secure nosings to concrete with suitable anchors at 15 inches on centers and not more than 4 inches from the ends.
 - 3. Provide rubber tape, 1/8-inch thick, at both ends and cut to fit shape of nosing prior to concrete placement.

3.03 CLEANING

- A. After installation, clean and touch up damaged surfaces of shop-primed metals with the same material used for the shop coat.

END OF SECTION

SECTION 05 58 01

FORMED SUCTION INLETS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies:
1. Formed suction inlets (FSI) replacement planning, fabrication, removal and installation.
 2. FSI isolation slide gate.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AISC 360	Specifications for Structural Steel Buildings
ASTM A36	Standard Specification for Carbon Structural Steel

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
1. FSI Replacement Pre-Submittal Meeting agenda and meeting notes.
 2. FSI Replacement Planning Activities Work Plan.
 3. FSI Replacement Planning Activities Results.
 4. FSI Replacement Execution Activities Work Plan.
 5. Fabricator and Erector Quality Control Plans in accordance with AISC 360 Chapter N.
 6. Fabricator's product data showing conformance to the specifications.
 7. Welding Procedure Specifications in accordance with Section 05 05 20.
 8. Detailed shop drawings for new FSIs coordinated and incorporating information obtained during the FSI replacement planning activities.
 9. Documentation from pump manufacturer verifying FSI connection at pump has been coordinated with pump fronthead (suction inlet) to allow direct connection of FSI to pump fronthead.
 10. Detailed shop drawings for new secondary isolation bulkhead coordinated and incorporating information obtained during the FSI replacement planning activities.
 11. Detailed shop drawing for new FSI isolation slide gate.
 12. Detailed shop drawing for removable and reusable seal plate at FSI pump suction connection end.
 13. Welding data and weld inspection reports, as specified in Section 05 05 20 Welding.

1.04 QUALITY ASSURANCE

- A. Shop and field welding shall conform to the requirements of Section 05 05 20.
- B. Welding and nondestructive test requirements: Section 05 05 20.
- C. The use of salvaged, reprocessed or scrap materials will not be permitted.

- D. Observation of Work: The Project Representative shall have access to any fabrication site or shop for the purpose of observing fabrication of items, structures, equipment, piping, electrical and other components which will be used in or incorporated in the work.
- E. The fabricator and erector shall comply with the Quality Control Plan provided by the fabricator and erector. The Quality Control Plan shall include the inspections required in AISC 360 Table N5.4-1, N5.4-2 and N5.4-3.
- F. The fabricator and erector shall comply with the Quality Assurance Plan as required by the permit issued by the Seattle Department of Construction and Inspection. Quality Assurance inspections are permitted to be waived when the work is performed in a fabrication shop or by an erector approved by the Seattle Department of Construction and Inspection to perform the work without Quality Assurance inspections.
- G. Notification of Start of Work: Notify the Project Representative in advance of the start of FSI fabrication. For fabrication sites within 50 miles of the project site, provide 48 hours notice. For fabrication sites greater than 50 miles from the project site, provide 7 days notice.
- H. Notification of Finish Work: Notify the Project Representative in advance of applying finish. For fabrication sites within 50 miles of the project site, provide 48 hours notice. For fabrication sites greater than 50 miles from the project site, provide 7 days notice.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.06 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.

1.07 FSI REPLACEMENT PRE-SUBMITTAL MEETING

- A. Conduct meeting as part of FSI replacement planning activities and prior to preparation and submittal of the FSI Replacement Planning Activities Work Plan and the FSI Replacement Execution Activities Work Plan.
- B. Purpose and topics of FSI Replacement Pre-Submittal Meeting:
 1. Review the responsibilities of the County and responsibilities of the Contractor during the FSI replacement planning activities and the FSI replacement execution activities.
 2. Discuss time required by the County to perform activities determined to be the County responsibilities.
 3. Discuss time required by the Contractor to perform activities determined to be the Contractor responsibilities.
 4. Discuss anticipated work hours of FSI replacement planning activities and FSI replacement execution activities.
 5. Discuss constraints associated with activities to isolate and access the RSP wet well.
 6. Discuss required content for the FSI Replacement Planning Activities Work Plan and the FSI Replacement Execution Activities Work Plan.
 7. Discuss sequence, duration, and schedule of FSI replacement planning activities included in the FSI Replacement Planning Activities Work Plan as specified in this Section.
 8. Discuss sequence, duration, and schedule of FSI replacement execution activities included in the FSI Replacement Execution Activities Work Plan as specified in this Section.
- C. Required attendees:
 1. Project Representative
 2. Contractor's representative and other Contractor staff.

3. Other contractors, as pertinent to agenda.
4. Subcontractors, as pertinent to agenda.
5. Contractor Safety Officer.
6. Coordinate with Project Representative to determine attendees from WPTP staff that include representatives from operations, safety and County-Department of Ecology coordination.

1.08 FSI REPLACEMENT PLANNING ACTIVITIES WORK PLAN

- A. Include FSI Replacement Planning Activities Work Plan as part of Overall Operational Work Plan and Specific Operational Work Plans specified in Section 01 88 00.
- B. Comply with the procedures and requirements of Section 01 88 00.
- C. Summarize sequence, duration, and schedule of FSI replacement planning activities requiring access to RSP wet well including at a minimum the following:
 1. County activities for isolation of half of RSP wet well for FSI replacement planning activities associated with initial two FSIs.
 2. Contractor activities when occupying the RSP wet well for FSI replacement planning activities associated with initial two FSIs.
 3. County activities for returning initial half of RSP wet well back in service following FSI replacement planning activities associated with initial two FSIs.
 4. County activities for isolation of half of RSP wet well for FSI replacement planning activities associated with remaining two FSIs.
 5. Contractor activities when occupying the RSP wet well for FSI replacement planning activities associated with remaining two FSIs.
 6. County activities for returning entire RSP wet well back in service following FSI replacement planning activities associated with remaining two FSIs.
- D. Provide details of FSI replacement planning activities during Contractor wet well access including at a minimum the following:
 1. Washing down and cleaning of the RSP wet well as required for activities of Contractor and to control odors.
 2. Means and methods of making the following barriers water tight as required to permit FSI replacement planning activities in the isolated half of wet well:
 - a. The existing isolation slide gate used to isolate half of RSP wet well.
 - b. The influent channel drainage slide gates.
 - c. The gates used on bar screen channels.
 3. Dewatering provisions in isolated half of wet well due to leakage into the isolated half of the wet well.
 4. Performing measurements and verification of existing conditions in the RSP wet well and existing FSIs to determine dimensions and conditions necessary to develop design details for the new secondary isolation bulkhead and new FSI isolation slide gate for FSI openings in wet well wall.
 5. Performing measurements and verification of existing conditions in the RSP wet well and existing FSIs to allow development of demolition details for removal of existing FSIs.
 6. Performing necessary measurements and verification of existing conditions in RSP wet well and existing FSIs to allow coordination of new FSIs with new pumps.
 7. Performing measurements and verification of existing conditions of the components of the influent channel drainage slide gates to allow development of equipment submittal for replacement slide gates per Section 40 05 59.33.
 8. Performing necessary measurements and verification of existing conditions in RSP wet well to allow installation of wet well baffle.
 9. Other activities as Contractor determines necessary for planning of FSI replacement.
- E. Provide details of FSI replacement planning activities in RSP Pump Room including at a minimum the following:

1. Measurements and verification of existing conditions to allow development of design details for the new FSIs.
2. Measurements and verification of existing conditions to allow development of demolition details for removal of existing FSIs.
3. Measurements and verification of existing conditions to allow coordination of new FSIs with new pumps and existing discharge piping.

1.09 FSI REPLACEMENT PLANNING ACTIVITIES RESULTS

- A. Provide summary of dimensions and condition of each existing FSI and other RSP wet well features obtained after access to RSP wet well pump inlet channel during the FSI replacement planning activities.
- B. Provide summary of dimensions and condition of RSP Pump Room obtained during FSI replacement planning activities.
- C. Provide summary of dimensions and condition of the influent channel drainage slide gates obtained during FSI replacement planning activities.
- D. Provide verification that information obtained during the FSI replacement planning activities has been used in the development of new FSI design and in the development of the FSI Replacement Execution Activities Work Plan.

1.10 FSI REPLACEMENT EXECUTION ACTIVITIES WORK PLAN

- A. Include FSI Replacement Execution Activities Work Plan as part of Overall Operational Work Plan and Specific Operational Work Plans specified in Section 01 88 00.
- B. Comply with the procedures and requirements of Section 01 88 00.
- C. Incorporate into the work plan:
 1. Agreed upon sequence, duration, and schedule of FSI replacement activities from FSI Replacement Pre-Submittal Meeting.
 2. FSI replacement planning activities results.
- D. Provide details in the work plan for the following work elements at a minimum:
 1. FSI replacement execution activities requiring RSP wet well access:
 - a. County activities for multiple independent events requiring Contractor RSP wet well access during FSI execution replacement activities.
 - b. Contractor activities for multiple independent events requiring RSP wet well access during FSI replacement execution activities including secondary bulkhead installation and removal for each FSI.
 2. Description of FSI isolation from wet well including:
 - a. Details of secondary isolation bulkhead and use of FSI isolation slide gate during replacement of each FSI.
 3. Description of replacement of the influent channel drainage slide gates:
 - a. Details of sealing the influent channel drainage slide gates if necessary prior to replacement of the slide gates:
 - 1) The existing influent channel drainage slide gates are not to be assumed to be watertight. The openings of these gates shall be sealed during the FSI replacement execution activities to prevent flow into the construction areas downstream of the wet well and secondary isolation bulkhead arrangement. The sealing of the openings may involve adjustments to the existing gates and/or installation of a plug compatible with the drainage pipes being isolated by the influent channel drainage slide gates.
 4. Description of installation of wet well baffle.
 5. FSI replacement execution activities in RSP Pump Room:

- a. Demolition activities for removal of existing FSI.
 - 1) Demolition activities shall not affect operation of other RSPs or prevent access of County personnel to areas and other equipment in the Pump Room.
 - 2) Demolition shall not be permitted by means of explosives of any type.
- b. Preparation of cavities in the existing mass concrete foundation for installation of new FSIs including saving existing reinforcing as shown in the Drawings.
- c. Placement of new FSIs in the proper location and alignment and restoration of the reinforcing and concrete in the mass concrete foundation.
- d. Connection details of new FSI to remaining segment of existing FSI.
- e. Repair or completion of coatings inside the FSI following installation and welding
6. Description of demolition of existing FSI and detailed proposal of maintaining any portion of existing FSI.
7. Fabrication and installation details for new FSI.
8. Description of installation method for new FSI.
9. Description of methods and materials to be used to hold the FSI in its correct shape, alignment, geometry and position when subjected to the hydrostatic pressure of the fluid concrete and to prevent overstressing of the FSI.
10. Details and description of connection between new FSI and existing FSI remaining.
11. Description of installation of flow straightening vanes within FSI.
12. Description of installation of lining within FSI.
13. Description of installation of seal plate at FSI pump suction connection end.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
FSI	Carbon Steel ASTM A36; 3/8" thick
FSI Vanes	A992
FSI Lining	See Section 09 06 90
FSI Connection to Pump Suction/Fronthead	See Section 43 23 04
Secondary isolation bulkhead	Contractor designed
FSI isolation slide gate	See Section 05 50 00
Influent channel drainage slide gates	See Section 40 05 59.33
Seal plates at FSI pump suction connection end	Carbon Steel ASTM A36
Wet well baffle	See Section 05 50 00

2.02 FORMED SUCTION INLETS (FSI)

- A. As shown in the Drawings.
- B. Coordinated and incorporating information obtained during the FSI replacement planning activities.
- C. Designed to be compatible with pump fronthead (suction inlet) to allow direct connection of FSI to pump fronthead. See Section 43 23 04.

2.03 FSI ISOLATION SLIDE GATE

- A. The new FSI isolation slide gate, as shown in the Drawings, is for Contractor use to isolate an FSI during replacement and is used in addition to the secondary isolation bulkhead.
- B. Coordinated and incorporating information obtained during the FSI replacement planning activities.
- C. Similar dimensions to existing FSI isolation slide gate to allow use of existing guide channels at existing FSI openings.
- D. Fabricate and provide new FSI isolation slide gate in adequate time to allow use in conjunction with the Contractor designed secondary isolation bulkhead as part of dual isolation of individual FSI from the wet well during FSI replacement execution activities.
- E. The existing FSI isolation slide gate is not available for use by the Contractor. The existing gate is intended for County to use when isolating half of the wet well and as needed for isolating an FSI other than the FSI being replaced by the Contractor during periods when the gate is not being used to isolate half the wet well.
- F. County to retain possession of new FSI isolation slide gate upon completion of use by Contractor.

2.04 SEAL PLATES AT FSI PUMP SUCTION CONNECTION END

- A. Designed to be compatible with FSI pump suction connection end and designed to be removable and reusable.
- B. Provides watertight isolation provisions of FSI pump suction connection end when pump is not connected to FSI.
- C. Provide two seal plates:
 - 1. Seal plates are for Contractor use during construction to provide additional isolation provisions of an installed FSI during periods when a pump has not been connected to the FSI.
 - 2. County to retain possession of seal plates upon completion of use by Contractor.

2.05 WELDING AND NONDESTRUCTIVE TEST REQUIREMENTS

- A. Welded connections visual inspection and nondestructive weld testing: As specified in Section 05 05 20 Welding

PART 3 EXECUTION

3.01 RSP WET WELL ACCESS ACTIVITIES

- A. FSI planning, demolition, fabrication, and installation activities will require multiple occurrences of Contractor accessing the RSP wet well pump inlet channel. Access to the FSI wall penetrations and access to the base of the RSP wet well will require isolation and draining of portions of the RSP wet well.
- B. Actual number of Contractor required RSP wet well access events will be determined by means and methods of the Contractor and are to be included in the FSI Replacement Planning Activities Work Plan and the FSI Replacement Execution Activities Work Plan. Consider the following activities that may require access to the RSP wet well:
 - 1. FSI replacement planning activities:
 - a. Access to one half of RSP wet well for initial two FSIs.
 - b. Access to other half of RSP wet well for remaining two FSIs.
 - 2. FSI replacement execution activities:

- a. Placement of secondary isolation bulkhead for first pump to allow removal of associated existing FSI.
 - b. Removal of secondary isolation bulkhead following installation of new FSI for first pump to allow testing of first pump per Section 01 75 20.
 - c. Placement of secondary isolation bulkhead for second pump after successful Individual RSP Pump Commissioning of first pump per Section 01 75 20.
 - d. Removal of secondary isolation bulkhead following installation of new FSI for second pump to allow testing of second pump per Section 01 75 20.
 - e. Placement of secondary isolation bulkhead for third pump after successful Individual RSP Pump Commissioning of second pump per Section 01 75 20.
 - f. Removal of secondary isolation bulkhead following installation of new FSI for third pump to allow testing of third pump per Section 01 75 20.
 - g. Placement of secondary isolation bulkhead for fourth pump and wet well baffle after successful Individual RSP Pump Commissioning of third pump per Section 01 75 20.
 - h. Removal of secondary isolation bulkhead following installation of new FSI for fourth pump to allow testing of fourth pump per Section 01 75 20.
- C. County responsibilities related to RSP wet well access activities:
- 1. Isolation of one-half of RSP wet well:
 - a. Verification of operation for the RSPs to remain in service in the active half of RSP wet well.
 - b. Isolation of three bar screens for the isolated half of RSP wet well.
 - c. Verification of operation of RSP wet well pump inlet channel drainage sump.
 - d. Placement of existing isolation slide gate to isolate half of RSP wet well.
 - e. Operation of influent channel drainage slide gates as feasible based on the functionality of the specific gate per Section 40 05 59.33.
 - f. Shutting down the two isolated RSPs for time period when half of RSP wet well is isolated.
 - g. Isolation of RSP discharge pipe for two isolated RSPs at morning glory weir structures when half of RSP wet well is isolated. Contractor is responsible for isolation of RSP discharge piping during the morning glory discharge structures replacement planning, fabrication, removal and installation per Section 05 58 02.
 - 2. Returning one-half of RSP wet well to service:
 - a. Operation of bar screen isolation gates for RSP wet well.
 - b. Operation of influent channel drainage slide gates as feasible based on the functionality of the specific gate per Section 40 05 59.33.
 - c. Operation of RSP wet well pump inlet channel drainage sump.
 - d. Removal of existing isolation slide gate that isolates half of RSP wet well.
 - e. Removal of discharge pipe isolation for two isolated RSPs at morning glory weir structures. Contractor is responsible for isolation of RSP discharge piping during the morning glory discharge structures replacement planning, fabrication, removal and installation per Section 05 58 02.
- D. Contractor responsibilities related to RSP wet well access activities:
- 1. All worker safety and health provisions: See Section 01 35 29.
 - 2. Providing necessary ladders and access equipment.
 - 3. Washing down and cleaning of the RSP wet well as required for activities of Contractor and to control odors.
 - 4. Minimizing activity duration in the RSP wet well pump inlet channel to reduce the required duration of isolation.
 - 5. Dewatering or sealing provisions in isolated half of wet well due to leakage of existing isolation slide gate used to isolate half of RSP wet well, influent channel drainage slide gates, and gates used on bar screening channels.
 - a. Existing isolation slide gate used to isolate half of RSP wet well, influent channel drainage slide gates, and gates used on bar screening channels are not watertight. Leakage will occur with the gates in place. Develop methods to make gates watertight to the degree needed for each activity occurring in the wet well.
 - 6. Isolation of RSP discharge piping during the morning glory discharge structures replacement planning, fabrication, removal and installation per Section 05 58 02.

7. Verify no tools, ladders, or debris in wet well prior to County returning wet well to service.
8. All other activities required for Contractor successful RSP wet well access.

3.02 FSI REPLACEMENT PLANNING ACTIVITIES

- A. Conduct FSI Replacement Pre-Submittal Meeting.
- B. Prepare and submit FSI Replacement Planning Activities Work Plan.
- C. Access RSP wet well pump inlet channel to determine dimensions and condition of existing FSIs and other wet well features necessary to develop design details for the new secondary isolation bulkhead for FSI openings in wet well wall.
- D. Access RSP wet well to determine dimensions and condition of existing FSIs and other wet well features necessary to develop design details for the new FSIs.
- E. Access RSP wet well to determine dimensions and condition of existing FSIs and other wet well features necessary to develop design details for the new FSI isolation slide gate.
- F. Access RSP wet well to determine dimensions and condition of the components of the influent channel drainage slide gates, such as mounting, shaft diameter, pipe sleeve sizes, and other wet well features necessary to allow development of equipment submittal for replacement slide gates per Section 40 05 59.33.
- G. Perform necessary measurements and verification of existing conditions in both the RSP wet well and the RSP Pump Room to allow development of demolition details for removal of existing FSIs.
- H. Performing necessary measurements and verification of existing conditions in RSP wet well to allow installation of wet well baffle.
- I. Perform necessary measurements and verification of existing conditions in both the RSP wet well and the RSP Pump Room to allow coordination of new FSIs with new pumps and existing discharge piping.
- J. Complete other activities as Contractor determines necessary for planning of FSI replacement.
- K. Prepare FSI Replacement Planning Activities Results submittal.
- L. Prepare FSI Replacement Execution Activities Work Plan submittal.

3.03 FSI REPLACEMENT EXECUTION ACTIVITIES

- A. General
 1. FSI replacement execution activities shall be included in the Overall Operational Work Plan and Specific Operational Work Plans prepared as part of Section 01 88 00.
- B. FSI isolation:
 1. Dual isolation required to allow removal of associated existing FSI.
 2. Be responsible for design and installation of new secondary isolation bulkhead to provide dual isolation when used in conjunction with the new FSI isolation slide gate to isolate individual FSI from the wet well during FSI replacement.
 3. Coordinate with the County for installation of the new FSI isolation slide gate to be used in conjunction with the new secondary isolation bulkhead to isolate individual FSI from the wet well during FSI replacement.
- C. Replacement of the influent channel drainage slide gates:
 1. Coordinate replacement of slide gate with the placement of the secondary isolation bulkhead.

2. Sequence replacement of influent channel drainage slide gates to prevent leakage through influent channel drainage slide gates during FSI demolition and replacement.
 3. See Section 40 05 59.33.
- D. Demolition of existing FSI:
1. Concrete removal per Section 03 83 00.
 2. Demolition by any explosive means is not permitted.
 3. Demolition shall not adversely affect the continuous operation of the other RSPs.
 4. Demolition shall not extend deeper than shown in the Drawings to avoid the risk of fully penetrating the mass concrete foundation.
 5. Demolition by concrete circular saw, chainsaw, wire saw, or core drilling is permitted to the extent that it not affect operation of other RSPs or prevent access of County personnel to areas and other equipment in the Pump Room.
 6. Demolition by the use of expansive grout products is permitted to the extent that it does not adversely affect the continuous operation of the other RSPs.
 7. Demolition by the use of hydraulic rock splitters is permitted to the extent that it does not adversely affect the continuous operation of the other RSPs.
 8. Demolition shall protect the existing reinforcing shown to be saved and restored by mechanical couplers or welded splices.
- E. FSI placement:
1. Install items plumb, level and square, accurately fitted, and free from distortion or defects.
 2. Place FSI to be embedded in concrete accurately and hold in correct position while the concrete is placed. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete.
 3. Allow for fluid concrete pressure and uplift and provide temporary bracing to maintain true alignment until completion of the concrete around the FSI.
 4. Complete joining of new FSI as necessary to provide watertight conduit.
 5. Complete installation of reinforcement including mechanical or welded coupling to existing reinforcement shown to be saved in the Drawings.
- F. Seal plates at FSI pump suction connection end:
1. Install seal plate on FSI pump suction connection end when FSI has been installed and pump has not been placed on FSI.
 2. Provides additional watertight isolation provisions of Pump Room from wet well following FSI installation and prior to pump placement.
- G. Lining of FSI interior: See Section 09 06 90.

END OF SECTION

SECTION 05 58 02

MORNING GLORY DISCHARGE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies:
1. Morning Glory Discharge Structure refurbishment planning, fabrication, removal and installation.
 2. Morning Glory Discharge Slide Gate refurbishment planning, fabrication, removal and installation.
 3. Morning Glory Discharge Temporary Bulkhead at Division Channel planning, installation, and removal.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AISC 360	Specifications for Structural Steel Buildings
AISC Deign Guide 27	Structural Stainless Steel
AISC 303	Code of Standard Practice for Steel Buildings and Structures
UNS	Metals & Alloys in the Unified Numbering System
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
1. Morning Glory Discharge Refurbishment Pre-Submittal Meeting agenda and meeting notes.
 2. Morning Glory Discharge Refurbishment Planning Activities Work Plan.
 3. Morning Glory Discharge Refurbishment Planning Activities Results.
 4. Morning Glory Discharge Refurbishment Execution Activities Work Plan.
 5. Fabricator and Erector Quality Control Plans in accordance with AISC 360 Chapter N.
 - a. All portions of AISC 360 Chapter N shall be applicable to the stainless steel used in the Morning Glory Refurbishment unless noted otherwise.
 6. Fabricator's product data showing conformance to the specifications.
 7. Welding Procedure Specifications in accordance with Section 05 05 20.
 8. Detailed shop drawings for new Morning Glory Discharge Refurbishment inserts coordinated and incorporating information obtained during the Morning Glory Discharge Refurbishment planning activities.
 9. Detailed shop drawings for new Morning Glory Discharge Temporary Bulkhead coordinated and incorporating information obtained during the Morning Glory Discharge Refurbishment planning activities.
 10. Detailed shop drawing for new Morning Glory Discharge Slide Gate.
 11. Welding data and weld inspection reports, as specified in Section 05 05 20.

1.04 QUALITY ASSURANCE

- A. Shop and field welding shall conform to the requirements of Section 05 05 20.
- B. Welding and nondestructive test requirements: Section 05 05 20.
- C. The use of salvaged, reprocessed or scrap materials will not be permitted.
- D. Observation of Work: The Project Representative shall have access to any fabrication site or shop for the purpose of observing fabrication of items which will be used in or incorporated in the work.
- E. The fabricator and erector shall comply with the Quality Control Plan provided by the fabricator and erector. The Quality Control Plan shall include the inspections required in AISC 360 Table N5.4-1, N5.4-2 and N5.4-3.
- F. The fabricator and erector shall comply with the Quality Assurance Plan as required by the permit issued by the Seattle Department of Construction and Inspection. Quality Assurance inspections are permitted to be waived when the work is performed in a fabrication shop or by an erector approved by the Seattle Department of Construction and Inspection to perform the work without Quality Assurance inspections.
- G. Notification of Start of Work: Notify the Project Representative in advance of the start of the Morning Glory Discharge Structure stainless steel assembly fabrication. For fabrication sites within 50 miles of the project site, provide 48 hours notice. For fabrication sites greater than 50 miles from the project site, provide 7 days notice.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.06 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.

1.07 MORNING GLORY DISCHARGE REFURBISHMENT PRE-SUBMITTAL MEETING

- A. Conduct meeting as part of Morning Glory Discharge refurbishment planning activities and prior to preparation and submittal of the Morning Glory Discharge Refurbishment Planning Activities Work Plan and the Morning Glory Discharge Refurbishment Execution Activities Work Plan.
- B. Purpose and topics of Morning Glory Discharge Refurbishment Pre-Submittal Meeting:
 - 1. Review the responsibilities of the County and responsibilities of the Contractor during the Morning Glory Discharge refurbishment planning activities and the Morning Glory Discharge refurbishment execution activities.
 - 2. Discuss time required by the County to perform activities determined to be County responsibilities.
 - 3. Discuss time required by the Contractor to perform activities determined to be Contractor responsibilities.
 - 4. Discuss anticipated work hours of Morning Glory Discharge Structure refurbishment planning activities and Morning Glory Discharge Structure refurbishment execution activities.
 - 5. Discuss constraints associated with activities to isolate and access the Division Channel to install the Morning Glory Discharge Temporary Bulkhead.
 - 6. Discuss required content for the Morning Glory Discharge Structure Refurbishment Planning Activities Work Plan and the Morning Glory Discharge Structure Refurbishment Execution Activities Work Plan.

7. Discuss sequence, duration, and schedule of Morning Glory Discharge Structure refurbishment planning activities included in the Morning Glory Discharge Refurbishment Planning Activities Work Plan as specified in this Section.
 8. Discuss sequence, duration, and schedule of Morning Glory Discharge Structure refurbishment execution activities included in the Morning Glory Discharge Refurbishment Execution Activities Work Plan as specified in this Section.
- C. Required attendees:
1. Project Representative
 2. Contractor's representative and other Contractor staff.
 3. Other contractors, as pertinent to agenda.
 4. Subcontractors, as pertinent to agenda.
 5. Contractor Safety Officer.
 6. Coordinate with Project Representative to determine attendees from WPTP staff that include representatives from operations, safety and County-Department of Ecology coordination.

1.08 MORNING GLORY DISCHARGE STRUCTURES REFURBISHMENT PLANNING ACTIVITIES WORK PLAN

- A. Include Morning Glory Discharge Structures Refurbishment Planning Activities Work Plan as part of Overall Operational Work Plan and Specific Operational Work Plans specified in Section 01 88 00.
- B. Comply with the procedures and requirements of Section 01 88 00.
- C. Fabrication details for new stoplogs for Division Channel isolation.
- D. Summarize sequence, duration, and schedule of Morning Glory Discharge Structures refurbishment planning activities requiring access to the Division Channel including at a minimum the following:
 1. County activities for isolation of the Division Channel required to allow the Morning Glory Discharge Temporary Bulkhead installation planning activities associated with each Morning Glory Discharge Structures being refurbished.
 2. Contractor activities for occupying the Division Channel required to allow the Morning Glory Discharge Temporary Bulkhead installation planning activities associated with each Morning Glory Discharge Structures being refurbished.
 3. County activities for returning the Division Channel to service following the Morning Glory Discharge Temporary Bulkhead installation planning activities.
 4. Contractor activities for returning the Division Channel to service following the Morning Glory Discharge Temporary Bulkhead installation planning activities.
- E. Provide details of Contractor activities when accessing the Division Channel during the Morning Glory Discharge Structures refurbishment planning activities including at a minimum the following:
 1. Requirements to access the Division Channel.
 2. Means of installing stoplogs in the Division Channel to isolate half of the Division Channel.
 3. Washing down and cleaning of the mounting surface proposed for the new Morning Glory Discharge Temporary Bulkhead as required for planning activities of Contractor.
 4. Determining dimensions and condition of the Division Channel required to develop design details for the new Morning Glory Discharge Temporary Bulkhead and to develop means and methods of installing the new Morning Glory Discharge Temporary Bulkhead during the Morning Glory Discharge Structure Refurbishment execution activities.
 5. Performing necessary measurements and verification of existing conditions in the Morning Glory Discharge Structure to allow development of demolition details for removal of the concrete shown to be removed for installation of the new stainless steel box, slide gate frames and checkered plate support angles.
 6. Other activities as Contractor determines necessary for planning of Morning Glory Discharge Structure refurbishment.

1.09 MORNING GLORY DISCHARGE STRUCTURE REFURBISHMENT PLANNING ACTIVITIES RESULTS

- A. Provide summary of dimensions and condition of each existing Morning Glory Discharge Structure and other Division Channel features obtained after access to Morning Glory Discharge Structures and Division Channel during the Morning Glory Discharge Structure refurbishment planning activities.
- B. Provide verification that information obtained during the Morning Glory Discharge Structure refurbishment planning activities has been used in the development of new Morning Glory Discharge Structure design and in the development of the Morning Glory Discharge Structure Refurbishment Execution Activities Work Plan .

1.10 MORNING GLORY DISCHARGE STRUCTURE REFURBISHMENT EXECUTION ACTIVITIES WORK PLAN

- A. Include the Morning Glory Discharge Structure Refurbishment Execution Activities Work Plan as part of Overall Operational Work Plan and Specific Operational Work Plans specified in Section 01 88 00.
- B. Comply with the procedures and requirements of Section 01 88 00.
- C. Use the Morning Glory Discharge Structure refurbishment planning activities results in the development of the Morning Glory Discharge Structure Refurbishment Execution Activities Work Plan.
- D. Fabrication details for new Morning Glory Discharge Structure.
- E. Summarize sequence, duration, and schedule of Morning Glory Discharge Structures refurbishment execution activities including at a minimum the following:
 - 1. Description of Morning Glory Discharge Structure isolation from Division Channel including details of Morning Glory Discharge Temporary Bulkhead.
 - 2. Description of Morning Glory Discharge Structure refurbishment execution activities requiring Morning Glory Discharge Structure access prior to demolition of the concrete slab over the Morning Glory Discharge Structure:
 - a. Access the Morning Glory Discharge Structure, prior to demolition of the concrete slab, is limited to remote video inspection or electronic measurement.
 - 3. Description of Morning Glory Discharge Structure refurbishment execution activities after demolition of existing concrete slab over the Morning Glory Discharge Structure:
 - a. Demolition activities for removal of existing Morning Glory Discharge Structures:
 - 1) Demolition activities shall not affect the operation of the pumps at the remaining discharge structures.
 - 2) Demolition shall not be permitted by means of explosives of any type.
 - 3) Demolition activities shall only occur at the discharge structure of the pump being replaced, after the pump has been removed from service in compliance with constraints of Section 01 14 00.
 - b. Description of installation method for new Morning Glory Discharge Structure:
 - 1) Description of methods and materials to be used to hold the Morning Glory Discharge Structure stainless steel assemblies in their correct shape, alignment, geometry and position when subjected to the hydrostatic and buoyant pressure of the fluid non-shrink grout and to prevent overstressing of the Morning Glory Discharge Structure.
 - 2) Description of grouting all spaces around and below the new Morning Glory Discharge Structures stainless steel assembly:
 - a) Placing grout in lifts to prevent buoyancy or displacement of the Morning Glory Discharge Structures stainless steel assembly.
 - b) Sealing spaces with compressible foam rod to prevent grout leakage into the Division Channel.
 - c) Installing and welding access holes (10 inch diameter and 24 inch diameter) in top of the Morning Glory Discharge Structures stainless steel assemblies.

- c. Placement of reinforcing above the Morning Glory Discharge Structures stainless steel assemblies.
4. Coordination of inspection of the existing concrete in the Morning Glory Discharge Structures by the County prior to the installation of the new Morning Glory Discharge Structures.
5. Coordination with the completion of the Discharge Pipe Lining Renewal.
6. Remove the Morning Glory Discharge Temporary Bulkhead prior to putting the pump back in service.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials specified are acceptable for the application.
- B. Materials of construction:

Component	Material
Morning Glory Discharge Structure box assembly	UNS S32205 (ASTM A240 Grade 2205)
Morning Glory Discharge Structure Slide Gate frames	UNS S32205 (ASTM A240 Grade 2205)
Morning Glory Discharge Structure checkered plate support angles	UNS S32205 (ASTM A240 Grade 2205)
Morning Glory Discharge Structure checkered plate at slide gate	UNS S32205 (ASTM A240 Grade 2205)
Morning Glory Discharge Structure Slide Gate	UNS S31603 (ASTM A240 Grade 316L)
Welded Headed Studs	UNS S31603 (ASTM A240 Grade 316L)
Morning Glory Discharge Temporary Bulkhead	ASTM A36
Stoplogs for Division Channel Isolation	8 inch by12inch, Untreated, Douglas Fir/Larch Select Structural. See Drawing S0502 from the Record Drawings for "West Point Treatment Plant Division Channel Repairs", Contract C03063C, Dated June 2000. See Section 01 13 00.

2.02 MORNING GLORY DISCHARGE STRUCTURE

- A. As shown in the Drawings.
- B. Coordinated and incorporating information obtained during the Morning Glory Discharge Structure refurbishment planning activities.

2.03 MORNING GLORY DISCHARGE STRUCTURE SLIDE GATE

- A. The new Morning Glory Discharge Structure slide gate (gate numbers 704-GT03BN012, 704-GT03BN022, 704-GT03BN032, and 704-GT03BN042), as shown in the Drawings.
- B. Coordinated and incorporating information obtained during the Morning Glory Discharge Structure refurbishment planning activities.

2.04 WELDING AND NONDESTRUCTIVE TEST REQUIREMENTS

- A. Welded connections visual inspection and nondestructive weld testing: As specified in Section 05 05 20 Welding.

2.05 STOPLOGS FOR DIVISION CHANNEL ISOLATION

- A. Verify dimensions with existing stoplog frame in Division Channel.

PART 3 EXECUTION

3.01 MORNING GLORY DISCHARGE STRUCTURE ACCESS ACTIVITIES AND RESPONSIBILITIES

- A. Morning Glory Discharge Structure planning, demolition, fabrication, and installation activities will require multiple occurrences of Contractor accessing the Division Channel and individual Morning Glory Discharge Structures. Access to the Division Channel will require isolation and draining of portions of the Division Channel while flow is maintained in the non-isolated portions of the Division Channel.
- B. Actual number of Contractor required Morning Glory Discharge Structure access events will be determined by means and methods of the Contractor and are to be included in the Morning Glory Discharge Structure Refurbishment Planning Activities Work Plan and the Morning Glory Discharge Structure Refurbishment Execution Activities Work Plan. Consider the following activities that may require access to the Division Channel and the Morning Glory Discharge Structures:
 - 1. Morning Glory Discharge Structure refurbishment planning activities.
 - 2. Morning Glory Discharge Structure refurbishment execution activities:
 - a. Placement of Morning Glory Discharge Temporary Bulkhead to allow isolation of the Morning Glory Discharge Structure from the Division Channel.
 - b. Removal of Morning Glory Discharge Temporary Bulkhead following completion of the Morning Glory Discharge Structure repairs.
 - c. Multiple access events will be necessary for placement and removal of individual Morning Glory Discharge Temporary Bulkheads to comply with the phased RSP replacement constraints in Section 01 14 00.
- C. County responsibilities related to Division Channel access activities:
 - 1. Coordination with the Contractor for installation of the stoplogs and control of flow to isolate a portion of the Division Channel.
 - 2. Returning the isolated portion of the Division Channel to operation following activities requiring access.
- D. Contractor responsibilities related to RSP Morning Glory Discharge Structure and Division Channel access activities:
 - 1. All worker safety and health provisions: See Section 01 35 29.
 - 2. Providing necessary ladders and access equipment.
 - 3. Washing down and cleaning of the RSP Division Channel and Morning Glory Discharge as required for activities of Contractor.
 - 4. Minimizing activity duration in the RSP Division Channel to reduce the required duration of isolation.
 - 5. Isolation of RSP discharge piping during the modifications to Morning Glory Discharge Structure.
 - 6. Verify no tools, ladders, or debris in work areas prior to County returning Division Channel or Morning Glory Discharge Structure to service.
 - 7. All other activities required for Contractor successful RSP Division Channel or Morning Glory Discharge Structure access.
 - 8. Design, fabrication and installation and removal of the Morning Glory Discharge Temporary Bulkhead.

3.02 MORNING GLORY DISCHARGE STRUCTURE REFURBISHMENT PLANNING ACTIVITIES

- A. Conduct Morning Glory Discharge Structure Refurbishment Pre-Submittal Meeting.
- B. Prepare and submit Morning Glory Discharge Structure Refurbishment Planning Activities Work Plan.

- C. Coordinate with the Project Representative for installation of the stoplogs and control of flow to isolate a portion of the Division Channel.
- D. Complete a phased approach to the planning activities with the constraint that the Division Channel isolation will allow limited duration access to either the east or west side of the Division Channel while flow will be maintained to the other side of the Division Channel.
- E. Division Channel isolation during planning activities shall be limited to the following durations:
 - 1. Time required in the isolated portion of the RSP Division Channel to determine dimensions and condition of the Division Channel necessary to develop design details for the new Morning Glory Discharge Temporary Bulkhead for openings in Division Channel wall.
 - 2. Time required in the isolated portion of the RSP Division Channel to perform necessary measurements and verification of existing conditions in both the RSP Division Channel and the Morning Glory Discharge Structure to allow development of demolition details for removal of existing Morning Glory Discharge Structure and associated features to the limits shown on the Contract Drawings.
 - 3. The duration of the isolation for either side of the Division Channel is limited to 120 hours per event.
- F. Coordinate with the Project Representative for removal of the stoplogs and returning flow to the entire Division Channel following planning activities that required access to the Division Channel.
- G. Complete other activities as Contractor determines necessary for planning of Morning Glory Discharge Structure refurbishment.
- H. Prepare Morning Glory Discharge Structure Refurbishment Planning Activities Results submittal.
- I. Prepare Morning Glory Refurbishment Execution Activities Work Plan submittal.

3.03 MORNING GLORY REFURBISHMENT EXECUTION ACTIVITIES

- A. General
 - 1. Morning Glory Discharge Structure refurbishment execution activities shall be included in the Overall Operational Work Plan and Specific Operational Work Plans prepared as part of Section 01 88 00.
 - 2. Phased approach to execution activities shall be coordinated with the constraints of RSP replacement in Section 01 14 00.
- B. Division Channel isolation:
 - 1. Coordinate with the Project Representative for installation of the stoplogs and control of flow to isolate a portion of the Division Channel.
 - 2. Complete a phased approach to the execution activities with the constraint that the Division Channel isolation will allow limited duration access to either the east or west side of the Division Channel while flow will be maintained to the other side of the Division Channel.
 - 3. Division Channel isolation during execution activities shall be limited to the following durations:
 - a. Time required in the isolated portion of the RSP Division Channel to install the Morning Glory Discharge Temporary Bulkhead at individual Morning Glory Discharge Structures prior to demolition and reconstruction of the Morning Glory Discharge Structure.
 - b. Time required in the isolated portion of the RSP Division Channel to remove the Morning Glory Discharge Temporary Bulkhead at individual Morning Glory Discharge Structures upon completion of the Morning Glory Discharge Structure repairs.
 - c. Multiple access events will be necessary for placement and removal of individual Morning Glory Discharge Structure Temporary Bulkheads to comply with the phased RSP replacement constraints in Section 01 14 00.
 - d. The duration of the isolation for either side of the Division Channel is limited to 120 hours per event.

4. Coordinate with the Project Representative for removal of the stoplogs and returning flow to the entire Division Channel following execution activities that required access to the Division Channel.
- C. Morning Glory Discharge Structure Isolation:
1. A Morning Glory Discharge Temporary Bulkhead is required at the interface with the Division Channel to access the existing Morning Glory Discharge for demolition and reconstruction of the Morning Glory Discharge Structure.
 2. Be responsible for design and installation of new Morning Glory Discharge Temporary Bulkhead at Division Channel to provide isolation during Morning Glory Discharge Structure refurbishment.
 3. Be responsible for the phased approach of multiple access events necessary for placement and removal of individual Morning Glory Discharge Structure Temporary Bulkheads to comply with the phased RSP replacement constraints in Section 01 14 00.
- D. Demolition of existing Glory Discharge Structure :
1. Concrete removal per Section 03 83 00.
 2. Demolition by any explosive means is not permitted.
 3. Demolition shall not adversely affect the continuous operation of the other RSPs.
 4. Demolition shall not extend deeper than shown in the Drawings to avoid the risk of breaching .
 5. Demolition by hydro-demolition, concrete circular saw, chainsaw, wire saw, or core drilling is permitted to the extent that it does not adversely affect the continuous operation of the other RSPs.
 6. Demolition by the use of expansive grout products is permitted to the extent that it does not adversely affect the continuous operation of the other RSPs.
 7. Demolition by the use of hydraulic rock splitters is permitted to the extent that it does not adversely affect the continuous operation of the other RSPs.
 8. Demolition shall protect the existing reinforcing shown to be saved and restored by mechanical couplers or welded splices.
- E. Morning Glory Discharge Structure Placement:
1. Install items plumb, level and square, accurately fitted, and free from distortion or defects.
 2. Place Morning Glory Discharge Structure to be embedded in concrete accurately and hold in correct position while the grout is placed. Thoroughly clean the surfaces of metalwork in contact with or embedded in grout or concrete.
 3. Allow for fluid grout pressure and buoyant uplift and provide temporary bracing to maintain true alignment until completion of the concrete around the Morning Glory Discharge Structure.
 4. Reinstall the existing discharge cone.
 5. Complete installation of reinforcement including mechanical or welded coupling to existing reinforcement shown to be saved in the Drawings.
 6. Removal of Morning Glory Discharge Structure Temporary Bulkhead following completion of the Morning Glory Discharge Structure repairs.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies rough carpentry, consisting of wood framework using lumber and plywood, and rough hardware to join the members and anchor framework to other construction.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A153/A153M	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
PS 2	Performance Standard for Wood Structural Panels 2018
PS 20	American Softwood Lumber Standard 2021

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. A detailed list of materials and type of fasteners proposed for use.
- C. On a project-wide basis, provide the following:
1. Total cost of FSC certified lumber used in final structure.
 2. Percent of total wood cost for FSC certified lumber used in final structure.

1.04 QUALITY ASSURANCE

- A. Perform the work in accordance with the following agencies:
1. Lumber Grading Agency: West Coast Lumber Inspection Bureau.
 2. Plywood Grading Agency: Certified by the Engineered Wood Association.

PART 2 PRODUCTS

2.01 LUMBER MATERIALS

- A. Unless specified otherwise, Grades and species shall be:
1. Douglas Fir: Graded in compliance with one of the following:
 - a. West Coast Lumber Inspection Bureau - Standard Grading and Dressing Rules No. 16 for Douglas Fir, West Coast Hemlock, Sitka Spruce, Western Red Cedar.
 - b. Western Wood Products Association - Grading Rules.

2. Western Larch - Western Hemlock: May be used in lieu of Douglas fir if of equal or better stress grade and quality than the grades of Douglas fir specified and if graded in compliance with either of the grading rules specified.

B. Seasoning:

1. Before surfacing, air or kiln dry to a moisture content not to exceed 19 percent.
2. Before incorporation into the work, allow to attain a state of equilibrium with the local atmosphere.
3. Air season not less than 30 days before covering with finish materials.
4. If specifications for pressure treating state the maximum percentages of moisture content at the time of treatment, comply with those requirements.

C. Forest Stewardship Council (FSC) Wood:

1. Fifty percent (50%) of all wood used on the project shall be FSC Certified Wood.
2. All permanent wood building materials and components including but not limited to blocking, finishes, and furnishes must be included in the calculation. New wood materials used for temporary purposes (e.g. formwork, bracing, etc) may also be included in the calculation. It is not necessary to include all other temporary wood products in the calculation.

2.02 PLYWOOD

- A. Comply with U.S. Department of Commerce Product Standard PS 1-74. Grade and grade-mark by the Engineered Wood Association.
- B. Use the galvanized variety of bolts, nuts, and washers, in compliance with ASTM A153, in locations subject to moisture, outside, in portions of the structure that are not completely enclosed, or as indicated elsewhere.

2.03 ACCESSORIES

- A. Fasteners: Galvanized steel for exterior, high humidity, and treated wood locations.
- B. Bolts:
 1. Grade A, with square or hexagonal heads, comply with ASTM A307.
 2. Sizes and spacing shall be as required by the Drawings.
 3. Fit heads and nuts bearing on wood with washers.
- C. Nails:
 1. Sizes and types of nails shall be as indicated, specified, or required for the purpose.
 2. Comply with FEDSPEC FF-N-105A.
 3. Unless otherwise indicated, use galvanized nails.
- D. Special Purpose Nails:
 1. Acceptable Manufacturer:
 - a. Independent Nail Corporation, Bridgewater Mass.
 - b. Philstone Nail Corp., Needham Heights, Mass.
 - c. Approved Equal.
 2. Types:
 - a. "Screw Tite" common spiral thread nails.
 - b. "Tite" hardened steel, knurled masonry nails (0.148-inch to 0.177-inch diameter).
 - c. "Heavy Duty" masonry nails (0.250-inch diameter).
 - d. Concrete stub nails (0.148-inch diameter).
 3. Requirements for galvanizing or other types of noncorrosive coating shall be as specified above.
- E. Building Paper: No. 15 asphalt saturated felt.

2.04 WOOD TREATMENT

- A. Pressure treatment: Comply with FEDSPEC TT-W-5711.
- B. Lumber in contact with concrete or masonry shall be untreated western red cedar or pressure treated Douglas fir, larch or hemlock.
- C. Acceptable treatments:

Applicable FEDSPEC		
Preservative	Final retention formula	lb/cu ft
Chromated zinc chloride	TT-W-551	0.75
Wolman salts	TT-W-573	0.35
Acid cupric chromate	TT-W-546	0.50
Chemonite	TT-W-571c	0.30

PART 3 EXECUTION

3.01 FRAMING

- A. Grounds and nailers:
 - 1. Accurately cut members to required sizes and securely fasten to the structure.
 - 2. Place horizontal members crown side up.
 - 3. Fasten wood nailers on steel frames with recessed bolt heads and install with washers.
- B. Plywood:
 - 1. Perform nailing in accordance with the Drawings.
 - 2. Cover all plywood nailing only after it has been inspected and approved.
- C. Furring and stripping: Provide and shim where indicated or where necessary to align faces of finish materials in a single plane.

3.02 FASTENERS

- A. Bolts: Holes for bolts in steel plates and angles shall be drilled 1/16-inch greater than bolt diameter.
- B. Powder-actuated fasteners:
 - 1. Use powder-actuated fasteners only where specifically permitted hereinafter, or when subsequently approved, provided all available safety features and guards are used.
 - 2. If adequate, use low velocity equipment.
 - 3. Submit a detailed list of equipment and type of fasteners for the Project Representative's approval prior to use.

3.03 CONNECTIONS

- A. Accurately saw-cut and fit lumber into the respective locations, true to line, grade and level, as indicated or required. Permanently secure in proper position with spikes, nails, lag screws, bolts, hangers, or other fastenings, to make the work substantial and rigid in all parts and connections.
- B. Make connections between members tight, accurate, and secure.
- C. Place fastenings without splitting wood, using pre-drilling when required.
- D. Drill bolt holes to the same size as bolt diameters.

- E. Drill holes for lag screws to the same size as thread root diameters and counter-bore to the same depth and diameter as the shank.
- F. Turn lag screws in place, do not drive.
- G. Provide bolts and lag screws with washers under every head and nut that bear on the wood.
- H. Tighten bolts and lag screws at installation and carefully retighten just prior to closing in or at completion of the project.
- I. When treated members are cut to shape or size, perform such cutting or shaping before treatment.
- J. Where members are cut after treatment or countersunk for flush installation of bolt heads, paint the cut surfaces with two saturating coats of treating liquid before installation.

END OF SECTION

SECTION 06 83 16

FIBERGLASS REINFORCED PANELING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies fiberglass reinforced plastic panels used on inside face of new exterior stud wall at Screening Room.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM D256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics 2010 (Reapproved 2018).
ASTM D3273	Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2021.
ASTM D5319	Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels 2017.
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
FM 4880	Evaluating the Fire Performance of Insulated Building Panel Assemblies and Interior Finish Materials 2017.
ISO 846	Plastics - Evaluation of the Action of Microorganisms 2019.

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.

Manufacturer's data showing compliance with the specified products and special storage, handling, and installation instructions. Samples: Submit two samples 4 by 6 inch in size illustrating material and surface design of panels.

Maintenance Materials: Furnish materials as recommended by manufacturer.

1.04 DELIVERY, STORAGE AND HANDLING

- A. See Section 01 67 00.
- B. Clearly identify manufacturer, contents, brand name, and R-value on each package.
- C. Store insulation materials off ground in a completely dry location. Protect against weather, condensation, and damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Crane Composites, Inc: Model: Glasbord Class C pebbled, Surfaseal Finish.
 - 2. Marlite, Inc; Model: Standard FRP Panels, Pebbled.
 - 3. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. FRP Paneling, FRP-1
 - 1. Slightly textured surface, Pebbled, white FRP paneling.
 - 2. Panel Size: 4 by 8 feet.
 - 3. Panel Thickness: 0.10 inch.
 - 4. Surface Design: Embossed.
 - 5. Color: White.
 - 6. Attachment Method: Adhesive only, sealant joints, no trim.
 - 7. Factory Mutual Approval per Standard 4880.
- C. Panel Characteristics
 - 1. Fiberglass reinforced plastic (FRP), complying with ASTM D5319.
 - 2. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when system tested in accordance with ASTM E84.
 - 3. Class 1 fire rated when tested in accordance with FM 4880.
 - 4. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 5. Impact Strength: Greater than 6 ft lb force per inch, when tested in accordance with ASTM D256.
 - 6. Biological Resistance: Rating of 0, when tested in accordance with ISO 846.
- D. Adhesive: Advanced Polymer, Advanced Polymer Panel Adhesive or as recommended by panel manufacturer.
- E. Sealant: Two-part polyurethane sealant for the seams and edges of the panels.
- F. No trim.

2.03 FINISHES

- A. Pebbled, White

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions and substrate flatness before starting work.
- B. Verify that substrate conditions are ready to receive the work of this Section.

3.02 INSTALLATION

- A. Inspect cement board substrate for plumb alignment and continuous backing. Substrate must be even and continuous to prevent loose spots, bulges, and buckles.
- B. Per manufacturer's instructions.

- C. Cut and drill panels with carbide tipped saw blades, drill bits, or snips.
- D. Adhere FRP panels using Advanced Polymer Adhesive applied to the back side of panel using trowel as recommended by adhesive manufacturer.
- E. Apply panels to wall with seams plumb and pattern aligned with adjoining panels.
- F. Install panels with manufacturer's recommended gap for panel field and corner joints.
- G. Seal gaps with applicable sealant to prevent moisture intrusion.
- H. Remove excess sealant after paneling is installed and prior to curing.

END OF SECTION

SECTION 06 84 00

FIBERGLASS REINFORCED PLASTIC (FRP)

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies general requirements for fiberglass reinforced plastic (FRP) including items fabricated with both polyester and epoxy resins.
- B. Equipment-specific requirements are detailed in other Sections and in the Drawings. This Section is to be used in conjunction with the other related equipment specification Sections and the Drawings. In case of conflict between the requirements of this Section and those listed in the specific equipment specification, the requirements of the specific equipment specification shall prevail.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM D2583	Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D3299	Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
National Bureau of Voluntary Stds PS 15	Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment
	The Society of the Plastics Industry, Inc., Recommended Practice for Shipping and Installation Reinforced Plastic Pipe, Duct and Tanks

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer and method of fabrication.
- C. Materials selected for laminates to be furnished for Contract.
- D. Manufacturer's shop drawings.
- E. Installation procedures, including field-jointing techniques.

1.04 QUALITY ASSURANCE

- A. Allowable Tolerances:
 - 1. Test Tolerances:
 - a. The average value of each of the tests performed on sample specimens for each individual FRP item shall satisfy the requirements set forth in:
 - 1) Table A, Hardness Requirements for Resins.

- 2) Table B, Minimum Requirements for Laminate Fabrication by Contact Molding, Matched Die Molding, and Filament Winding; ASTM D3299 and PS 15.
- b. Should an individual FRP item be found deficient in any of the tests, the testing laboratory shall select a second series of sample specimens as specified in this Section and shall perform all tests on these specimen coupons. Failure of the second series of coupons to satisfy the physical requirements shall constitute cause for rejection of that individual FRP item.

Table A - Hardness Requirements for Resins ¹	
Resins ²	Barcol hardness, ³ minimum average
Type A (non-fire resistant)	
Atlac 382	30
Atlac 382 (4010A) d	35
Atlac 580	30
Derakane 411-45d	30
Derakane 470-36	40
Dion Cor-Res 6694	30
Dion Cor-Res 7000d	30
Hetron 197	40
Type A (fire-resistant)	
Atlac 711-05A plus 3% antimony trioxide (Sb ₂ O ₃)	30
Atlac 797AT plus 3% antimony trioxide (Sb ₂ O ₃)	40
Derakane 510N	30
Derakane 510A-40 plus 5% antimony trioxide (Sb ₂ O ₃)	30
Dion Cor-Res 6695 plus 3% antimony trioxide (Sb ₂ O ₃)	30
Hetron 92 FR	40
Hetron 197 plus 5% antimony trioxide (Sb ₂ O ₃)	40
Hetron 800 FR	40
Type B (fire-resistant)	
Aropol 7240	40
Atlac 400	35
Dion/SO 6631	40
Atlac 793 plus 5 percent antimony trioxide (Sb ₂ O ₃)	30
Dion Cor-Res 6693 plus 5 percent antimony trioxide (Sb ₂ O ₃)	30

Notes:

1. For resins not listed, Barcol hardness shall be at least 90 percent of the resin manufacturer's minimum specified hardness for the cured resin.
2. For description of Types A and B resins, refer to Paragraph 06 84 00.
3. Determined with Barcol impressor, Model GYZJ 934-1 calibrated at 2 points in accordance with ASTM D2583.
4. Resins that shall be used for filament-winding construction.

Table B - Minimum Requirements for Laminate Fabrication by Contact Molding, Matched Die Molding, and Filament Winding

Method of Laminate Fabrication	Property	Laminate Thickness, inches			
		3/16 & less	1/4	5/16	3/8 & up
Contact molded, and matched die molded	Glass content percent ⁰	25-30	30-34	34-38	38-42
Filament wound process	Glass content percent	25-30	30-34	34-38	38-42
	Ultimate tensile strength, a psi	40,000	40,000	40,000	40,000
	Modulus of elasticity (tangent), b psi	3x10 ⁶	3x10 ⁶	3x10 ⁶	3x10 ⁶

Notes:

1. *Minimum hoop tensile strength.*
2. *Minimum hoop tensile modulus of elasticity.*

2. Product Tolerances:

- a. General: Reject any FRP specialty item that does not satisfy the tolerances specified in this Section.
- b. Section Uniformity: Wall, flange and edge thickness shall be uniform to within +1/32 of an inch in 12 inches.
- c. Color: Items of a similar nature or subassemblies of a single unit shall be similar in color.
- d. Out-of-Round and Parallel:
 - 1) Unless otherwise indicated, the out-of-round tolerance for cylindrical sections 12 inches in diameter and greater shall be 1/2 that listed in NBS PS-15 for ductwork. The out-of-round tolerance for cylindrical sections smaller than 12 inches in diameter shall be as listed in NBS PS-15.
 - 2) Out-of-parallel tolerance for rectangular and square sections shall be as specified for out-of-round.
- e. Flanges:
 - 1) Flange faces shall be flat and true to a tolerance of +1/32-inch for tanks, and 1 percent of the nominal diameter or 1/8-inch for ducts, whichever is less.
 - 2) Variation in manhole flange thickness shall be within +1/16-inch. Variations in all other flanges shall be within +1/32-inch. Tolerance in bolt hole locations and in bolt circle diameter shall be within +1/16-inch.
- f. Surfaces: Tolerances for defects on the surface of FRP items are specified in Table C of this a Section.

Table C - Allowable Product Surface Tolerances		
Defect	Surface Inspected	
Cracks	Process Side	Non-process Side
Crazing (fine surface cracks)	None	Max. length: /2-inch
		Max. density: 5 per sq. ft.
		Min. separation: 2-inch
Blisters (rounded elevations of the laminate surface over bubbles)	None	Max. dimension: 1/4-inch dia x 1/8-inch high
		Max. density: 1 per sq ft.
		Min. separation: 2-inch apart
Wrinkles and solid blisters	Max. deviation: 10% of wall thickness, but not exceeding 1/8-inch	Max. deviation: 10% of wall thickness, but not exceeding 1/8-inch
Pits (craters in the laminate surface)	Max. dimension: 1/8-inch dia. x 1/32-inch deep	Max. dimension: 1/8-inch dia. x 1/16-inch deep
	Max. number: 10 per sq. ft.	Max. density: 10 per sq.ft.
Surface porosity (pin holes or pores in the laminate surface)	None	None
Chips	None	Max. Dimension of break: 1/4 inch and thickness no greater than 10% of wall thickness
		Max. density: 1 per sq ft
Dry spot (nonwetted reinforcing)	None	Max. dimension: 2 sq inch per sq ft
		Max. dimension of break: 1/4-inch and thickness no greater than 10% of wall thickness
Entrapped air (bubbles or voids in the laminate)	Max. dia.: 1/16-inch	Max. dia. and density: /8-inch and 4 sq inch or 1/16-inch and 10 per sq inch
	Max. density: 10 per sq. inch but none to a depth of 1/32 -inch	
Exposed glass	None	None
Burned areas	None	None
Exposure of cut edges	None	None
Scratches	None	Max. length: 1 inch
		Max. depth: 0.010-inch
Foreign matter	None	None

1.05 PRODUCT SHIPPING, STORAGE AND HANDLING

- A. Be responsible for proper packaging and protection of all materials to prevent damage during shipping, handling and storage.
- B. As material arrives on site, it will be inspected for compliance with "Recommended Practices for Shipping and Installation of Reinforced Plastic Pipe, Duct and Tanks". The Society of the Plastics Industry, Inc.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Resins:
 - 1. General:
 - a. Resins used for FRP specialties exposed to view shall contain antimony compounds or other fire retardant agents and shall have a flame spread rating of 25 or less based on ASTM E84.
 - b. No thixotropic agent shall be added to resins used for a corrosion barrier:
 - 1) Up to 2 percent by weight of thixotropic agent may be added for viscosity control of resins not used for a corrosion barrier. The quantity of thixotropic agent added, however, shall not interfere with visual inspection of the laminate.
 - 2) No other fillers to the resin, including pigments, dyes and colorants, shall be permitted, unless approved in writing by the Project Representative.
 - 2. Type A Resin:
 - a. Shall provide sufficient chemical resistance under the corrosive environments listed in the detailed specifications for FRP structures and equipment.
 - b. Where specified, shall also meet flame spread requirements as given in this Section.
 - c. Shall be selected from the resins listed in Table A of this Section.
 - 3. Type B Resin:
 - a. Shall be suitable for weather-resistant, non-corrosive chemical service and, where specified, shall meet flame spread requirements as given in this Section.
 - b. Shall be selected from the resins listed in Table A of this Section.
 - c. Type A resins may be substituted for Type B resins.
- B. Reinforcement:
 - 1. General: Glass reinforcement shall be Type C, chemical glass, or Type E, electrical glass, as specified.
 - 2. Surfacing Veil:
 - a. Type C glass surfacing mat with silane finish and styrene-soluble barrier.
 - b. Thickness: 10 to 20 mils for all applications, except those involving exposure to chlorine or hypochlorite solutions, where a minimum 20-mils thickness shall be employed.
 - c. Surfacing veils for applications where the glass may be attacked by compounds in the process shall be a suitable spun-laced synthetic organic entangled fiber fabric, such as Nexus, not less than 20 mils in thickness, backed by chopped strand in a Type A resin.
 - 3. Chopped Strand Mat: Type E glass, 1-1/2 oz/sq ft with silane finish and a styrene-soluble binder.
 - 4. Continuous Roving:
 - a. That used in chopper guns for spray-up shall be Type E glass with chrome finish or silane coupling agent.
 - b. Continuous roving used for filament winding shall be Type E glass with silane-type finish.
 - 5. Woven Roving: Type E glass, 24 oz/sq yd, 4 by 5 weave, with silane-type finish.
 - 6. Woven Cloth: Type E glass with silane-type finish.
- C. Miscellaneous:
 - 1. Stainless Steel: Unless otherwise indicated, stainless steel nuts, bolts, washers, hangers and miscellaneous fabricated parts shall be ANSI Type 316.
 - 2. Gaskets: Unless otherwise indicated, gaskets shall be neoprene.

PART 3 EXECUTION

3.01 GENERAL

- A. Ship, install, join and erect FRP specialties under the direction of factory-trained specialists.
- B. Where jointing is required, employ workers who have been trained in proper jointing techniques by the FRP manufacturer's representative.

- C. Affix to fabricated equipment a warning reading "Plastic Equipment Handle with Care", stenciled on two sides in letters a minimum of 2 inches high.

3.02 FABRICATION

- A. Fabricate FRP items by the contact molding, filament winding, or pultrusion method:
 - 1. Contact Molding: Unless otherwise indicated, contact-molding fabrication shall be in conformance with NBS PS-15. Perform lay-up in the following sequence:
 - a. Provide an interior surface corrosion barrier:
 - 1) Laminate thickness shall be 100-mils minimum. Do not use a separately cured, unreinforced gel coat.
 - 2) Make the interior surface layer resin-rich, smooth and reinforced with a 10- to 20-mil Type C glass-surfacing veil saturated with Type A resin.
 - 3) Cover the interior surface layer with a minimum of 3 ounces per square foot of chopped strand mat and resin in 2 plies of 1 1/2-ounce mat saturated with Type A resin.
 - 4) Allow the interior surface corrosion barrier laminate to gel.
 - b. For laminates of 3/16-inch nominal thickness, continue mat plies or spray- as required with adequate rollout between the application of each chopped pass or mat.
 - c. For laminates of 1/4-inch nominal and thicker, apply mat (1-1/2 ounces per square foot) or spray-up and woven roving (24-1/2 ounces per square yard, 5 x 4 weave) to the total required to achieve the desired nominal thickness:
 - 1) Two adjacent plies of woven roving will not be permitted.
 - 2) Roll out each ply or pass.
 - 3) Include at least 1 ply of woven roving for reinforcement for laminates having a nominal thickness of 1/4-inch.
 - 4) If interruption of laminate buildup is required for exotherm, such interruption shall be permitted only after every third ply of woven roving has been laid.
 - d. Provide an exterior surface corrosion barrier:
 - 1) Buried FRP storage tanks and for FRP specialties exposed to corrosive exterior environments:
 - a) Laminate thickness shall be 100-mils minimum. Do not use a separately cured, unreinforced gel coat.
 - b) Make the inner layer of the exterior corrosion barrier with a minimum of 3 ounces per square foot of chopped strand mat and resin in 2 plies of 1 1/2-ounce mat saturated with Type A resin.
 - c) Cover the inner layer of the exterior corrosion barrier with a resin-rich, smooth and reinforced with a 10- to 20-mil Type C glass-surfacing veil saturated with Type A resin.
 - 2) Exterior surfaces of FRP specialties not exposed to corrosive environments shall be Type C glass veil and Type A resin, 15 mils minimum thickness.
 - e. Make the outer surface of the fabricated product relatively smooth and such that no glass fibers are exposed.
 - f. Incorporate paraffin for full cure in the final coat of resin.
 - g. Lap all edges of reinforcement material to a minimum of 1 inch for mat and 2 inches for woven roving. Stagger lapped edges of adjacent layers.
 - h. For all cut edges on parts that will make up a secondary joint or will be incorporated into a finished product, first apply a seal with at least 2 coats of lay-up resin.
- B. Filament Winding:
 - 1. Unless otherwise indicated, filament-winding fabrication shall be in conformance with ASTM D3299. Sequence of laminate construction shall be as follows:
 - a. Provide an interior surface corrosion barrier:
 - 1) Laminate thickness shall be 100 mils minimum. Do not use a separately cured unreinforced gel coat.
 - 2) Make surfaces exposed to the fluids to be resin rich, smooth and reinforced with a 10- to 20-mil thick Type C glass veil mat saturated with Type A resin.
 - 3) Follow the inner surfacing layer with a minimum of 3 ounces per square foot or more of chopped strand mat and resin in a minimum of 2 plies saturated with Type A resin. Glass

content of this portion of the laminate shall be 25 to 30 percent by weight. For laminates 1/2-inch and thicker, the nominal 100-mil layer shall have a thickness of at least 90 mils after curing.

- b. Subsequent reinforcing shall be resin-saturated, continuous roving, as may be required to satisfy all other requirements of this Specification.
- c. Additional chopped roving and resin may be sprayed up between winding cycles to provide improved resistance to interlaminar shear.
- d. For underground FRP storage tanks and for FRP specialties exposed to corrosive exterior environments:
 - 1) Provide an exterior surface corrosion barrier of 100 mils minimum thickness:
 - a) Make the inner layer of the exterior corrosion barrier with a minimum of 3 ounces per square foot of chopped strand mat and resin in 2 plies of 1 1/2-ounce mat saturated with Type A resin.
 - b) Cover the inner layer of the exterior corrosion barrier with a resin-rich, smooth and reinforced with a 10- to 20-mil Type C glass-surfacing veil saturated with Type A resin.
- e. Exterior surfaces of FRP specialties not exposed to corrosive exterior environments shall be Type C glass veil saturated with Type A resin, 15-mils minimum thickness.
- f. Allow no glass fibers to be exposed on the outer surface.
- g. Incorporate paraffin for full cure in the final coat of resin.
- h. Provide a chemical resistant liner consisting of 2 mats and a veil for cut edges exposed to the chemical environment. Do not use cloth or woven roving for this purpose.
- i. For all cut edges on parts that will make up a secondary joint or be incorporated into a finished product, first apply a seal with at least 2 coats of lay-up resin.

3.03 ASSEMBLY AND ERECTION PLANS

- A. Prior to assembly and erection of FRP towers, tanks, stacks and similar structures, provide assembly and erection plans prepared by the FRP manufacturer.
- B. The plans shall provide details on handling, field connections and final installation.

3.04 FIELD JOINTS

- A. Bell and spigot or butt-strap type:
 - 1. Bell and spigot:
 - a. The provisions of this Section and the detailed specification with respect to surface veils, laminate thickness and design shall apply to both the bell and spigot without regard to any consideration that they will ultimately be joined to each other.
 - b. Design bell and spigot to be airtight and watertight.
 - c. Upon completion of jointing, wrap bell and spigot joints with a butt-strap joint as described below.
 - 2. Butt-strap:
 - a. Thickness: Not less than 1-1/2 times the longest cross-sectional dimension of the FRP specialty.
 - b. Shall develop at least 200 percent of the strength of the parent laminate. Notwithstanding this requirement, butt-strap joints shall be comprised of at least 2 layers of surfacing veil plus sufficient reinforcing glass impregnated in the specified barrier resin.
 - c. Surface preparation, methods of curing, and ultraviolet light protection shall be as specified for the parent laminate.

3.05 DAMAGED OR DEFECTIVE AREAS

- A. Repair damaged or defective areas that are otherwise acceptable.

3.06 TESTING

- A. Sampling:

1. Cut sample specimens at locations selected by testing laboratory personnel from items fabricated for the Contract.
 2. Take sample specimens at a rate of 1 per 1,000 square feet of surface area, with a minimum of 5 specimens per individual item.
 3. An individual FRP item shall be defined as an FRP product that is unique in fabrication and dimension from all other FRP products.
 4. Identify sample specimens by item sampled and sampling location.
 5. Save cuttings required for nozzles, openings or connections and submit as sample specimens to be used for testing.
- B. Tests: Tests to be performed on each sample specimen may consist of the following from the National Bureau of Standards Voluntary Standard PS 15:
1. Glass Content: Subsection 4.3.1.
 2. Tensile Strength: Subsection 4.3.2.
 3. Flexural Strength: Subsection 4.3.3.
 4. Modulus of Elasticity (Tangent): Subsection 4.3.4.
 5. Hardness: Subsection 4.3.5.

END OF SECTION

SECTION 06 84 02

FIBERGLASS REINFORCED PLASTIC (FRP) GRATING AND STAIR TREADS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies vinylester fiberglass reinforced plastic (FRP) grating, stair treads, and associated FRP elements.
- B. FRP tanks, pipe, ductwork and structural shapes are specified in other Sections.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM D635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
IBC	International Building Code (as adopted by the Authority Having Jurisdiction)
ISO	International Standards Organization

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Qualifications.
- C. Manufacturer's specifications of resin and reinforcement materials, dimensional tolerances, fabrication process.
- D. Manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, embedded FRP support angles, clip angles, member sizes, and connection details.
- E. Manufacturer's published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Structural Engineer licensed in the state of Washington.
- F. Sample pieces of each item specified herein for acceptance by the Project Representative as to quality and color. Sample pieces shall be manufactured by the same method used to produce the members to be installed in the finished structure.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. All items to be provided under this Section shall be furnished by a manufacturer having a minimum of ten (10) years of experience in the design and manufacture of similar products and systems.

Additionally, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.

2. Manufacturer shall be certified to the ISO 9001.
3. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.
4. Manufacturer shall provide proof, via independent testing less than six months old, that materials proposed for the intended use do not contain heavy metals in amounts greater than that allowed by current EPA requirements.
5. Manufacturer shall provide independent testing data verifying that FRP products exhibit good corrosion resistance for exposure to corrosive liquids and gases normally encountered in the West Point Treatment Plant and corrosive compounds as specified in this Section, taking into account the provision that temperatures may range from 30 to 100 degrees F.
6. The manufacturer shall certify that the stiffness of all grating panels manufactured are never more than 2.5% below the published load-deflection values.
7. FRP Installer: Experience in erecting and installing similar FRP products for at least two similar projects in the last five years.

1.05 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Design of Grating, Stair Treads and Ladder Treads:
 1. Anti-slip surface, with manufacturer's standard abrasive surface cast integral with the grating. Adhesive, anti-slip tape is not acceptable.
 2. Structural:
 - a. A minimum structural safety factor of 5.
 - b. Unless otherwise indicated on Drawings or by code or permit, design loads for FRP grating:
 - 1) 250 psf uniform live load.
 - 2) 300 pound concentrated load.
 - 3) Maximum live load deflection: 0.25-inch or 1/300 of span under superimposed live load of 250 psf for the required spans, whichever is less.
 3. Dimensions:
 - a. Grating depth: minimum 1.5 inch unless otherwise noted on the Drawings.
 - b. Nominal Grid: 1.5 inch X 1.5 inch square grid.
 - c. Grating sheet sizes shall be compatible with the support spans shown on the Drawings and shall require a minimum of field cutting.

1.06 FIELD MEASUREMENTS

- A. Verify that field measurements prior to ordering are as indicated on Drawings.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
- B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, and other types of damage. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Grating and Stair Treads and associated FRP elements:

1. "Fibergrate" Molded Grating and Stair Treads, as manufactured by Fibergrate Composite Structures Inc., 5151 Belt Line Road, Suite 1212, Dallas, TX.
2. "DURAGRATE" Molded Fiberglass Grating and Stair Treads, as manufactured by Strongwell Corporation, 400 Commonwealth Ave., Bristol, VA.
3. Approved Equal.

2.02 MATERIALS

- A. Vinylester resin and chemically resistant to:
 1. Sodium hydroxide: 25%.
 2. Sodium hypochlorite: 15%.
 3. Chlorine gas: 20%.
 4. Ferrous chloride: 30%.
 5. Sulfuric acid: 15%.
- B. Provide UV protection coating for all FRP located in the outside environment.
- C. Color: Molded FRP Grating: orange unless otherwise specified; Handrails and stair treads: orange unless otherwise specified.
- D. Grating: Manufacture by molded process as follows: Grating shall be of a one piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane. Grating shall have a square mesh pattern providing bidirectional strength. Grating shall be reinforced with continuous rovings of equal number of layers in each direction. The top layer of reinforcement shall be no more than 1/8" below the top surface of the grating so as to provide maximum stiffness and prevent resin chipping of unreinforced surfaces. Percentage of glass (by weight) shall not exceed 35% so as to achieve maximum corrosion resistance, and as required to maintain the structural requirements of the intended use. After molding, no dry glass fibers shall be visible on any surface of bearing bars or cross bars. All bars shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin rich or resin starved areas. Grating bar intersections are to be filleted to a minimum radius of 1/16" to eliminate local stress concentrations and the possibility of resin cracking at these locations.
- E. Stair treads: Stair treads shall have integral non-skid nosings.
- F. Assembled and glued bar grating will not be acceptable.
- G. Embedded grating supports, FRP with integral continuous anchor.
- H. Grating hold-downs and attachments: 316 stainless steel.
- I. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- J. Fiberglass reinforcement shall be continuous roving in sufficient quantities as needed by the application and/or physical properties required.
- K. All finished surfaces of FRP items and fabrications shall be smooth, resin rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
- L. All molded grating products shall be fire-retardant and shall have a tested flame spread rating of 25 or less per ASTM E 84 Tunnel Test. Gratings shall not burn past the 25 mm reference mark and will be classified HB per ASTM D635.

PART 3 EXECUTION

3.01 FABRICATION

- A. Measurements: Grating supplied shall meet the dimensional requirements and tolerances as shown or specified. Provide and/or verify measurements in field for work fabricated to fit field conditions. Determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.
- B. Layout: Each grating section shall be readily removable, except where indicated on Drawings. Manufacturer to provide openings and holes where located on the Drawings. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.
- C. Sealing: All shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated grating cuts shall be coated similarly in accordance with the manufacturer's instructions.
- D. Hardware: Type 316 stainless steel hold down clips shall be provided and spaced at maximum of four feet apart with a minimum of four per piece of grating, or as recommended by the manufacturer.

3.02 INSTALLATION

- A. Install gratings and stair treads in accordance with manufacturer's assembly drawings. Fasten grating panels and stair treads securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation. Install all end panel attachments, and appurtenances as shown on the Contract Documents or on approved shop drawings to make the work secure and complete.
- B. Use AISI Type 316 Stainless steel for nuts, bolts, embeds, clips and other required accessories.

END OF SECTION

SECTION 06 84 10

RETROFIT OF CONCRETE STRUCTURES USING BONDED FRP COMPOSITES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies construction of FRP systems used as externally bonded reinforcement to enhance axial, shear, or flexural strength or ductility of a concrete member, such as column, beam, slab or wall.

1.02 DEFINITIONS

- A. The following definitions apply to this Section:
1. **Batch:** A quantity of material formed during the same field installation in one continuous process, and having identical characteristics throughout.
 2. **Bi-Directional Laminate:** Reinforced polymer laminate with fibers oriented in two different directions in its plane.
 3. **Binder:** Resin constituent that holds together the other constituents of an FRP composite.
 4. **Bond-Critical Applications:** Applications of FRP systems for strengthening structures that rely on bond to the concrete substrate. Examples are flexural and shear strengthening of beams and slabs.
 5. **Catalyst:** A substance that initiates a chemical reaction and enables it to proceed under milder conditions than otherwise required and which does not, itself, alter or enter into the reaction. (See Hardener).
 6. **Composite:** A combination of two or more materials differing in form or composition on a macro-scale. The constituents retain their identities; they do not dissolve or merge completely into one another, although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another. (See Composite FRP.)
 7. **Composite FRP:** A polymer matrix, either thermosetting or thermoplastic, reinforced with a fiber or other material with a sufficient aspect ratio (length to thickness) to provide a discernible reinforcing function in one or more directions. (See Composite.)
 8. **Contact-Critical Applications:** Applications of FRP systems that rely on intimate contact between concrete substrate and FRP system to function as intended. An example is confinement of columns for seismic retrofit. In this Specification, contact-critical applications are treated the same as bond-critical applications. (See Bond-critical applications.)
 9. **Creep Rupture:** Failure of FRP system resulting from its gradual, time dependent reduction of capacity due to sustained loading.
 10. **Cure:** The process of causing irreversible changes in the properties of a thermosetting resin by chemical reaction. Cure is typically accomplished by addition of curing agents or initiators, with or without heat and pressure. Full cure is the point at which a resin reaches its specified properties. Resin is under-cured if its specified properties have not been reached.
 11. **Cure Time:** The time necessary to cure a thermosetting resin system, thermoset based composite or prepreg at a given temperature.
 12. **Curing Agent:** A catalytic or reactive agent that, when added to resin, causes polymerization. Also called hardener.
 13. **Debonding:** A separation at the interface between substrate and the reinforcing layer.
 14. **Delamination:** Separation of the layers of the FRP laminate from each other.
 15. **Development Length:** The bonded distance required for transfer of stresses from concrete to the FRP to develop tensile capacity of FRP.
 16. **Durability:** The ability of a material to resist cracking, oxidation, chemical degradation, delamination, wear, or the effects of foreign object damage for a specified period of time, under the appropriate load conditions and specified environmental conditions.

17. **Epoxy:** A polymerizable thermosetting polymer containing one or more epoxide groups, cured by reaction with phenols, anhydrides, polyfunctional amines, carboxylic acids, or mercaptans. An important matrix resin in FRP; also used as structural adhesive.
18. **Fabric:** Arrangement of fibers held together in two or three dimensions. It may be woven, nonwoven, knitted or stitched. Fabric architecture is the specific description of the fibers, their directions and construction.
19. **Fiber:** A general term used to refer to filamentary materials. The smallest unit of a fibrous material. Often, fiber is used synonymously with filament.
20. **Fiber Content:** The amount of fiber present in a composite, usually expressed as volume fraction or mass fraction of the composite.
21. **Fiber Fly:** Short filaments that break off dry fiber tows or yarns during handling and become air borne, classified as nuisance dust.
22. **Fiber Reinforced Polymer (FRP) System:** Composite material consisting of a polymer matrix reinforced with cloth, mat, strands, or any other fiber form. (See Composite.)
23. **Filament:** (See Fiber.)
24. **Filler:** A relatively inert substance added to a resin to alter its properties or to lower cost or density. Also used to term particulate additives. Also called extenders.
25. **Fire Retardant:** Chemicals used to reduce the tendency of resin to burn. They can be added to the resin or coated on the surface of the FRP.
26. **Flow:** The movement of uncured resin under pressure or gravity loads.
27. **Glass Transition Temperature (T_g):** The approximate midpoint of the temperature range over which a transition in material response from elastic to viscoelastic takes place based on ASTM D7028.
28. **Hardener:** Substance added to thermosetting resin to cause polymerization. Usually applies to epoxy resins.
29. **Impregnation:** The process of saturating the interstices of a reinforcement or substrate with a resin.
30. **Inhibitor:** A substance that retards a chemical reaction, such as ultraviolet degradation. Also used to prolong shelf life of certain resins.
31. **Initiator:** Chemicals, most commonly peroxides, used to initiate the curing process for unsaturated polyester and vinyl ester resins. (See Catalyst).
32. **Laminate:** One or more layers or plies of fiber, bonded together in a cured resin matrix.
33. **Lay-Up:** The process of placing the FRP reinforcing material in position for installation.
34. **Lot:** A quantity of material manufactured during the same plant production in one continuous process, and having identical characteristics throughout. In this Specifications, Batch is used interchangeably. (See Batch).
35. **Mat:** A fibrous material for reinforced polymer consisting of randomly oriented chopped filaments, short fibers (with or without a carrier fabric), or long random filaments loosely held together with a binder.
36. **Matrix:** The essentially homogeneous resin or polymer material in which the fiber system of a composite is embedded.
37. **Micro-cracking:** Cracks formed in composites when stresses locally exceed the strength of the matrix.
38. **MSDS:** Material Safety Data Sheet.
39. **Pin Holes:** A small cavity, typically less than 0.06 in. (1.5 mm) diameter that penetrates the surface of a cured composite part.
40. **Pitch:** Petroleum or coal tar precursor base used to make carbon fiber.
41. **Ply:** A single layer of fabric or mat.
42. **Polyester:** A thermosetting polymer synthesized by the condensation reaction of certain acids with alcohols, and subsequently cured by additional polymerization initiated by free radical generation. Polyesters are used as binders for resin mortars and concretes, fiber laminates, and adhesives. Commonly referred to as "unsaturated polyester."
43. **Polymer:** A compound formed by the reaction of simple molecules, which permit their combination to proceed to high molecular weights under suitable conditions.
44. **Polyurethane:** A thermosetting resin prepared by the reaction of diisocyanates with polyols, polyamides, alkyd polymers, and polyether polymers.
45. **Postcure:** Additional elevated-temperature cure to increase the level of polymer cross linking; final properties of the laminate or polymer are enhanced.

46. **Pot Life:** Time that a catalyzed resin retains a viscosity low enough to be used in processing. Also called working life.
47. **Prepreg:** A fiber or fiber sheet material containing resin whose reaction has progressed to the stage where consistency is tacky. Multiple plies of prepreg are typically cured with applied heat and pressure. Also preimpregnated fiber or sheet.
48. **Pultrusion:** A continuous process that combines pulling and extrusion for manufacturing composites that typically have a constant cross-sectional shape. The process consists of pulling a fiber material through a resin bath and then through a heated shaping die, where the resin is cured.
49. **Resin:** A component of a polymeric system that requires a catalyst or hardener to polymerize or cure for use in composites. Resin often refers to the mixed polymer component or matrix of the FRP.
50. **Resin Content:** The amount of resin in a laminate expressed as either a percentage of total mass or total volume.
51. **Roving:** A number of yarns, strands, tows, or ends of fibers collected into a parallel bundle with little or no twist.
52. **Shelf Life:** The length of time a material, substance, product, or reagent can be stored under specified environmental conditions and continue to meet all applicable specifications or remain suitable for its intended function. Also called storage life.
53. **Structural Adhesive:** A resinous bonding agent used for transferring required loads between adherents.
54. **Substrate:** The original concrete and any cementitious repair materials used to repair or replace the original concrete. It can consist entirely of original concrete, entirely of repair materials or of a combination of the two. The FRP is installed on the surface of the substrate.
55. **Thermoplastic:** A non-cross-linked polymer capable of being repeatedly softened by an increase of temperature and hardened by a decrease in temperature. Examples are nylon, polypropylene, and polystyrene.
56. **Thermoset:** A cross-linked polymer which cannot be softened and reformed by an increase in temperature. Cross-linking is an irreversible process; thermosets cannot be returned to a molten state. Examples are epoxy, phenolic, and vinyl ester.
57. **Tow:** An untwisted bundle of continuous filaments.
58. **Unidirectional Laminate:** A reinforced polymer laminate in which substantially all of the fibers are oriented in the same direction.
59. **Vinyl Ester:** A polymerizable thermosetting resin containing vinyl and ester components, cured by additional polymerization initiated by free-radical generation. Vinyl esters are used as binders for fiber laminates and adhesives.
60. **Viscosity:** The property of resistance to flow exhibited within the body of a material, expressed in centipoises. A higher viscosity has higher resistance to flow.
61. **Volatiles:** Materials such as water and solvents in a resin formulation that are capable of being driven off as vapor.
62. **Wet Lay-Up:** A method of making a laminate system by applying the resin system as a liquid, when the fabric or mat is put in place.
63. **Wet-Out:** The process of coating or impregnating roving, yarn, or fabric in which all voids between the strands and filaments are filled with resin. It is also the condition at which this state is achieved.
64. **Wetting Agent:** A substance capable of lowering surface tension of liquids, facilitating the wetting of solids surfaces and permitting the penetration of liquids into the capillaries.
65. **Witness Panel:** A small FRP panel, manufactured on site under conditions similar to the actual construction. The panel may be later tested to determine mechanical and physical properties to confirm the expected properties for the full FRP structure.

1.03 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ACI 224.1R	Causes, Evaluation, and Repair of Cracks in Concrete Structures
ACI 224R	Control of Cracking in Concrete Structures
ACI 440.2R	Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening of Concrete Structures
ACI 503R	Use of Epoxy Compounds with Concrete
ACI 503.4	Standard Specification for Repairing Concrete with Epoxy Mortars
ACI 546R	Concrete Repair Guide
ASM 2001	ASM International Engineered Materials Handbook 2001 Edition
ASTM D3039	Test Method for Tensile Properties of Polymer Matrix Composite Materials
ASTM D3418	Test Method for Transition Temperatures of Polymers by Differential Scanning Calorimetry
ASTM D4541	Test Method for Pull-off Strength of Coatings Using Portable Adhesion Tester
ICC-ES AC178	Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-Reinforced Polymer (FRP) Composite Systems
ICRI 310.1R	International Concrete Repair Institute: Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
ICRI 320.2R	Guide for Selecting and Specifying Materials for Repairs of Concrete Surfaces
UL 263	Standard for Fire Tests of Building Construction and Materials

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Material Certifications: Material Test Certifications for FRP Materials and Structural Adhesive Materials.
- C. Working (Shop) Drawings: Working (shop) drawings shall include the type of FRP system, repair locations, relevant dimensions of the system and the work plan including the necessary preparations of the existing structure. The drawings shall be accompanied by the design calculations, the MSDS and the manufacturer's system data sheet identifying mechanical, physical and chemical properties of all components of the FRP system; application guide, including the installation and maintenance procedures; and time schedule for various steps in the repair process. The installation procedure shall clearly identify the environmental and substrate conditions that may affect the application and curing of the FRP system.
- D. Structural calculations and design drawings that demonstrate compliance with the contract requirements.
 - 1. Structural Calculations and design drawings shall be stamped by a Structural Engineer registered in the State of Washington.
- E. Quality Control/Quality Assurance Plan.
- F. Qualifications.

1.05 QUALITY ASSURANCE

- A. Allowable Tolerances: Tolerances recommended by the FRP manufacturer shall be followed, unless more stringent requirements are specified in this Specification or in the Contract Documents. In case of any conflict or appearance of any conflict, the Project Representative shall provide clarification before proceeding.
- B. Quality Control/Quality Assurance Plan: The Contractor shall be responsible for the quality control of all materials and processes in the project. The quality control and quality assurance (QC/QA) plan shall be

approved by the Owner or its representative. It shall include specific procedures for personnel safety, tracking and inspection of all FRP components prior to installation, inspection of all prepared surfaces prior to FRP application, inspection of the work in progress to assure conformity with specifications, quality assurance samples, inspection of all completed work including necessary tests for approval, repair of any defective work, and clean-up. Any part of the work that fails to comply with the requirements of the Contract Documents shall be rejected by the Project Representative, and shall be remedied, or removed and replaced by the Contractor at its own expense to be in full compliance with the Contract Documents.

- C. Qualifications: Contractor/Applicator shall be pre-qualified by the Project Representative for each FRP system after providing the following necessary information:
 - 1. Minimum of 3 years of documented experience or 15 documented similar field applications with acceptable reference letters from respective owners.
 - 2. Certificate of completed training from Manufacturer/ Supplier for at least one field representative who will be present on site throughout the project.

1.06 PRODUCT SHIPPING, STORAGE AND HANDLING

- A. Be responsible for proper packaging and protection of all materials to prevent damage during shipping, handling and storage.
- B. Storage Requirements: All components of FRP system shall be delivered and stored in the original factory-sealed unopened packaging or containers with proper labels identifying the manufacturer, brand name, system identification number and date. Store catalysts and initiators separately. All components shall be protected from dust, moisture, chemicals, direct sunlight, physical damage, fire, and temperatures outside the range specified in the system data sheets. Any component that has been stored in a condition different from that stated above shall be disposed of as specified in this Section.
- C. Shelf Life: All components of the FRP system, especially resins and adhesives, that have been stored longer than the shelf life specified on the system data sheet, shall not be used, and shall be disposed of as specified in this Section.
- D. Handling: All components of the FRP system, especially fiber sheets, shall be handled with care according to the manufacturer's recommendations to protect them from damage and to avoid misalignment or breakage of the fibers by pulling, separating or wrinkling them or by folding the sheets. After cutting, sheets shall be either stacked dry with separators, or rolled gently at a radius no tighter than 12 in. (305 mm) or as recommended by the manufacturer.
- E. Safety Hazards: All components of the FRP system, especially resins and adhesives, shall be handled with care to avoid safety hazards, including but not limited to skin irritation and sensitization, and breathing vapors and dusts. Mixing resins shall be monitored to avoid fuming and inflammable vapors, fire hazards, or violent boiling. The Contractor is responsible to ensure that all components of the FRP system at all stages of work conform to the local, state, and federal environmental and worker's safety laws and regulations.
- F. Material Safety Data Sheets: The MSDS for all components of the FRP system shall be accessible to all at project site. Specific handling hazards and disposal instructions shall be specified in the MSDS.
- G. Personnel and Work-place Protection: The Contractor is responsible for providing proper means of protection for safety of the personnel and the work place. The Contractor shall inform the personnel of the dangers of inhaling fumes of primer, putty or resin, and shall take all necessary precautions against injury to personnel. The resin mixing area shall be well vented to the outside.
- H. Clean-up: The Contractor is responsible for the clean-up of the equipment and the project site from hazardous and aesthetically undesirable FRP components using appropriate solvents, as recommended in the system data sheet.

- I. Disposal: Any component of the FRP system that has exceeded its shelf life or pot life, or has not been properly stored, and any unused or excess material that is deemed waste, shall be disposed of in a manner amiable to the protection of the environment and consistent with the MSDS.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Wet Lay-Up FRP Systems using FRP fiber sheets:
 1. Provide size and type of ICC-ES approved high strength, non-corrosive Carbon Fiber Reinforced Polymer (CFRP) system with epoxy saturant as indicated on the drawings and in this Section.
 2. Cured Single Ply Properties for Unidirectional Fibers: When post cured for 48 hours maximum at 140°F and tested in accordance with ASTM D3039:
 - a. Design Value Tensile Strength in Primary Fiber Direction: 121,000 psi, minimum.
 - b. Design Value Tensile Modulus: 10.4×10^6 psi, minimum.
 - c. Design Value Elongation: 0.85 percent, minimum.
 3. Cured Single Ply Properties for Bidirectional Fibers: When post cured for 48 hours maximum at 140°F and tested in accordance with ASTM D3039:
 - a. Design Value Tensile Strength in Primary Fiber Direction: 66,000 psi, minimum.
 - b. Design Value Tensile Modulus: 5.9×10^6 psi, minimum.
 - c. Design Value Elongation: 1.19 percent, minimum.
 4. Acceptable Manufacturers and Products:
 - a. Fyfe Co. LLC of Aegion Corp.; Tyfo SCH Series with Tyfo S epoxy saturant.
 - b. Sika Corp.; SikaWrap Hex Series with Hex 300 epoxy saturant.
 - c. Simpson Strong-Tie Co., Inc.; CSS-CUC Series with CSS-ES epoxy saturant.
- B. CFRP Anchor:
 1. High strength, non-corrosive carbon anchor designed to be field laminated with saturant resin.
 2. Compatible with and from same manufacturer as the strengthening system used.
 3. Cured Composite Properties: When post cured for 48 hours maximum at 140°F and tested in accordance with ASTM D3039:
 - a. Design Value Tensile Strength in Primary Fiber Direction: 121,000 psi, minimum.
 - b. Design Value Tensile Modulus: 11.9×10^6 psi, minimum.
 - c. Design Value Elongation: 0.85 percent, minimum.
 4. Acceptable Manufacturers and Products:
 - a. Fyfe Co. LLC of Aegion Corp.; Tyfo SCH Composite Anchor with Tyfo S epoxy saturant.
 - b. Sika Corp.; SikaWrap FX Fibre Connector with Hex 300 epoxy saturant.
 - c. Simpson Strong-Tie Co.; CSS-CA Anchor with CSS-ES epoxy saturant.
- C. Epoxy Paste and Filler:
 1. Two-component, high strength epoxy paste system used to fill and transition irregular substrates.
 2. Compatible with and from same manufacturer as the strengthening system used.
 3. Cured Epoxy Properties: When cured 7 days at 72°F and tested in accordance with ASTM D638:
 - a. Tensile Strength: 3,000 psi, minimum.
 - b. Tensile Modulus: 3.7×10^5 psi, minimum.
 - c. Elongation at Break: 0.5 percent, minimum.
 4. Acceptable Manufacturers and Products:
 - a. Fyfe Co. LLC of Aegion Corp.; Tyfo S thickened with Cab-o-Sil TS-720 fumed silica.
 - b. Sika Corp.; Sikadur 330.
 - c. Simpson Strong-Tie Co.; CSS-EP.
- D. Slurry Seal:
 1. Cementitious, fire protection mortar that achieves a 4-hour fire rating when subjected to ASTM E119/UL 263 full-scale testing when applied over a CFRP strengthening system.
 2. Compatible with and from same manufacturer as the strengthening system used.
 3. Acceptable Manufacturers and Products:

- a. Sika Corp.; Sikacrete-213F.
- b. Simpson Strong-Tie Co.; FX-207.

PART 3 EXECUTION

3.01 GENERAL

- A. Site Considerations: Provide necessary pathways, scaffoldings and other means of access to the general project site and to the specific repair area for the personnel, equipment and materials. All obstructions such as pipes, conduits and wiring shall be removed at the expense of the Contractor, upon approval of the Project Representative and after making records for subsequent reinstallation by the Contractor. Soil materials, plants, fences and other obstructions that prevent access for repair shall be removed, and upon approval of the Project Representative, re-installed or disposed in an acceptable manner at the expense of the Contractor.

3.02 SUBSTRATE REPAIR AND SURFACE PREPARATION

- A. The concrete substrate shall be repaired, if necessary, and all concrete surfaces shall be cleaned and prepared prior to installing the FRP system.
- B. Removal of Defective Concrete: All defective areas of concrete substrate shall be removed according to ACI 546R and ICRI No. 310.1R, using appropriate equipment such as air or electric powered jack hammer or saw, at a sufficient depth of at least 1/2 in. beyond the repair area to expose sound aggregates. If any reinforcing or prestressing steel is exposed in the process, and it is either deteriorated or its bond with concrete is broken in the process, an additional nominal depth of 3/4 in. or at least 1/4 in. larger than the largest aggregate in repair material shall be cut from its underneath. If any deterioration is noticed in the repair area, its source shall be located and treated to the satisfaction of the Project Representative prior to restoring the section. Upon removing defective concrete, and before restoring the section, the substrate shall be cleaned from any dust, laitance, grease, oil, curing compounds, impregnations, foreign particles, wax and other bond inhibiting materials.
- C. Repair of Defective Reinforcement: All defective reinforcement shall be repaired according to ICRI No. 03730, and to the satisfaction of the Project Representative. FRP systems shall not be applied to concrete suspected of containing corroded reinforcement. Corroded or otherwise defective reinforcement that is to be supplemented shall be cleaned and prepared thoroughly by abrasive cleaning to near white appearance. Damaged reinforcement that needs to be replaced shall be cut at sufficient length, according to the Contract Documents and the approval of the Project Representative, to ensure full section and sound material in the remaining portion. Splice for the ruptured or cut reinforcing or prestressing steel shall be provided at sufficient length, according to the Contract Documents.
- D. Mechanical Anchorage: Mechanical anchorage of the repair material with the substrate shall be placed, if specified in the Contract Documents. Anchors shall be secured in place by tying to other secured bars, and shall not protrude outside concrete surface. If that is not possible, the concrete surface shall be built up to cover the protrusions.
- E. Restoration of Concrete Cross Section: The area of removed concrete substrate, and any void larger than 1/2 in. diameter and depth, shall be filled with repair material that conforms to ICRI No. 320.2R. The repair material shall have a compressive strength equal to or greater than that of the original concrete, but no less than 4,500 and 5,500 psi at 7 and 28 days, respectively. The design mix for all repair materials shall be approved by the Project Representative. The bond strength of the repair material to the existing concrete shall be a minimum of 200 psi in the pull-off test according to ASTM D4541. The concrete substrate and the exposed reinforcing or prestressing steel shall be clean, sound and free of surface moisture and frost before restoring the section. Before placement of patching materials, an epoxy bonding agent shall be applied to concrete and exposed reinforcement. Also,

cracks within solid concrete in the substrate shall be stabilized using epoxy injection methods. If water leaks through cracks or concrete joints is significant, water protection and a water conveyance and weep holes shall be provided before restoring the section. The repair material shall be cured a minimum of 7 days before installing the FRP system, unless its curing and strength are verified by tests.

- F. Surface Preparation: All necessary repair and restoration of concrete section shall be approved by the Project Representative, prior to surface preparation. In this Specification, contact-critical applications are treated the same as bond-critical applications. An adhesive bond with adequate strength shall always be provided between FRP and concrete. Surface preparation shall also promote continuous intimate contact between FRP and concrete by providing a clean, smooth, and flat or convex surface. Surface preparation for FRP shell systems where grout is pumped into the gap between the shell and the existing column surface. All surface preparations shall be approved by the Project Representative, before installing the FRP system.
- G. Surface Grinding: All irregularities, unevenness, and sharp protrusions in the surface profile shall be ground away to a smooth surface with less than $\frac{1}{32}$ in. (0.8 mm) deviation. Disk grinder or other similar devices shall be used to remove stain, paint, or any other surface substance that may affect the bond. Concrete surface shall be ground to the concrete surface profile range of CSP 2–3 defined by ICRI as minimum surface roughness level. Voids with diameters larger than $\frac{1}{2}$ in. (12.7 mm) and depressions on the concrete surface deeper than $\frac{1}{16}$ in. (1.6 mm) measured from a 12 in. (305 mm) straight edge placed on the surface, shall be filled in accordance with provisions in this Section.
- H. Chamfering Corners: All inside and outside corners and sharp edges shall be rounded or chamfered to a minimum radius of $\frac{1}{2}$ in. (12.7 mm) as per ACI 440.2R. Ridges, form lines, and sharp or roughened edges greater than $\frac{1}{4}$ in. (6.4 mm) shall be ground down or filled with putty, in accordance with provisions in this Section. Obstructions and embedded objects shall be removed before installing the FRP system, if required by the Project Representative.
- I. Crack Injection: All cracks in the surface of concrete or the substrate wider than 0.01 in. (0.25 mm) and with spacing less than 1.5 in. (38 mm) or cracks wider than $\frac{1}{32}$ in. (0.8 mm) shall be filled using pressure injection of epoxy according to ACI 224.1R. Smaller cracks may also require resin injection in aggressive environments. Follow ACI 224R crack width criteria for various exposure conditions. FRP system shall be installed no earlier than 24 hours after crack injection. Any surface roughness caused by injection shall be removed in accordance with provisions in this Section.
- J. Surface Profiling: After surface grinding, any remaining unevenness in the surface greater than that specified in accordance with provisions in this Section, including out-of-plane variations, fins, protrusions, bug holes, depressions voids, and roughened corners shall be filled and smoothed over using putty made of epoxy resin mortar or polymer cement mortar, as specified in the Contract Documents, with strength equal to or greater than the strength of the original concrete. The patching material shall be cured a minimum of 7 days before installing the FRP system, unless its curing and strength are verified by tests.
- K. Surface Cleaning: Substrate concrete and finished surface of concrete shall be cleaned to the approval of the Project Representative. Cleaning shall remove any dust, laitance, grease, oil, curing compounds, wax, impregnations, stains, paint coatings, surface lubricants, foreign particles, weathered layers or any other bond-inhibiting material. If power wash is used, the surface shall be allowed to dry thoroughly before installing the FRP system. The cleaned surface shall be protected against re-deposit of any bond-inhibiting materials. Newly repaired or patched surfaces that have not cured a minimum of 7 days shall be coated with a water-based epoxy paint or other approved sealers.

3.03 INSTALLATION OF FRP SYSTEMS

- A. General: This Section specifies general installation procedures for wet lay-up FRP systems. Specific procedures for installing FRP systems may vary slightly for each system and manufacturer.

- B. **Environmental Conditions for Installation:** Environmental conditions shall be examined before and during installation of the FRP system to ensure conformity to the Contract Documents and manufacturer's recommendations. Do not apply primers, putty, saturating resins, or adhesives on cold, frozen, damp, or wet surfaces. Ambient and concrete surface temperatures shall be within 50°–90°F (10°–32°C), unless specified by the manufacturer. Moisture level on all contact surfaces shall be less than 4.3% at the time of installation of FRP system, as evaluated according to ACI 503R. Moisture restrictions may be waived for resins that have been formulated for wet applications. Relative humidity at the time of FRP application should be in the range of 65%–82%.
- C. **Moisture Vapor Transmission:** Application of bonded FRP systems shall not proceed, if any moisture vapor transmission is present. Concrete dryness is necessary, when using elevated temperature cure. Any bubble that develops from moisture vapor transmission can effectively be injected with the same adhesive material used for the FRP system, following the procedures specified in accordance with provisions in this Section.
- D. **Application in Inclement Weather:** When inclement weather does not allow installation of FRP system, as specified in accordance with provisions in this Section, auxiliary measures may be employed to correct the conditions. Auxiliary heat source may be used in cold weather to raise the ambient and concrete surface temperatures to acceptable levels, as recommended by the manufacturer, but no more than the glass transition temperature (T_g). Pressurized air may be used to dry the surface dampness.
- E. **Shoring:** Repaired members shall be shored temporarily with conventional methods, if specified in Contract Documents, or required by the Project Representative for safety. Shoring shall not be removed until the FRP system has fully cured and gained its design strength, as recommended by the manufacturer and approved by the Project Representative.
- F. **Equipment:** The Contractor shall provide all necessary equipment, in sufficient quantities and in clean and operating conditions, for continuous uninterrupted FRP installation.
- G. **Application of Wet Lay-up FRP Systems:** This Section specifies the necessary measures for installing wet lay-up systems using dry or prepreg fiber sheets and saturants:
1. **Mixing of Resin Components:** All resin components, including main agent and hardener shall be mixed at proper temperature using appropriate weight ratio and for a duration specified by the manufacturer, until thorough mixing with uniform color and consistency is achieved. Resins shall not be diluted with any organic solvents such as thinner. Manual stirring and small electrically powered mixing blades are allowed. Resin shall be mixed in quantities sufficiently small to ensure that it can be used within its pot life. Any mixed resin that exceeds its pot life, or begins to generate heat or show signs of increased viscosity, shall not be used, and shall be disposed of in accordance with provisions in this Section. Mixing of some resins may be accompanied by noxious fumes. Precautions shall be taken, in accordance with provisions in this Section, regarding their impact on the environment, including emission of volatile organic compounds and toxicology.
 2. **Primer and Putty:** A primer coat is generally required in all available FRP systems. Apply one or two coats of primer on the concrete surface to penetrate its open pores. Ambient and concrete surface temperatures shall be within the range specified in accordance with provisions in this Section. The putty, if used in the FRP system, shall be applied as soon as the primer becomes tack-free or until not-sticky to the fingers. The putty shall be applied within 7 days after primer application; otherwise, the primer coated surface shall be roughened with sandpaper or similar tool. The resulting surface shall be cleaned in accordance with provisions in this Section before applying the putty. Apply a thin coat of putty in one or two layers, and smoothen over the surface to fill in any small voids, cracks or uneven areas. Any swelling on the surface after applying the putty shall be corrected to meet surface profile as specified in accordance with provisions in this Section. The surfaces of primer and putty shall be protected from dust, moisture and any other contaminants before applying the FRP.
 3. **Saturant:** The first coat of saturating resin, saturant, shall be uniformly applied as an undercoat to all locations on the concrete surface where the FRP system is to be installed. The saturant shall have sufficiently low viscosity to ensure full impregnation of the fiber sheets prior to curing. To

maintain proper viscosity of the saturant, the ambient and concrete surface temperatures shall be within the range specified in accordance with provisions in this Section. Any mixed saturant that exceeds its pot life shall be disposed of, in accordance with provisions in this Section.

4. Applying Fiber Sheet and Saturant: Upon uniformly applying the first layer of saturant as undercoat, the fiber sheet previously cut to the length specified in the Contract Documents, shall be installed in place and gently pressed onto the wet saturant. Any entrapped air between fiber sheet and concrete surface shall be released or rolled across the sheet in the direction parallel to the fibers, while allowing the resin to impregnate the fibers and achieve intimate contact with the substrate. Rolling perpendicular to the fiber direction is not allowed. In bi-directional fabrics, rolling shall be initially in the fill direction end to end, and then in the warp direction. Sufficient saturant shall be applied on top of the fiber sheet, as overcoat, to ensure full saturation of the fibers. Undercoat, fiber sheets and overcoat shall be applied with no interruption.
 5. Multiple Fiber Plies: In multi-ply installations, the sequence shall be repeated for each additional fiber sheet. The amount of resin overcoat for intermediate plies is approximately 15%–20% greater than a single-ply installation, because the saturant serves as overcoat for the applied ply and undercoat for the next ply. Follow the Contract Documents for the fiber orientation and ply stacking sequence. Each ply shall be applied before the onset of complete gelation of the previous layer. The number of plies that can be applied in a single day shall be determined based on the manufacturer's recommendation and the approval of the Project Representative. Multiple plies can also be applied in several days. When previous layers are cured, interlayer surface preparation, such as light sanding and filling with putty may be required, as specified in accordance with provisions in this Section.
 6. Overlapping: A lap joint shall be constructed when an interruption occurs in the direction of the fibers. The length of lap splice shall be as specified by the Contract Documents, but at least 8 in. (152 mm). Staggering of lap splices on multiple plies and adjacent strips shall be required, unless permitted by Contract Documents. No lap joint is necessary in the transverse direction, unless specified in the Contract Documents.
 7. Alignment of FRP Materials: The fiber plies shall be aligned on the structural member according to the Contract Documents. Any deviation in the alignment more than 5° (approximately 1 in./ft or 87 mm/m) is not acceptable, as specified in accordance with provisions in this Section. Once installed, the fibers shall be free of kink, folds and waviness.
 8. Anchoring of FRP Sheets: Anchoring of FRP sheets to the concrete substrate shall follow the method specified in the Contract Documents, or approved by the Project Representative. When using mechanical clamps and fasteners, care shall be taken to avoid damage to the FRP system or to the concrete substrate. Precautions shall be taken when steel fasteners are used for carbon FRP to avoid galvanic corrosion. FRP anchors shall be sufficiently embedded into concrete.
 9. Stressing Applications: Stressing of FRP systems shall follow the method specified in Contract Documents. Active end anchorages shall be used for linear prestressing. For circular prestressing of wet lay-up systems, the gap left between the FRP system and the concrete column shall be filled using expansive mortar or pressure injection of epoxy grout, as specified in accordance with provisions in this Section.
- H. Curing: The FRP system shall be allowed to cure, as recommended by the manufacturer. Field modification of resin chemistry for rapid curing is not allowed. Elevated cure temperature may be used, as specified in accordance with provisions in this Section if rapid curing is necessary. Cure of installed plies shall be monitored before placing subsequent plies. In case of any curing irregularity, installation of subsequent plies shall be halted. Unless otherwise noted in the Contract Documents and approved by the Project Representative, full load shall not be applied until curing is complete. Protect the FRP system while curing, as specified in accordance with provisions in this Section.
- I. Protective Coating and Finishing: Protective coating shall be applied on the surface of the FRP system. The coating shall be non-vapor-barrier, flexible, water-proofing, and compatible with the FRP system. The coating may be a polymer-modified Portland cement coating or a polymer based latex coating. The mortar finish shall be made with silicate sand between sieves No. 40 (1/64 in. or 0.42 mm) and No. 6 (1/8 in. or 3.36 mm), spread over the FRP system before the resin hardens. Appropriate methods shall be used for vertical or overhead work. The thickness of the coating shall be specified in Contract Documents. Final appearance is to match, within reason, the color and texture of the adjacent concrete.

Surface preparation shall be as recommended by the manufacturer. Solvent-wipes shall not be used to clean the FRP surface, unless approved by the FRP manufacturer. If abrasive cleaning is necessary, air pressure shall be limited to avoid any damage to fibers. Ambient and surface temperatures shall be within the range specified in accordance with provisions in this Section prior to applying the protective coating. Do not apply the coating when surface moisture is present or when rainfall or condensation is anticipated.

- J. Temporary Protection: Temporary protection shall be installed, as specified in the Contract Documents, until the resin has fully cured, as approved by the Project Representative.

3.04 INSPECTION AND QUALITY ASSURANCE

- A. General: All inspections and tests in this Section will be performed by a trained special inspector, acting on behalf of the Owner for quality assurance of the project, in accordance with IBC Chapter 17 requirements and ICC-ES AC85 and AC178, in the presence of the Contractor and the Project Representative. The Contractor may have its own inspector for quality control.
- B. Inspection of Materials: Manufacturer's certifications for all delivered and stored FRP components will be inspected for conformity to the Contract Documents before starting the project. Materials testing will be conducted on samples of pre-cured or witness panels of wet lay-ups, if specified in the Contract Documents. Any material that does not meet the requirements of the Contract Documents will be rejected. Additional witness panels may be taken during the installation process, if specified in the Contract Documents.
- C. Daily Inspection: Daily inspection will include date and time of repair; ambient and concrete surface temperatures; relative humidity; general weather conditions; surface dryness per ACI 503.4; surface preparation and surface profile using ICRI surface-profile-chips; qualitative description of surface cleanliness; type of auxiliary heat source, if any; widths of cracks not injected with epoxy; fiber or precured laminate batch numbers and their locations in structure; batch numbers, mixture ratios, mixing times, and qualitative descriptions of the appearance of all mixed resins, primers, putties, saturants, adhesives, and coatings; observations of progress of cure of resins; conformance with installation procedures; adhesion test results: bond strength, failure mode, and location; FRP properties from tests of field sample panels or witness panels, if required; location and size of any delaminations or air voids; and general progress of the work.
- D. Inspection for Fiber Orientation: Fiber or ply orientation, fiber kinks and waviness will be examined by visual inspection for conformity to the Contract Documents. Tolerances shall be in accordance with provisions in this Section. Non-conforming FRP area shall be removed, and repaired as specified in accordance with provisions in this Section.
- E. Inspection for Debonding: After at least 24 hours for the initial cure of the resin, a visual inspection of the surface shall be performed for any swelling, bubbles, voids or delaminations. If an air pocket is suspected, an acoustic tap test shall be carried out with a hard object to identify delaminated areas by sound, with at least one strike per 1 ft² (0.1 m²). Defects smaller than 1/4 in. (6.4 mm) diameter shall require no corrective action, unless as specified in accordance with provisions in this Section. Defects larger than 1/4 in. (6.4 mm) but smaller than 1 1/4 in. (32 mm) diameter shall be repaired as specified in accordance with provisions in this Section. Defects larger than 1 1/4 in. (32 mm) but smaller than 6 in. (152 mm) diameter, and frequency of less than 5 per any unit surface area of 10 ft (3 m) length or width shall be repaired as specified in accordance with provisions in this Section. Larger defects shall be repaired as specified in accordance with provisions in this Section.
- F. Inspection for Cure of Resin: If specified in the Contract Documents, relative cure of resin in FRP systems shall be examined by visual inspection, or laboratory testing of witness panels or resin-cup samples using ASTM D3418. Follow recommendations of the resin manufacturer for acceptance criteria. If cure of resin is found unacceptable, the entire area shall be marked and repaired as specified in accordance with provisions in this Section.

- G. **Inspection for Adhesion:** After at least 24 hours for the initial cure of the resin and before applying the protective coating, direct pull-off test shall be performed following ASTM D4541 to verify tensile bond between FRP system and concrete. Test locations and sampling frequency are as specified on the Contract Documents, or recommended by the Contractor and approved by the Project Representative. At a minimum, three pull-off tests with at least one test per span or one test per 1000 ft² (93 m²) of the FRP system, and one test per substrate concrete type shall be performed. Inspect failure surface of the core specimen to ensure that it is by cohesive failure within concrete. Failure at the bond line at tensile stresses below 200 psi (1.4 MPa) is unacceptable. If one or more of the pull-off tests is found unacceptable the work will be rejected, and repair shall be as specified in accordance with provisions in this Section. Repair cored areas as specified in accordance with provisions in this Section.
- H. **Inspection for Cured Thickness:** If specified in the Contract Documents, or required by the Project Representative, 1/2 in. (12.7 mm) diameter core samples shall be taken to inspect the cured laminate thickness and number of plies. Sampling frequency shall be the same as that specified in accordance with provisions in this Section unless otherwise specified in the Contract Documents. Repair cored areas as specified in accordance with provisions in this Section. The FRP system will be not acceptable if the number of plies is less than that specified in the Contract Documents, or if the cured thickness of the FRP system is less than that specified in the Contract Documents by more than 1/32 in. (0.8 mm). The entire area of FRP system marked unacceptable shall be repaired as specified in accordance with provisions in this Section.
- I. **Load Tests:** If specified in the Contract Documents, an in-situ conventional load testing shall be conducted on the retrofitted structure.
- J. **Auxiliary Tests:** If specified in the Contract Documents, auxiliary tests on witness panels shall be carried out. The most common is the tensile test following ASTM D3039 on at least 5 witness panels for each type of FRP system to measure strength, elastic modulus, and ultimate strain. The measured thickness of the FRP laminate shall also be recorded. The FRP system will be not acceptable if the average tensile strength or the lowest tensile strength are more than 5% and 10% respectively, below the values specified in the Contract Documents.

3.05 REPAIR OF DEFECTIVE WORK

- A. **General:** This Section specifies the conditions and types of defects that require repair, and the acceptable methods of repair. Defects are of different types, and may be generally classified as aesthetic, short-term critical, or long-term critical. Repair procedure depends on the type, size and extent of defects. Repair procedures for any condition not addressed in this Section or in the Contract Documents shall be submitted by the Contractor and approved by the Project Representative prior to proceeding with the work.
- B. **Repair of Protective Coating:** Defects in protective coating can be of three types: small hair- line cracks, blistering, and peeling. In all cases, moisture content of the substrate should be below 0.05% before applying a new coating. Prior to any repair of protective coating, the FRP system shall be examined visually or otherwise to ensure that no defect exists within or on the surface of the FRP. Defects in FRP, if found, shall be repaired as specified in accordance with provisions in this Section. If the protective coating appears to show small areas with cracks, the local surface shall be lightly sanded. Then, a new coating with appropriate primer shall be applied based on the manufacturer's recommendations. At the minimum, the coating shall be applied over an area extending 3 in. (25 mm) on either side of the defect. If the protective coating shows signs of blistering, the entire area of blisters as well as the surrounding area to a distance of at least 12 in. (305 mm) shall be carefully scraped clean. In no case should a blistered surface be re-coated without complete removal of the existing coating. The area shall be wiped clean and then dried thoroughly. Once dry, the area can be re-coated after application of the primer coat, as required by the manufacturer. If the surface shows signs of excessive peeling, the entire coating shall be scraped off, and the surface lightly sanded, wiped cleaned and thoroughly dried, before applying a new coat according to the manufacturer's recommendations.

- C. **Epoxy Injection of Small Defects:** Small entrapped voids or surface discontinuities no larger than 1/4 in. (6.4 mm) diameter shall not be considered defects, and require no corrective action, unless occurred next to edges or when there are more than 5 such defects in an area of 10 square feet (0.9 m²). Small defects of size between 1/4 and 1-1/4 in. (6.4 and 32 mm) diameter shall be repaired using low pressure epoxy injection, as long as the defect is local and does not extend through the complete thickness of the laminate in case of multi-ply FRP systems. If any delamination growth is suspected between the FRP plies due to injection, the procedure shall be halted, and repair shall be as specified in accordance with provisions in this Section.
- D. **Patching of Minor Defects:** Minor defects are those with diameter between 1-1/4 inches and 6 inches (32 and 152 mm), and frequency of less than 5 per any unit surface area of 10 ft (3 m) length or width. The area surrounding the defects to an extent of at least 2 in. (25 mm) on all sides shall be carefully removed. The area shall be wiped cleaned and thoroughly dried. The area shall then be patched by adding an FRP patch of the same type as the original laminate and extending at least 6 in. (25 mm) on all sides of the removed area. Repair can also be conducted using the procedures as specified in accordance with provisions in this Section.
- E. **Replacement of Large Defects:** Defects larger than 6 in. (152 mm) diameter shall be carefully marked and scarfed out extending to a minimum of 1 in. (25 mm) on all sides. Scarfing shall be progressive through the layers, in the case of multi-ply FRP systems until past the defective area. In case the defect extends to the first FRP ply adjacent to the concrete, the entire thickness of FRP and primer shall be removed. The substrate shall be appropriately prepared and primer re-applied after ensuring that the surface and FRP are clean and dry. Application of a new FRP system within the scarfed area shall follow procedures for the original FRP system with new FRP reinforcements lapped with original FRP as recommended by the manufacturer. In addition, an additional layer extending a minimum of 6 in. (152 mm) on all sides of the scarfed area shall be added as a patch. Once cured, the protective coating shall be applied over the entire area.

END OF SECTION

SECTION 07 01 50.91

ROOF RESTORATION

PART 1 GENERAL

1.01 SUMMARY

- A. Roof repairs for the Fine Grit Handling Structure IRMA, Inverted roof membrane assembly. The Fine Grit Handling Structure has a torch-down roofing system over the concrete deck that is covered with gravel.

1.02 QUALITY ASSURANCE

- A. The Contractor shall perform all repairs in accordance with the guidelines outlined in the NRCA Roofing and Waterproofing Manual, Fifth Edition, and the latest edition of the Sheet Metal and Air-conditioning Contractors National Association (SMACNA) Manual.
- B. Repair to the torch-down roofing base layer of the IRMA system shall comply with the referenced standards, performance requirements, and submittal, quality assurance, delivery, storage, warranty and products requirements as well as the execution requirements of Torch-Applied SBS Modified Bituminous Membrane Roofing, Section 07 52 16.13.

1.03 SITE CONDITIONS

- A. Field measurements and material quantities: Contractor shall have SOLE responsibility for accuracy of all measurements, estimates of material quantities and sizes, and site conditions that will affect work.
- B. Existing conditions:
 - 1. Refer to Section 01 14 30 for use of facilities.
 - 2. When mechanical units, conduits, vents, piping, and equipment are to be moved, all equipment shall be reconnected in such a way that they are restored to their prior operating condition. Appropriate measures shall be taken to prevent dust, vapors, gases, or odors from entering the building during roof removal, replacement, or repair.
- C. Safety requirements:
 - 1. All repairs, material handling, and associated equipment shall conform to and be operated in conformance with OSHA safety requirements and as specified in other Sections.
 - 2. Comply with federal, state, local, and King County fire and safety requirements.
 - 3. Advise the Project Representative whenever work is expected to be hazardous to County employees.
 - 4. Maintain a crewman as a floor area guard whenever roof decking is being repaired or replaced.
 - 5. Maintain fire extinguishers within easy access whenever power tools, roofing kettles, or torches are being used.
 - 6. At least two persons must be on site when repairs are being made.
- D. Waste disposal: Reuse, recycle, or dispose of all roofing materials and product containers in accordance with all applicable regulations.
- E. Environmental requirements:
 - 1. Do not work in the rain, snow, or standing water unless directed by the Project Representative.
 - 2. Do not work in temperatures below 40 degrees F.
 - 3. Do not install materials marked "keep from freezing" when daily temperatures are forecasted to fall below 40 degrees F.

4. Advise the Project Representative when any volatile materials are to be used near ventilation intakes so that they can be shut down or blocked as necessary.

PART 2 PRODUCTS

2.01 GENERAL

- A. Prior to repair, the concrete deck shall be prepared to ensure conditions are satisfactory to proceed with the installation of specified roofing materials. Preparation of substrates includes, but is not limited to, substrate repairs, securement of substrates, eliminating all incompatible materials, and cleaning.
- B. Where conditions are found to be unsatisfactory, work shall not begin until conditions are made satisfactory to begin work. Commencing of work shall indicate Contractor's acceptance of conditions.
- C. Torch-down roofing base layer of the IRMA system shall comply with all requirements of Torch-Applied SBS Modified Bituminous Membrane Roofing, Section 07 52 16.13.
- D. Use a Poly Methyl Methacrylate (PMMA) Liquid Flashing system to seal all transitions from new-to-old roofing, penetrations, and lap seams with a minimum six (6) inches of overlap on both sides of the seams.
- E. Repair upper layers of the IRMA system to match the existing Fine Grit Handling Structure roof system and create an even, uniform appearance.
- F. Comply with Quality Assurance, References, Specifications, and Manufacturer's data. Where conflict may exist, requirements that are more stringent govern. Use only "Asbestos Free Material" certified products.

PART 3 EXECUTION

3.01 GENERAL

- A. Torch-down roofing base layer of the IRMA system shall comply with the Part 3 Execution requirements of Torch-Applied SBS Modified Bituminous Membrane Roofing, Section 07 52 16.13.
- B. Use personal protective equipment for handling all products in accordance with the Material Safety Data Sheets.

END OF SECTION

SECTION 07 20 00
WATER-PROOFING AND MOISTURE-PROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies waterproofing and moisture proofing for concrete.

1.02 REFERENCED STANDARDS [NOT USED]

1.03 REQUIREMENTS

- A. Not less than 72 hours prior to starting work, test concrete and certify its suitability to receive waterproofing and moisture proofing.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's data: Before delivery of any water-proofing materials, provide manufacturer product data showing conformance to the specified products or material descriptions and any special storage, handling, or application instructions.
 2. Manufacturer product data.
 3. Storage, handling, and application instructions.
 4. Material Safety Data Sheets.
 5. Qualifications:
 - a. Manufacturer experience.
 - b. Installer experience:
 - 1) Manufacturer Certification: Certify installer as trained and acceptable to manufacturer.
 - 2) Installer Previous Experience: List of 5 representative projects installed within the last 5 years using the specified waterproofing system. Include the owner's name and telephone number, location of project, square feet of product installed and completion date.
 6. Remedial Measures: Description of proposed remedial measures to be used, if measured water infiltration rates, exceeds the allowable value.

1.05 QUALITY ASSURANCE

- A. Manufacturer: Minimum of 20 years experience in the production and sale of waterproofing systems.
- B. Installer: Minimum of 5 years experience in the type of work required of the Specification.
- C. Materials: Primary products from one manufacturer.
- D. Pre-Installation Meeting: Prior to the commencement of field operations to establish procedures to be used during construction. Meeting agenda shall include discussions on:
1. Waterproofing details:
 - a. Utility penetrations through waterproofing.
 - b. Waterproofing protection.
 - c. Waterproofing damage repair.
 - d. Substrate conditions.
 - e. Reinforcing steel placement.
 - f. Concrete placement.
 - g. Concrete forming system.

- E. Manufacturer's Representative: Make arrangements necessary to have a trained employee of the manufacturer on site periodically during waterproofing work to review installation procedures.
- F. Single Installer: Installation of the waterproofing membrane, flashing, protection layers, separation layers, and leveling layers shall be the responsibility of the membrane applicator.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove expired or damaged material from the site and dispose of in accordance with applicable regulations.
- B. Do not double-stack pallets of membrane on the job site. Provide cover on top and all sides, allowing for adequate ventilation.
- C. Protect primer, mastic, and adhesive from moisture.
- D. Store protection layer material flat and off the ground. Provide cover on top and all sides.
- E. Protect flammable materials from possible sources of ignition.

1.07 PROJECT CONDITIONS

- A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer.
- B. Proceed with installation only when substrate construction and preparation work is complete and in condition to receive waterproofing.

1.08 WARRANTY

- A. Waterproofing: Provide written 5-year water-tightness warranty issued by the membrane manufacturer upon completion of the work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Waterproofing Coating:
 - 1. Plex Seal 3201 by Porter.
 - 2. Superkote by Ven Chem Corp.
 - 3. Approved Equal.
- B. Water-Proofing Membrane:
 - 1. Acceptable manufacturer:
 - a. Membrane:
 - 1) Bituthene by W. R. Grace and Company.
 - 2) Jiffy Seal by Protecto Wrap Co.
 - 3) Approved Equal.
 - 2. Volclay panels or Bentonize bentonite system are acceptable alternates except where membrane is required between concrete slabs or where there is concrete over waterproofing membrane.
 - 3. Protective Board: ½-inch asphalt impregnated Celotex insulation board.
- C. Moisture-Proofing Underlay:

1. Plastic membrane: Polyethylene film with a thickness of 6 mils.
2. Pressure sensitive tape: 2-inch wide polyethylene tape.

PART 3 EXECUTION

3.01 GENERAL

- A. Mask adjacent surfaces not receiving waterproofing or moisture proofing.
- B. Clean and repair adjacent surfaces, if run-over of waterproofing or moisture proofing occurs.
- C. Make vertical and horizontal passes to cover and saturate all surfaces.

3.02 WATERPROOFING COATING

- A. Location: Apply to the water side of walls and bottoms of channels or tanks that are common with areas to be occupied at any time by equipment, piping, conduit, or personnel.
- B. Surface Preparation:
 1. Unless otherwise indicated by the manufacturer, age new concrete a minimum of 60 days.
 2. Concrete surface shall be cleaned, neutralized and abraded. Muriatic acid shall not be used.
 3. Dry surface required prior to coating.
- C. Application:
 1. Thin prime coat and apply at the rate of approximately 200 to 300 square feet per gallon, depending on surface condition.
 2. Apply finish coats at the rate of 100 square feet per gallon.
 3. Apply a black final coat.
 4. Total dry film thickness shall be a minimum of 20 mils.
 5. Allow drying time between coats as recommended by the material manufacturer.

3.03 WATER-PROOFING MEMBRANE

- A. Location: Apply to surfaces as shown on the Drawings.
 1. Extend water-proofing membrane a minimum of 24 inches onto adjacent surfaces unless noted otherwise.
- B. Surface Preparation: Clean, dry, and free of voids, spalled areas, loose aggregate, and sharp protrusions, with no coarse aggregate visible.
- C. Application:
 1. Clean and prime surfaces prior to application of the membrane.
 2. Apply in accordance with the manufacturer's recommendations.
 3. Manufacturer's representative shall be present during initial application to certify that the Contractor's procedures comply with manufacturer's requirements.
 4. Make pipes or conduits that enter structures to be watertight.
 5. Place protective board directly against the membrane prior to backfilling. Where the membrane is turned up from the base of the walls, at angles in walls, and at any other place where the membrane may be subjected to unusual strain, apply strips consisting of two additional plies of membrane.

3.04 MOISTURE PROOFING UNDERLAY

- A. Location: Unless otherwise indicated, provide under concrete floors or floating slabs-on-grade including those deposited on drain rock.

- B. Surface Preparation: In order to minimize contact with sharp edges level off and smooth over backfilled surfaces that are to receive moisture-proofing underlay.
- C. Application:
 - 1. At joints, lap moisture-proofing membrane 6 inches and seal with pressure sensitive tape.
 - 2. Where pipes and conduits pass through the membrane, wrap tightly with separate sheets of membrane, which shall then be sealed with tape to the main membrane.
 - 3. Repair tears or other damage with new material and pressure sensitive tape. Overlap all repair patches by at least 6 inches.

3.05 PENETRATIONS

- A. Penetrations through the membrane for the purpose of supporting reinforcing steel or form ties will not be permitted.
- B. Install and waterproof pipe, conduit, and other utility penetrations in accordance with the manufacturer's instructions.

3.06 REPAIRS

- A. Replace or repair membrane areas showing injury due to excessive scuffing, puncture, or distress.
- B. Replace or repair defective seams.
- C. Accomplish repairs in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 07 20 10
BUILDING INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies thermal insulation: rigid board, glass fiber, and mineral batt.
- B. See Section 07 22 00 for roof insulation.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C578	Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C612	Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C665	Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM D897	Test Method for Tensile Properties of Adhesive Bonds
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's data showing compliance with the specified products and special storage, handling, and installation instructions.

1.04 DELIVERY, STORAGE AND HANDLING

- A. See Section 01 67 00.
- B. Clearly identify manufacturer, contents, brand name, and R-value on each package.
- C. Store insulation materials off ground in a completely dry location. Protect against weather, condensation, and damage.

PART 2 PRODUCTS

2.01 GENERAL

- A. No products shall contain asbestos.

2.02 INSULATION

- A. Unfaced Fiberglass Batt and Blanket Insulation:
 - 1. ASTM C665, Type I preformed unfaced glass fiber roll.
 - 2. Flame spread of 25 or less and smoke developed of 50 or less when tested in accordance with ASTM E84.
 - 3. Oversize widths for friction-fit between metal framing.

4. Density to provide the R values as indicated.
 5. GreenGuard Indoor Air Quality Certified.
- B. Extruded Polystyrene:
1. Continuous Foamular High-R CW plus high-R XPS
 2. ASTM C578 Type IV.
 3. Flame spread: less than 25 when tested per ASTM E84.
 4. R-Value and widths as indicated on Drawings.
 5. Acceptable manufacturer:
 - a. Dow Chemical Co. Styrofoam SM.
 - b. UC Industries Foamular.
 - c. Approved Equal.
- C. Fiberglass or Mineral Batt Insulation:
1. ASTM C665 Type III, Class A.
 2. Facing: reflective aluminum foil, one side.
 3. Perm Rating: 0.5.
 4. R-Value and widths as shown on Drawings.
 5. Acceptable manufacturer:
 - a. Mansville.
 - b. Owens-Corning.
 - c. Certainteed.
 - d. Approved Equal.
- D. Interior Mineral Wool Insulation:
1. ASTM C612 type IVA, or ASTM C665 type III class A Category I.
 2. Foil facing with a flame spread of 25 or less when tested in accordance with ASTM E84.
 3. R-Value and widths as indicated in the Drawings.
 4. Acceptable manufacturer:
 - a. VersaBaord 40 by Thermafiber Wabash, IN.
 - b. RockBoard 40 by Rockwool.
 - c. Approved Equal.
- E. Exterior Mineral Wool Insulation:
1. ASTM C612 type IB; CAN/ULC S702-97 type 1.
 2. R-Value and widths as indicated in the Drawings.
 3. Acceptable manufacturer:
 - a. RainBarrier 45 by Thermafiber Wabash, IN.
 - b. Cavity Rock DD by Rockwool.
 - c. Approved Equal.

2.03 MINERAL FIREPROOFING AND SAFING

- A. Mineral Fiber: non-combustible, ASTM C665 Type I, Class A.
- B. Density: 4 pounds per cubic foot.

2.04 ADHESIVE

- A. Adhesive for rigid board insulation shall be a system approved by the board manufacturer for the underlying substrate.
- B. Bond strength shall be 80-psi min on masonry when tested in accordance with ASTM D897.

2.05 ACCESSORIES

- A. Vapor Barrier: polyethylene, 10-mils thick.
- B. Protection Boards: wood fiberboard, 1/2-inch thick.

2.06 SUSTAINABILITY

- A. See Sustainability Requirements: Section 01 33 29.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation boards are dry and ready to receive adhesive.

3.02 INSTALLATION: RIGID INSULATION

- A. Cut to fit neatly together and around corners. Butt joints tightly together.
- B. Apply adhesive to clean dry surface in quantities called for by manufacturer.
- C. Where thicker than 1-1/2 inches, install 2 layers of boards, staggering all joints six inches minimum.

3.03 INSTALLATION: BATT INSULATION

- A. Batt insulation shall be in width suitable for tight installation. Install without gaps or voids.
- B. Cut in practical lengths and secure neatly to construction.
- C. Install with vapor barrier facing warm side.
- D. Tape edges where they abut.
- E. Replace insulation, which has damage to the facing.

3.04 INSTALLATION: MINERAL FIREPROOFING AND SAFING

- A. Locate where shown on the Drawings.
- B. Locate in openings in floors and walls, to completely seal without voids around pipe, conduit, duct, and other penetrations.
- C. Install in accordance with manufacturer's recommendations.

3.05 VAPOR BARRIER

- A. Tape vapor barrier to securely adhere.

3.06 INSPECTION

- A. Do not cover Insulation installations until inspected by the Project Representative.

END OF SECTION

SECTION 07 22 00
ROOF AND DECK INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies materials required for the installation of insulation, crickets, cover board, and related materials over concrete and steel decks.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C472	Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete
ASTM C728	Standard Specification for Perlite Thermal Insulation Board
ASTM C1177	Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1289	Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
FS HH-I-1972/2	Insulation Board, Thermal, Polyurethane or Polyisocyanurate, Faced with Asphalt/Organic Felt, Asphalt/Asbestos Felt, or Asphalt/Glass Fiber Felt on Both Sides of the Foam

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Shop drawings, taper plan, manufacturers literature, including installation instructions, fastening pattern, and product specifications.
 2. Roofing system submittal per Section 07 52 16.13.
 3. Written approval from the warrantor of the primary roof membrane materials
 4. Completed and signed re-roofing permit affidavit

1.04 DESIGN REQUIREMENTS

- A. The average overall roof insulation shall meet or exceed an R-Value of 38.

1.05 QUALITY ASSURANCE

- A. All insulation materials shall be approved by the warrantor of the primary roof membrane materials.
- B. All insulation components shall be compatible with the roof system and certified by the roofing material manufacturer as a single-source warranty roof system. All materials shall be certified as "asbestos free".
- C. Prior to commencement of work, the Contractor shall be responsible for the verification of existing conditions and dimensions. Should there be conflicts, the Contractor shall notify the Project Representative for resolution.

1.06 DELIVERY AND STORAGE

- A. Product Delivery, Storage, and Handling: Refer to Section 07 52 16.13.
- B. All material shall be delivered to the job in new, dry, and unopened containers showing product name and manufacturer's name. Materials shall be delivered in sufficient quantity to allow continuity of work. Storage under polyethylene or similar non-breathing film stock shall not be permitted. Remove plastic packaging shrouds from insulation.
- C. Materials shall be handled in a manner to avoid bending, tearing, or other damage during transportation and installation. Material handling equipment shall be selected and operated so as not to damage existing construction or applied roofing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer – Polyisocyanurate:
 - 1. Johns Manville.
 - 2. Rmax.
 - 3. Approved Equal.

2.02 ROOF INSULATION

- A. Maximum thickness of any single insulation layer of flat stock: 2.3 inches.
- B. Non-tapered polyisocyanurate insulation system:
 - 1. ASTM C1289, FS HH-I-1972/2(1), Type II, Class 1, Grade 2, polyisocyanurate, minimum 20 PSI.
 - 2. Black, glass fiber reinforced, non-asphaltic facer.
- C. Tapered polyisocyanurate insulation system:
 - 1. ASTM C1289, FS HH-I-1972/2(1), Type II, Class 1, Grade 2, polyisocyanurate, minimum 20 PSI.
 - 2. Black, glass fiber reinforced, non-asphaltic facer.
 - 3. Slope: 2% (¼ inch per running foot).
 - 4. Minimum thickness: ½ inch.
- D. Asphaltic Cover Board:
 - 1. Water Absorption: ASTM D994, Min. 0.25%.
 - 2. Compressive Strength: ASTM C472, Min. 517 psi.
 - 3. Size: Minimum ¼-inch thickness.

2.03 ADDITIONAL MATERIALS

- A. Tapered Edge and Cant Strip: ASTM C728, perlite.
- B. Crickets and Drain Sumps:
 - 1. Slope a minimum of 1/4 inch per foot.
 - 2. Maximum thickness of polyisocyanurate: 2.5 inches.
- C. Insulation Adhesive: Refer to per Manufacturers recommendation.
- D. ½-inch primed gypsum deck sheathing board; shall meet ASTM C1177 at metal deck only.

2.04 MECHANICAL FASTENERS AND PLATES

- A. Wood to wood:

1. No. 10 coated or hot dip galvanized screw which is compatible with SBX or CA pressure treated lumber and long enough to penetrate underlay blocking 1¼ inches.
 2. Acceptable manufacturers:
 - a. Grabber Construction Products, Concord, CA.
 - b. ITW Buildex, Itasca, IL.
 - c. Approved Equal.
- B. Wood to concrete:
1. ¼-inch diameter, flat head anchor which is compatible with SBX or CA pressure treated lumber and long enough to provide minimum 1½-inch embedment.
 2. 5/16-inch diameter Concrete Screws, compatible with SBX or CA pressure treated lumber and long enough to penetrate underlay concrete 1¼ inches
 3. Acceptable manufacturers:
 - a. Powers Fasteners, USA; Tapcon, IL.
 - b. ITW Buildex, Itasca, IL
 - c. Approved Equal.
- C. Termination bars or metal channels to masonry/concrete:
1. ¼-inch diameter, flat head anchor with EPDM washer long enough to provide 1¼- inch embedment minimum
 2. Acceptable manufacturers:
 - a. Powers Fasteners, USA
 - b. ITW Buildex, Itasca, IL.
 - c. Approved Equal.
- D. Roofing plies to wood:
1. Nails: Spiral or annular ring shank, twelve (12) gage minimum, with integral 1 inch cap.
 2. Acceptable manufacturers:
 - a. National Nail Corp., Grand Rapids, MI.
 - b. Simplex Nails, Inc., Americus, GA.
 - c. Approved Equal.
- E. Sheet Metal to Wood Blocking or metal channels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head with EPDM or PVC washer under heads of fasteners bearing on weather side of sheet metal
- F. Sheet metal to sheet metal: High-strength aluminum or stainless-steel rivets.
- G. Drawband: Gold Seal stainless steel worm gear clamp by Murray Corporation, Cockeysville, MD., Power-Seal stainless steel worm drive clamp by Breeze Clamp Company, Saltsburg, PA., or approved equal.
- H. Insulation to metal or wood: Steel Insulation Plates (OD: 2-7/8 inch) with #12 Fasteners.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

- A. Contractor shall be responsible for prepare and maintaining the deck for a clean, smooth, and dry condition.

3.02 FIELD QUALITY CONTROL

- A. New insulation boards shall be full size except when cutting is required at roof edges and openings. Boards that are broken, cracked, have been exposed to moisture or are otherwise damaged shall not be used.

- B. The proper installation and fit of wood nailers, blocking and other rough carpentry in appropriate locations shall be verified prior to installation of roof insulation.
- C. Caution shall be exercised with construction traffic to avoid damage to new insulation. Breaking or crushing of insulation is unacceptable and any damaged insulation shall be replaced at the Contractor's expense.
- D. No more insulation shall be installed during any work period than can be waterproofed during the same work period. At the end of the work period, temporary waterstops shall be installed to protect the roof insulation. Upon resumption of work, they shall be removed.
- E. Insulation surfaces shall be cleared of all debris before roofing is placed.
- F. Material which is wet or is otherwise damaged shall be rejected. Any material which indicates 20% or greater (Wood Scale) moisture content on a Delmhorst moisture meter or is damp to the touch shall be deemed wet.

3.03 INSTALLATION

- A. Prime existing concrete deck and vertical substrates with asphalt primer at a rate of 1 gallon per 100 sq. ft. prior to installing the vapor barrier per Section 07 52 16.13.
- B. Substrate board shall be mechanically fastened. Fastening patterns shall meet or exceed FM Global 1-90 for Wind Uplift.
- C. Insulation shall be laid with joints staggered and all joints no wider than ½ inch; however, boards shall not be forced into place.
- D. Roof insulation shall be installed in multiple layers with all joints staggered 12 inches minimum. Adhesive, other than hot asphalt, application shall be minimum 1-inch wide beads spaced 12 inches on centers through the field of the roof, spaced 6 inches on centers at the perimeter, and spaced 4 inches on centers in the corners. The perimeter shall be defined as all area within four feet of the roof edge and the corners shall be defined as four feet from each roof edge.
- E. Crickets, polyisocyanurate insulation and cover board adhered in specified adhesive.
 - 1. Install insulation boards in courses parallel to roof edges, mopping surface up.
 - 2. Firmly butt each insulation board to surrounding boards without deforming boards.
 - 3. Offset joints of top layer 12 inches in both directions from joints of base layer.
 - 4. Maximum elevation variation between boards at joints: 1/8 inch.
 - 5. Cut and fit insulation boards where roof deck intersects vertical surfaces. Cut board ¼ inch from vertical surface.
 - 6. Immediately after placement, walk insulation boards into the adhesive to achieve a solid bond; follow the manufacturer's requirements and recommendations.
- F. Crickets:
 - 1. Install crickets as per tapered insulation design, ensuring positive drainage to drainage components (minimum slope ½ inch per foot tapered to nothing) using specified adhesive.
- G. Perlite Cants:
 - 1. Cant strips shall be adhered at all 90-degree angles where the horizontal installation of insulation meets the vertical sides of roof penetrations and walls using specified adhesive.

3.04 WATER CUTOFF

- A. Insulation work shall be closely coordinated with roof membrane application to protect insulation from water damage.

- B. Insulation shall be place in conformance with manufacturer's instructions. Strip edges with 12-inch wide ply sheet embedded completely in alternate uniform courses of specified Interply Adhesive or Asphalt Mastic.
- C. Remove embedded gravel/debris from top ply of felt along termination. Width: 18 inches.
- D. Install "deadman" insulation filler at insulation staggers.
- E. Extend roofing plies at least twelve inches onto prepared area of adjacent roofing. Embed plies into Specified Interply Adhesive or Asphalt Mastic.
- F. At beginning of next day's work remove temporary connection by cutting felts evenly along edge of existing roof system. Remove "deadman" insulation fillers. Overlap previous day's work 24 inches.

END OF SECTION

SECTION 07 27 20
FLUID APPLIED AIR BARRIER SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies:
1. Fluid-applied vapor permeable air barrier system at exterior envelope construction with conditioned space behind.
 2. Sealant and fluid applied membrane flashing systems required to seal joints and penetrations to form a continuous air barrier assembly.
 3. Related air barrier accessories and components.
 4. Flexible flashing membrane.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C661	Standard Test Method for Indentation Hardness of Elastomeric- Type Sealants by Means of a Durometer
ASTM C794	Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D1781	Standard Test Method for Climbing Drum Peel for Adhesives
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E547	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference
ASTM E2178	Standard Test Method for Air Permeance of Building Materials
ASTM E 779	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Product Data: Catalog cuts and installation instructions for specified manufactured products.

1.04 QUALITY ASSURANCE

- A. Air Barrier Pre-Installation Conference:
1. Administer pre-installation conference in accordance with Section 01 31 19.
 2. Discuss air barrier components and sequence of installation.
 3. Discuss joints; penetrations and methods for sealing.
 4. Identify and discuss special conditions.

1.05 DEFINITIONS

- A. Air Barrier System: Airtight components of the building enclosure and the joints, junctures and transitions between materials, products, and assemblies forming the air-tightness of the building enclosure.

1.06 SYSTEM DESCRIPTION

- A. Voids within air barrier systems shall be closed to resist air flow across the assembly.
- B. Air Barrier Performance Requirement: The air leakage of the Crane Hall Level Space between Grids 1-3 and Grids E-F and Crane Hall Level Space between Grids 1-2 and Grids B – E shall not exceed 0.4 cfm/ft² under a pressure differential of 0.3 in. water (1.57psf) when tested according to ASTM E 779. Also the air leakage of the Electrical Room shall not exceed 0.4 cfm/ft² under a pressure differential of 0.3 in. water (1.57psf) when tested according to ASTM E 779.
- C. The following elements specified in other Sections shall be considered integral parts of the air barrier assembly:
 - 1. Concrete foundation.
 - 2. Roof vapor retarder and roof membrane.
 - 3. Exterior windows and door assemblies.
- D. For the GFRC systems, air barrier systems shall consist of the following:
 - 1. Liquid applied air barrier membrane applied over exterior gypsum sheathing surfaces, backside of precast concrete surfaces, and concrete masonry surfaces as indicated.
 - 2. Connections to adjacent construction, including foundation and roof vapor retarder membrane.
 - 3. Sealing of penetrations in the building exterior building air barrier envelope, including windows, doors, plumbing elements, electrical elements, and mechanical components, including duct penetrations at rooftop mechanical unit.
- E. For the existing cast-in-place walls and concrete walls with insulation on the interior, the air barrier will be provided by the taped interior gypsum board system or interior coating system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Pro-So-Co "R-Guard".
 - 2. Barritech VP by Carlisle Coatings and Waterproofing.
 - 3. Enershield HP by BASF.
 - 4. Approved Equal.

2.02 MATERIALS

- A. Fluid Applied Air Barrier Membrane:
 - 1. Seamless, fluid applied, single component, vapor-permeable, elastomeric, acrylic membrane designed for application to exterior above-grade walls to seal assemblies and prevent moisture and air infiltration.
 - 2. Design requirements:
 - a. Air infiltration: Less than 0.004 cfm per square foot when tested in accordance with ASTM E2178 or ASTM E283.
 - b. Water vapor permeability: Minimum 10.5 perms when tested in accord with ASTM E96.
 - c. Structural performance: Weather and air barrier system shall withstand positive and negative wind pressure loading when tested in accord with ASTM E330.

- d. Water penetration (static pressure): No uncontrolled water penetration when tested in accord with ASTM E331, with differential static pressure not less than 6.24 psf.
 - e. Water penetration (cyclical static air pressure difference): No uncontrolled water penetration when tested in accord with ASTM D547.
 - f. Hardness: Shore A, 20-25 when tested in accord with ASTM C661.
 - g. Tensile strength: 15 psi or exceeds strength of substrate when tested in accordance with ASTM C297.
 - h. Elongation at break: 300% when tested in accordance with ASTM D412.
 - i. Peel strength: 30 pli when tested in accordance with ASTM D1781 or ASTM C794.
 - j. Volatile organic content (VOC): 15 g/L or less.
 - 3. Acceptable manufacturers:
 - a. Pro-So-Co R-Guard Cat 5.
 - b. Approved Equal.
- B. Fluid Applied Flashing Membrane:
- 1. 99% solids, roll/trowel/brush-applied, elastomeric liquid flashing material.
 - 2. Design requirements:
 - a. Thickness: Minimum 12 mils.
 - b. Water vapor permeability: Minimum 14 perms when tested in accord with ASTM E96.
 - c. Water penetration (cyclical static air pressure difference): No uncontrolled water penetration when tested in accord with ASTM E547.
 - d. Hardness: Shore A, 40-45 when tested in accord with ASTM C661.
 - e. Tensile strength: 180 psi when tested in accord with ASTM D412.
 - f. Elongation at break: 400% when tested in accord with ASTM D412.
 - g. Peel strength: 25 pli when tested in accord with ASTM D1781.
 - h. Volatile organic content (VOC): 30 g/L.
 - 3. Acceptable manufacturers:
 - a. Pro-So-Co "R-Guard Fast Flash".
 - b. Approved Equal.
- C. Fiber Reinforced Joint and Seam Filler:
- 1. Waterproof, high modulus, single-component fiber reinforced joint and seam treatment and filler for application to joints, gaps and seams of sheathing and fenestration substrates.
 - 2. Design requirements:
 - a. Hardness: Shore A, 45-50 when tested in accord with ASTM C661.
 - b. Tensile strength: 225 psi when tested in accord with ASTM D412.
 - c. Lap shear strength: 275 psi when tested in accord with ASTM D1002.
 - d. Elongation at break: 275% when tested in accord with ASTM D412.
 - e. Peel strength: 30 pli when tested in accord with ASTM D1781.
 - f. Volatile organic content (VOC): 15 g/L.
 - g. Water vapor permeability: Minimum 14 perms when tested in accordance with ASTM E-96.
 - 3. Acceptable manufacturers:
 - a. Pro-So-Co "R –Guard Joint & Seam Filler".
 - b. Approved Equal.
- D. Air Barrier Sealant:
- 1. 99% solids, one-component, low-modulus, elastomeric, paintable, silyl-terminated polyether sealant.
 - 2. Design requirements:
 - a. Hardness: Shore A, 20-25 when tested in accordance with ASTM C661.
 - b. Tensile strength: 110 psi when tested in accord with ASTM D412.
 - c. Elongation at break: 1300% when tested in accord with ASTM D412.
 - d. Peel strength: 30 pli when tested in accord with ASTM D1781.
 - e. Type: Type S, Grade NS, Class 50 when tested in accord with ASTM C920.
 - f. Volatile organic content (VOC): 15 g/L.
 - 3. Acceptable manufacturers:
 - a. Pro-So-Co R-Guard "AirDam,"

- b. Approved Equal
- E. Gypsum Edge Primer:
 - 1. Primer to consolidate and seal the cut edges of exposed gypsum sheathing surfaces to receive fluid applied air barrier.
 - 2. Design requirements:
 - a. Volatile organic content (VOC): less than 100 g/L.
 - 3. Acceptable manufacturers:
 - a. Pro-So-Co . R-GUARD "GypPrime".
 - b. Approved Equal
- F. Backer Rod: Compressible, closed cell rod stock as recommended by manufacturer for compatibility with sealant. Provide size and shape of rod to control joint depth.
- G. Silicone Transition Membrane:
 - 1. Extruded pre-cured silicone membrane transition between aluminum framed glazing systems and adjacent air barrier assemblies.
 - 2. Acceptable manufacturers:
 - a. Pro-So-Co "SureSpan EX,".
 - b. Approved Equal
- H. Flexible Flashing:
 - 1. Modified asphalt or butyl based self adhering sheet flashing; minimum 40 mil thickness
 - 2. Compatible with liquid applied air barrier system.
 - 3. Provide manufacturer's recommended mastics for sealing of penetrations.
 - 4. Primer: as recommended by the flexible flashing manufacturer for the application.

2.03 ACCESSORIES

- A. Provide surface conditioners, primers, mastic, tape, and other accessories as specified by or acceptable to the manufacturer of each product.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence. Notify the Project Representative in writing of conditions detrimental to the proper and timely completion of the work.
- B. Do not begin installation until unsatisfactory conditions are resolved. Beginning work constitutes acceptance of site conditions and responsibility for defective installation caused by prior observable conditions.

3.02 PREPARATION

- A. Surfaces shall be sound, dry or damp, clean and free of oil, grease, dirt, excess mortar or other contaminants.
- B. Concrete and Masonry Surfaces:
 - 1. Fill spalled or depressed areas in concrete substrates to provide an even plane.
 - 2. Form tie holes/voids in poured concrete shall be filled flush and smooth with Polymer-Modified Repair Mortar as specified in Section 03 01 32 and allow to cure for a minimum of 7 days.
 - 3. Cracks in concrete shall be filled with a trowel application of Polymer-Modified Repair Mortar and allow to cure for a minimum of 7 days.

- C. Exterior Sheathing:
 - 1. Ensure that sheathing is properly installed with ends, corners and edges properly fastened.
 - 2. Mechanical fasteners used to secure sheathing boards or penetrate sheathing boards shall be set flush with sheathing, fastened and spotted with fiber reinforced joint and seam filler and fastened into solid backing.
 - 3. Fill sheathing end and prime edge joints with gypsum edge primer.
 - 4. Joints between panels of exterior grade gypsum board up to 1/4 inch wide shall be filled with a trowel application of liquid applied air barrier membrane and reinforced with a 2 inch wide strip of glass fiber tape or sealed with sheet transition membrane prior to the application of liquid membrane.
 - 5. Joints between gypsum sheathing panels and adjacent construction greater than 1/4 inch wide shall be sealed with sheet transition membrane supported by mechanically-fastened stainless steel flashing to bridge the gap and the membrane lapped a minimum of 3 inches on both sides of the flashing prior to the application of liquid membrane.
- D. Flexible Flashing:
 - 1. Apply primer to surfaces and install flexible flashing at below grade portions of concrete foundation walls where precast panels are installed in front of the wall.
 - 2. Install in accordance with manufacturer's recommendations.
 - 3. Lap joints and run the flexible flashing down the face of the concrete foundations wall as necessary to integrate with existing waterproofing..
 - 4. Run the flexible flashing up the curb or wall as necessary to align with the fluid applied air barrier installed to the backside of the precast panels. Seal the joint between the flexible flashing and the air barrier on the precast to form an airtight seal.

3.03 FLUID APPLIED FLASHING MEMBRANE

- A. Apply air barrier liquid flashing membrane at expansion joints, penetrations through wall substrate and at rough openings for windows, doors, louvers and other openings in exterior wall construction, and at transitions to adjacent construction.
- B. Spread liquid flashing to create a monolithic flashing membrane extending a minimum of 2 inches at upturned vertical surfaces and a minimum of 1 inch at downturned vertical surfaces. Apply additional product as needed to achieve a void and pinhole free surface.
- C. Allow treated surfaces to skin before installing other air barrier components.

3.04 FLUID APPLIED AIR BARRIER MEMBRANE

- A. Apply fluid applied air barrier membrane continuously over exterior substrate surfaces in accordance with the manufacturer's recommendations.
- B. Apply to the manufacturer's recommended thickness.
- C. After transition membrane areas are installed, trowel, or brush a complete and continuous unbroken film of liquid membrane at an average dry film thickness of 12 mils. Overlap transition membrane a minimum of 1 inch. Apply around projections ensuring a complete and continuous air seal.

3.05 AIR BARRIER SEALANT

- A. Install air barrier sealant with professional grade caulking gun in continuous beads without air gaps or air pockets.
- B. Apply to a clean, dry or damp surfaces.
- C. Install backer rod: Provide size and shape of rod to control joint depth, for a width to depth ratio of 2:1.

- D. Install air barrier sealant to provide uniform, continuous ribbons without gaps or air pockets, with complete wetting of the joint bond surfaces.
- E. Tool sealant immediately to ensure complete wetting of joint bond surface and to produce a smooth, concave joint profile flush with the edges of the adjacent surfaces. Where horizontal and vertical surfaces meet, tool sealant to create a slight cove so as to not trap moisture or debris.
- F. Do not allow materials to overflow onto adjacent surfaces. Prevent staining of adjacent surfaces.
- G. Remove excess and misplaced materials as work progresses. Clean the adjoining surfaces to remove misplaced materials, without damage to adjacent surfaces or finishes.

3.06 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed in accordance with the requirements specified in Section 01 15 00.

3.07 PROTECTION OF FINISHED WORK

- A. Cover as soon as possible. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air barrier and at protrusions according to air barrier manufacturer's written instructions.

END OF SECTION

SECTION 07 42 14
INSULATED METAL WALL PANEL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies factory-formed and field-assembled, concealed-fastener, lap-seam insulated metal wall panels.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A 755	Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A 792	Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM C 578	Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM D 523	Test Method for Specular Gloss
ASTM D 2244	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D 4214	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM E 330	Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

1.03 SYSTEM DESCRIPTION

- A. Provide insulated metal wall panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
- B. Performance Requirements:
1. Structural Performance:
 - a. Provide manufactured wall panel assemblies capable of withstanding design wind loads indicated under in-service conditions with deflection no greater than the following, in accordance with ASTM E 330.
 - b. Uniform pressure as indicated on Drawings.
 2. Thermal Movements:
 - a. Provide insulated metal wall panel assemblies that allow for thermal movements resulting from the maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.
 - b. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of insulated metal wall panel and accessory.
 2. Shop drawings: Show layouts of panels, details of corner conditions, joints, panel profiles, supports, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work.
 3. Samples for Verification: Provide sample panels 12 inches long by actual panel width, in the profile, style, color, and texture indicated. Include clips, caps, battens, fasteners, closures, and other exposed panel accessories.
 4. Product Data: Manufacturer's data sheets for wall panels and accessories.
 5. Structural calculations for Insulated Aluminum Wall Panels indicating design conforms to specified design criteria, sealed by Professional Structural Engineer licensed in the state of Washington.
 6. Certification of installer qualifications.
 7. Field Water Infiltration Test reports.
- C. Installer Qualifications: Engage an experienced installer who has completed insulated metal wall panel projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Handling: Exercise care in unloading, storing, and erecting wall panels to prevent bending, warping, twisting, and surface damage.
- B. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight and ventilated covering. Store panels to ensure dryness. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

1.06 WARRANTY

- A. Warranty to cover waterproof integrity of panel system against leaks through wall. Provide 2-year warranty.
- B. Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace insulated metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 1. Designwall 4000 by Benchmark by Kingspan.
 2. Centria.
 3. Approved Equal.

2.02 METALS AND FINISHES

- A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755 and the following requirements:

1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792, Class AZ-55 coating, Grade 40; structural quality.
2. Thickness: As required to meet performance criteria, but not less than 22 gauge.
3. Surface: Smooth, flat, mill finish.
4. Exposed Finish: Manufacturer's standard 2-coat, fluoropolymer system composed of not less than 70 percent polyvinylidene fluoride resin by weight with a total minimum dry film thickness of 0.9 mil and 30 percent reflective gloss when tested according to ASTM D 523:
 - a. Color: PPG "ZACTique II".
 - b. Approved Equal.
5. Prime Coat for Concealed Surfaces: Apply pretreatment and white or light-colored, baked-on polyester primer coat; with a minimum dry film thickness of 0.2 mil.

2.03 THERMAL INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft. minimum density, unless otherwise indicated; with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.

2.04 MISCELLANEOUS MATERIALS

- A. Z-Shaped Furring: With slotted or non-slotted web, face flange of 1¼-inches, wall attachment flange of 7/8-inch, minimum bare metal thickness of 0.0179-inch, and depth required to fit insulation thickness indicated.
- B. H-Shaped Channels: With 7/8-inch depth, minimum bare metal thickness of 0.0179-inch.
- C. Fasteners:
 1. Self-tapping stainless-steel screws, bolts, nuts, self-locking rivets and bolts, EPDM or neoprene sealing washer, end-welded studs, designed to withstand design loads.
 2. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating.
- D. Accessories:
 1. Unless otherwise specified, provide components required for a complete wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, seam covers, flashings, louvers, sealants, gaskets, fillers, closure strips, and similar items.
 2. Match materials and finishes of panels.
 3. Closure Strips: Closed-cell, self-extinguishing, expanded, cellular, rubber or cross-linked, polyolefin-foam flexible closure strips. Cut or premold to match configuration of panels. Provide closure strips where indicated or necessary to ensure weathertight construction.
 4. Joint Sealant: One-part elastomeric polyurethane, polysulfide, or silicone-rubber sealant as recommended by panel manufacturer.
- E. Bituminous Coating:
 1. Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat, unless otherwise indicated.
 2. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- F. Test for water leakage based on differential test pressure amounting to 20percent of specified performance pressure required relative to complete module of metal panel system:
 1. Water leakage: No evidence of uncontrolled leakage of water when tested in accord with AAMA 501.1.
- G. Test for Air Leakage:

1. Not to exceed 0.09 cfm per sf when tested to ASTM E283 at a static pressure differential of 6.24 psf.

2.05 FABRICATION

- A. Fabricate panels to approximate dimensions and profiles indicated:
 1. R-value: 13.
 2. Adjust dimensions as required based on actual field dimensions.
 3. Allow for thermal expansion/contraction between panels and structure.
 4. Design panels to withstand structural loads indicated.
 5. Shop assemble panels to tolerances specified.
- B. Fabrication Tolerances:
 1. Panel lines: Sharp, true and free from warp or buckle.
 2. Panel bow: 0.2% of panel dimension in width and length up to 1/8 inch maximum.
 3. Width or length: Plus/minus 1/32 inch up to 48 inches and plus/minus 1/16 inch when greater than 48 inches.
 4. Thickness: Plus/minus 0.02 mm.
 5. Square: Not greater than 3/16 inch difference between diagonal measurements.
 6. Camber: No greater than 1/32 inch.
- C. Fabricate and finish panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- D. Apply bituminous coating or other permanent separation materials on concealed panel surfaces where panels would otherwise be in direct contact with substrate materials that are non-compatible or could result in corrosion or deterioration of either materials or finishes.
- E. Fabricate panel joints with captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements indicated for conditions affecting performance of metal panel walls:
 1. Panel Supports and Anchorage: Examine wall framing to verify that girts, angles, and other secondary structural panel support members and anchorage have been installed to meet requirements of panel manufacturer.
 2. Do not proceed with wall panel installation until unsatisfactory conditions have been corrected.
- B. Field Measurements: Verify location of structural members and openings in substrates by field measurements before fabrication and indicate measurements on Shop Drawings.

3.02 PREPARATION

- A. Coordinate insulated metal wall panels with rain drainage work; flashing; trim; and construction of roofing, guardrails, parapets, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.
- B. Promptly remove protective film, if any, from exposed surfaces of metal panels. Strip with care to avoid damage to finish.

- C. Secondary Structural Supports: Install girts, angles, and other secondary structural panel support members and anchorage according to manufacturer's requirements.

3.03 PANEL INSTALLATION

- A. General:
 - 1. Comply with panel manufacturer's written instructions and recommendations for installation, as applicable to project conditions and supporting substrates.
 - 2. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 3. Field cutting exterior panels by torch is not permitted.
 - 4. Locate and space exposed fasteners in true vertical and horizontal alignment. Use proper tools to obtain controlled, uniform compression for positive seal without rupture of neoprene washer.
- B. Accessories: Install components required for a complete wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, seam covers, flashings, louvers, sealants, gaskets, fillers, closure strips, and similar items.
- C. Joint Sealers:
 - 1. Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of wall panel assemblies.
 - 2. Provide types of gaskets, fillers, and sealants indicated or, if not otherwise indicated, types recommended by panel manufacturer.
 - 3. Install weatherseal to prevent air and moisture penetration. Flash and seal panels at ends and intersections with other materials with rubber, neoprene, or other closures to exclude weather.
 - 4. Seal panel end laps with a bead of tape or sealant, full width of panel. Seal side joints where recommended by panel manufacturer.
- D. Separate dissimilar metals by painting each metal surface in area of contact with a bituminous coating or by other permanent separation as recommended by manufacturers of dissimilar metals.
- E. Installation Tolerances: Shim and align panel units within installed tolerance of 1/4-inch in 20 feet on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.04 CLEANING AND PROTECTION

- A. Damaged Units: Replace panels and other components of the Work that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- B. Cleaning: Remove temporary protective coverings and strippable films, if any, as soon as each panel is installed. On completion of panel installation, clean finished surfaces as recommended by panel manufacturer and maintain in a clean condition during construction.

END OF SECTION

SECTION 07 44 56
GLASS-FIBER REINFORCED CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies:
1. Architectural precast glass-fiber-reinforced concrete (GFRC) wall panels and fabricated units.
 2. Supports, anchors, and attachments.
- B. GFRC panel fabrication shall include all labor, materials, equipment, and related services necessary to manufacture and deliver the panels as indicated and described by the Contract Documents, including the following:
1. GFRC composite panels produced by the spray-up process, including integral metal stud frame.
 2. Shop drawings and engineering calculations for panels, stud frame, connections, and attachments to building structure.
 3. Loose connection hardware, and hardware for anchorage to cast-in-place concrete, as indicated or required for panel attachment to building structure.
 4. Color adjustment of GFRC panels to coordinate with cast-in-place concrete sample provided.
- C. GFRC panel erection shall include all labor, materials, equipment, and related services necessary for the erection of the panels as indicated and described by the Contract Documents, in accordance with the approved shop drawings, including the following:
1. Attaching all loose connection hardware between panel frames and building structural frame.
 2. Installation of mockup to remain as part of the project upon approval.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A108	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric)
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A706	Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
ASTM A767	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

Reference	Title
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C979	Standard Specification for Pigments for Integrally Colored Concrete
ASTM F436	Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F959	Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series.
ASTM F3125	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
IAS AC157	Accreditation Criteria for Fabricator Inspection Programs for Reinforced and Precast/Prestressed Concrete
PCI MNL-128	Recommended Practice for Glass Fiber Reinforced Concrete Panels
PCI MNL-130	Manual for Quality Control for Plants and production of Glass Fiber Reinforced Concrete Products
AIS	American Iron and Steel Consolidated Appropriations Act

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
 1. Complete shop drawings and erection drawings showing:
 - a. Unit shapes (elevations and sections) and dimensions.
 - b. Thickness of facing and GFRG backing.
 - c. Finishes.
 - d. Steel stud frame details.
 - e. Joint and connection details.
 - f. Lifting and erection details.
 - g. Location and details of hardware attached to structure.
 - h. Size, location and details of flex and gravity anchors.
 - i. Other items sprayed in panels.
 - j. Handling procedures.
 - k. Sequence of erection for special conditions.
 - l. Relationship to adjacent material.
 - m. Description of all loose, cast-in, and field hardware.
 2. Design data and certification of materials compliance with ASTM standards of all raw materials, including:
 - a. Aggregates.
 - b. Admixtures.
 - c. Fiberglass reinforcement.
 - d. Cement.
 - e. Metal framing components.
 - f. Connection hardware.

3. Shop drawings and engineering calculations shall be stamped by a professional engineer registered in the state of Washington.
 4. Mix designs: Backup and face mix designs.
 5. Product data: Manufacturer's information on accessory products, including pigments, admixtures, inserts, plates, etc.
 6. Submit complete design calculations for panels, connections and attachments including:
 - a. Loads used in design:
 - 1) Design loads shall meet the requirements of the City of Seattle Building Code:
 - a) Wind Load Factors on components and cladding:
 - (1) Exposure C as permitted by the City of Seattle Department of Construction and Inspections Wind Speed Up Areas Maps.
 - (2) $K_{zt} = 1.0$ as permitted by the City of Seattle Department of Construction and Inspections Wind Speed Up Areas Maps.
 - (3) Wind Speed: 104 mph.
 - b) Seismic anchorage design in accordance the requirements of Section 01 73 00. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00. Unless noted otherwise, $I_p = 1.0$ all GFRC components, connections and attachment design.
 - b. Metal stud frame design.
 - c. Connection hardware design.
 - d. Anchorage design.
 - e. Test data on which GFRC design is based and data on GFRC insert and anchor tests.
 7. AIS compliance certification documents.
 8. Quality Assurance testing reports.
 9. Manufacturer's installation instructions.
 10. Procedures and patch mix design for repairing and cleaning panels.
 11. GFRC Designer qualifications.
 12. GFRC Fabricator qualifications.
 13. GFRC Installer qualifications.
 14. Welders' Performance Qualification Records and Welder Logs.
 15. Welding data and weld inspection reports, as specified in Section 05 05 20.
- C. Samples: GFRC fabricator is to be provided with two 12" x 12" samples from job site of adjacent cast-in-place concrete for color coordination. Submit for approval, two samples 12" x 12" in size illustrating surface color, finish, and texture.

1.04 QUALITY ASSURANCE

- A. GFRC Designer qualifications:
 1. Professional Engineer currently licensed in the state of Washington.
 2. Employed by or retained by the GFRC Fabricator.
 3. Experienced in design of GFRC panels using material property data generated from fabricator's actual production.
 4. Comply with procedures in PCI MNL-128 and PCI MNL-130.
- B. GFRC Fabricator qualifications:
 1. Company specializing in performing the work of this Section with minimum 5 years of documented experience.
 2. Precast concrete fabricator accredited by IAS according to IAS AC157.
 3. The GFRC fabrication plant shall be certified by the Precast/Prestressed Concrete Institute as Category "G" prior to bid date.
- C. GFRC Installer qualifications: Company specializing in performing the work of this Section with minimum 5 years of documented similar experience.
- D. Welding qualifications: As specified in Section 05 05 20.

- E. Testing: In accordance with PCI MNL-128, and PCI MNL-130, including the following:
 - 1. Glass content by "wash-out" test.
 - 2. Flexural yield strength.
 - 3. Flexural ultimate strength.
 - 4. Flex anchor/gravity anchor strength.
 - 5. Slurry unit weight test.
 - 6. Slurry slump test.
 - 7. Aggregate gradation testing.
- F. Maintain plant records and quality control program during production of units. Make records and access to plant available to Project Representative upon request.

1.05 MOCK-UP

- A. Construct one panel, minimum 6 ft wide and 4 ft high with surface finish applied, including supporting backup structure, attachments, air and vapor seals applied.

PART 2 PRODUCTS

2.01 FABRICATORS

- A. Acceptable fabricators:
 - 1. Glass-Fiber-Reinforced Concrete:
 - a. Stromberg.
 - b. Unlimited Designs, Inc.
 - c. Olympian Precast.
 - d. GFRC Cladding.
 - e. Approved Equal.

2.02 CONCRETE MATERIALS

- A. Cement: ASTM C150 Portland Type I or Type II - Normal; white color, or ASTM C595 Portland-Limestone Type 1L.
- B. Sand: Fine, clean, dry sand, able to pass a no. 16 sieve, free of contaminants and meeting ASTM C144.
- C. Water: Fresh, clean, potable and free of any deleterious matter that would interfere with color, setting or strength of concrete.
- D. Glass Fibers: High zirconia content (minimum 16%), alkali resistant glass fibers specifically designed for use in concrete. Lengths varying from 1-1/2 to 2 inches.
- E. Concrete Pigment: Harmless to concrete, sunlight-fast, alkali resistant, conforming to ASTM C979.
- F. Aggregate (if used): Clean, hard, strong, durable, inert and free of deleterious material, conforming to ASTM C33 except for gradation. Size to be less than 1/2 inch diameter.
- G. Acrylic Thermoplastic Copolymer: Conforming to the specifications in Appendix F of the PCI MNL-128.
- H. Admixtures:
 - 1. Air entrainment: ASTM C260.
 - 2. Chemical admixtures: ASTM C494.
 - 3. Fly ash or natural pozzolan: ASTM C618.
 - 4. Do not use admixtures that contain more than 0.1% chloride ions.

- I. The casting of the concrete product must also take place in the US. The cement and other raw materials used in the concrete production as not required to be of domestic origin.

2.03 FRAMING MATERIALS

- A. Metal Framing Members: As specified in Section 05 41 00.
 - 1. G90 hot dip galvanizing.
- B. Structural Tubing: As specified in Section 05 50 00.
 - 1. Galvanized and coated in accordance with Section 05 50 00.
- C. Flex Anchors: 3/8 inch or 1/4 inch diameter bent rod - ASTM A36, electroplate galvanized.
- D. Miscellaneous Steel (channels, angles, etc.): As specified in Section 05 50 00.
 - 1. Galvanized and coated in accordance with Section 05 50 00.
- E. Reinforcing (deformed) Bars: ASTM A706 deformed billet steel bars, grade 60. Galvanized rebar to ASTM A767, class II, grade 40.
- F. Headed Stud Embed Anchors: As specified in Section 05 50 00.
- G. Cast in Place Anchors: As specified in Section 03 15 19.
- H. Post Installed Anchors: As specified in Section 05 05 19.
- I. Comply with AIS. The reinforcing bar and wire must be produced in the US and meet the same standards as for any other iron or steel product.

2.04 SUPPORT DEVICES

- A. Connecting and Support Devices: ASTM A36 steel; hot-dip galvanized in accordance with ASTM A153.
- B. Bolts, Nuts, and Washers: As specified in Section 05 05 23.
- C. Comply with AIS. The connecting and support devices of iron or steel must be produced in the US and meet the same standards as for any other iron or steel product.
- D. Coating System:
 - 1. As specified in Section 09 06 90, Coating System C-1.
 - 2. Support Rods to be galvanized and Coated with C-1 epoxy primer, polyurethane finish.

2.05 PRODUCT CHARACTERISTICS

- A. Typical Mixes:
 - 1. Portland cement, glass fibers, sand, and selected admixtures in proper proportions to meet design requirements.
 - 2. Glass content of no less than 4-1/2% and no more than 6%.
 - 3. Average yield strength of not less than 900 psi and average ultimate strength of not less than 2,500 psi.
- B. Typical Range of GFRC Properties at 28 days:
 - 1. Ultimate Flexural Strength (psi): 2500-4000.
 - 2. Yield Flexural Strength (psi): 900-1500.
 - 3. Ultimate Tensile Strength (psi): 1000-1600.
 - 4. Yield Tensile Strength (psi): 700-1000.
 - 5. Compressive Strength (edgewise), (psi): 7000-12000.

6. Shear Strength (interlaminar), (psi): 400-800.
 7. Shear Strength (in-plane), (psi): 1000-1600.
 8. Coeff. of Thermal Expansion (in/°F x 10⁶): 6-9.
 9. Thermal Conductivity (Btu/in/hr/ft²/°F): 3.5-7.0.
 10. Modulus of Elasticity (10⁶ psi): 1.5-2.9.
- C. Facing Mix Thickness:
1. Minimum possible to achieve the desired finish.
- D. GFRC Skin:
1. Per skin design requirements.
 2. In no case shall the panel skin be less than 1/2 inch thick.
 3. Backup mixes shall have same proportion of pigments as face mixes to eliminate the possibility of bleeding through of a different colored backup.
- E. Coloring Agent: The amount of coloring agent shall not exceed 10% of the cement weight.

2.06 FABRICATION

- A. Forms for GFRC Panels:
1. Rigid and constructed of materials that will result in finished products conforming to the profiles, dimensions and tolerances indicated in the Contract Documents and the approved shop drawings.
 2. Release agents:
 - a. Applied and used according to manufacturer's instructions.
 - b. Compatible with architectural finish and joint sealants.
- B. Proportioning and Mixing:
1. Measure mix constituents in a careful manner to achieve the desired mix proportions.
 2. Meter glass fiber and cement slurry to the spray head at rates to achieve the desired mix proportion and glass content. Check in accordance with standard procedures described in PCI MNL-130.
 3. Maintain cleanliness of equipment and working procedure at all times.
- C. Hand Spray Application:
1. Spray operators shall be trained personnel.
 2. A mist coat consisting of the matrix without fiber may, if necessary, be sprayed onto the form. The thickness of this coating shall generally not exceed 1/16 inch to avoid an unreinforced surface.
 3. Spray-up of the main body of material shall proceed before any mist coat or facing mix has set.
 4. Application shall be by spraying such that uniform thickness and distribution of glass fiber and cement matrix is achieved during the application process.
 5. Consolidation shall be by rolling or such other techniques as necessary to achieve complete encapsulation of fibers and compaction.
 6. Control of thickness shall be achieved by using a pin gauge or other approved method. A minimum of one measurement per each 5 square feet of panel surface shall be made.
 7. All hand-forming of intricate details, incorporation of formers or infill material, and over-spraying shall be carried out before the material has achieved its initial set so as to ensure complete bonding.
 8. Spray-up concrete mix in multiple passes; maintain consistent quality during manufacture.
- D. Inserts and Embedments:
1. Properly embedded inserts in built-up homogeneous GFRC bosses or bonding pads to develop their strength. Waste material such as over-spray is not acceptable to encapsulate inserts or for bonding pads.
 2. Rigid embedded items bonded to the GFRC shall not create undesirable restraint to volume changes.
 3. Embed anchors, inserts, plates, angles, and other cast-in items as indicated on shop drawings.
 4. Locate hoisting devices to permit device removal after erection.

- E. Steel Stud Frame System:
1. Prefabricated welded frame produced in accordance with the approved erection drawings.
 2. Touch up all accessible welds after welding.
 3. Place metal framing members in position in mold.
- F. Allowable Tolerances:
1. Manufacture units so that each panel complies with the dimensional tolerances listed below. For dimensional tolerances not listed below, those listed in PCI MNL-130, shall apply:
 - a. Dimensional Tolerances of Finished Units:
 - 1) Overall height and width of units measured at the face adjacent to the form:
 - a) 10 feet or under: $\pm 1/8$ inch.
 - b) 10 feet and over: $\pm 1/8$ inch per 10 feet.
 - 2) Thickness:
 - a) Skin thickness: $\pm 1/4$ inch, -0 inch.
 - b) Architectural facing thickness: $\pm 1/8$ inch, -0 inch.
 - c) Side return thickness: $\pm 1/2$ inch, -0 inch.
 - d) Panel depth from face of skin to back of steel stud or integral rib: $\pm 3/8$ inch, $-1/4$ inch.
 2. Angular variation of plane of side mold: $1/32$ inch per 3 inch depth or $1/16$ inch total, whichever is greater.
 3. Variation from square or designated skew (difference in length of the two diagonal measurements):
 - a. $1/8$ inch per 6 feet or $1/4$ inch total, whichever is greater.
 - b. Length and width of blockouts and openings within one unit: $\pm 1/4$ inch.
 4. Position Tolerances (measured from datum line locations as shown on the approved erection drawings):
 - a. Steel studs and tracks: $\pm 1/4$ inch.
 - b. Flashing reglets, at edge of panel: $\pm 1/4$ inch.
 - c. Reglets for glazing gaskets: $\pm 1/8$ inch.
- G. Finishes:
1. Exposed face of panels to match approved sample.
 2. Exposed face of panels shall be manufactured free from joint marks, "grain" or other obvious defects.
- H. Cover:
1. Provide embedded anchors, inserts, and other sprayed-in items with sufficient anchorage and embedment for design requirements.
- I. Curing
1. Use a curing method immediately after the completion of spraying of the panel to ensure sufficient strength for removing the units from the form.
 2. After initial curing, remove panel from form and place in a controlled curing environment.
 3. Keep panels continuously wet for a minimum of 7 days in accordance with fabricator's standard curing practice.
 4. Maintain the temperature between 60° F and 120° F during this period.
 5. In lieu of moist curing, acrylic thermoplastic copolymer dispersion shall be used as a curing admixture. Only copolymers shown to eliminate the need for moist curing through published independent laboratory test data shall be used.
 6. Cure units to minimize appearance blemishes such as non-uniformity, staining or surface cracking.
- J. Panel identification
1. Mark each GFRC panel to correspond to identification marks on shop drawings for panel location.
 2. Mark each GFRC panel with date cast.
- K. Acceptance:
1. GFRC units which do not meet the color and texture range, or the dimensional tolerances may be rejected at the option of the Project Representative if they cannot be satisfactorily corrected.

PART 3 EXECUTION

3.01 PRE-INSTALLATION INSPECTION

- A. Preinstallation Conference:
 - 1. Prior to installation of work of this Section, conduct a meeting at the project site to discuss quality assurance requirements. Arrange for attendance of the following:
 - a. Contractor Superintendent.
 - b. GFRC Fabricator and supplier representatives.
 - c. GFRC installer.
 - d. Other installers affected by the work of this Section.
 - e. Project Representative.
- B. Verify the following as part of pre-installation inspection:
 - 1. Building lines, center and grades are in sufficient detail to allow installation of the GFRC units.
 - 2. True and level load-bearing surfaces.
 - 3. Accurate placement and alignment of anchor bolts, plates, dowels, or other items embedded in the concrete structure or that are a part of the structural building frame.
 - 4. All parts of the supporting structure are complete and ready to receive the panels and that site conditions are conducive to proper installation.
 - 5. Jobsite dimensions affecting the work:
 - a. Any discrepancies between design dimensions and field dimensions which could adversely affect installation shall be brought to the attention of the Project Representative.
 - b. If discrepancies exist, installation shall not proceed until they are corrected or until installation requirements are modified and reviewed by the Project Representative.

3.02 DELIVERY, STORAGE AND HANDLING

- A. Delivery and handling:
 - 1. Handle and transport units in a position consistent with their shape and design to avoid excessive stresses or damage.
 - 2. Lift or support units only at the points shown on the erection shop drawings.
 - 3. Place non-staining resilient spacers of even thickness between units.
 - 4. Support units during shipment on non-staining shock-absorbing material.
 - 5. Protect units from dirt and damage during handling and transport.
- B. Storage at jobsite:
 - 1. Store units to protect them from contact with soil, staining and from physical damage.
 - 2. Store units, unless otherwise specified, with non-staining, resilient supports located in same positions as when transported.
 - 3. Store units on firm, level, and smooth surface.
 - 4. Place stored units so that identification marks are easily readable.

3.03 INSTALLATION OF PANELS

- A. Setting:
 - 1. GFRC units shall be lifted with suitable lifting devices at points approved by the fabricator.
 - 2. GFRC units shall be set level, plumb, square and true within allowable tolerances.
 - 3. Panel-to-panel joints shall be a minimum of 1/2 inch.
- B. Supports and bracing:
 - 1. Provide temporary supports and bracing as required to maintain position, stability and alignment as units are being connected.
- C. Fastening:

1. Fasten GFRC units in place by bolting or welding or both as shown on the approved erection submittal drawings.
 2. Field welding shall be done by qualified welders using equipment and materials compatible to the base material.
 3. Shall be completely free and independent of adjacent materials.
- D. Tolerances of erected units:
1. Tolerances for location of GFRC units shall be non-cumulative and as listed below. For erection tolerances not listed below, those listed in PCI MNL-130 shall apply.
 - a. Tolerance for face width of joint:
 - 1) Panel dimension 10 feet or less: $\pm 3/16$ inch.
 - 2) Panel dimension 10 feet to 20 feet: $\pm 1/4$ inch.
 - 3) Panel dimension greater than 20 feet: $\pm 5/16$ inch.
- E. Warpage:
1. Maximum permissible warpage of one corner out of the plane of the other three shall be $1/16$ inch per foot distance from the nearest adjacent corner, or $1/4$ inch total after installation.
- F. Bowing:
1. Not over $L/360$ with a maximum of 1 inch, where L is the panel length in the direction of the bow. Differential bowing as erected between adjacent members of the same design shall be $1/4$ inch.

3.04 PATCHING

- A. Patching methods:
1. As approved by manufacturer.
 2. Mix and place patch mixture to match color and texture of surrounding concrete.
 3. If patching is not possible or if unacceptable to Project Representative, GFRC unit shall be replaced.
- B. Structural Adequacy:
1. Patching will not be permitted if structural adequacy of the unit is impaired.

3.05 CLEANING

- A. Cleaning methods:
1. As approved by manufacturer.
 2. After installation:
 - a. Clean any soiled GFRC surfaces with detergent and water, using fiber brush and sponge, and rinse thoroughly with clean water.
 3. Prevent damage:
 - a. Use extreme care to prevent damage to GFRC surfaces and to adjacent materials.

3.06 PROTECTION OF WORK

- A. Be responsible for protection of the panels from damage by the erection crews, field welding or cutting operations by providing non-combustible shields as necessary during these operations.
- B. Be responsible for any chipping, spalling, cracking, or other damage to the units after delivery to the jobsite.
- C. Be responsible for any damage to panels after installation and after damaged or soiled panels have been cleaned, repaired, inspected, and approved.

3.07 INSPECTION AND ACCEPTANCE

A. Acceptance:

1. Inspection and acceptance of erected GFRC panels shall be made by the Project Representative to verify conformance with Contract Documents.

B. Rejection:

1. Panels may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished:
 - a. Nonconformance to specified tolerances.
 - b. Air voids (bug-holes or blowholes) larger than 3/8 inch in diameter.
 - c. Defects visible to a person with normal eyesight when viewed from a distance of 20 feet in broad daylight including:
 - 1) Casting lines.
 - 2) Form joints.
 - 3) Irregularities.
 - 4) Stains on panel surface.
 - 5) Differences between panel and submitted sample.
 - 6) Non-uniformity of textures or color.
 - 7) Areas of backup concrete bleeding through the facing concrete.
 - 8) Foreign material embedded in the face.
 - 9) Repairs or cracks.
 - 10) Reinforcement shadow lines.

END OF SECTION

SECTION 07 52 16.13

TORCH-APPLIED STYRENE-BUTADIENE-STYRENE MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies modified bitumen-roofing system.
- B. Work shall include, but is not limited to, the following:
 - 1. Preparation of existing roof deck, and all flashing substrates.
 - 2. Gypsum deck sheathing board.
 - 3. Install heat-welded Vapor Barrier.
 - 4. Install Insulation and cover-board.
 - 5. SBS-modified bitumen Base Sheet heat-welded.
 - 6. Manufacturer's Representative inspection of installation.SBS-modified bitumen inter-ply heat-welded.
 - 7. SBS-modified bitumen cap sheet heat-welded.
 - 8. SBS-modified bitumen membrane flashings.
 - 9. Liquid-applied, reinforced flashings on all inside and outside corners, penetrations, and flashing lap seams.
- C. Install flashings, coping, metal wall system, sheet metal flashings, sheet metal, and gutters/downspouts.
- D. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/FM 4474	American National Standard for Evaluating the Simulated Wind Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures.
ANSI/SPRI/FM 4435/ES-1	Wind Design Standard for Edge System Used with Low Slope Roofing System.
ASTM C728	Standard Specification for Perlite Thermal Insulation Board
ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM D41	Standard Specification for Asphalt Primer Used in Roofing, Damp Proofing, and Waterproofing.
ASTM D3746	Standard Test Method for Impact Resistance of Bituminous Roofing System
ASTM D4586	Standard Specification for Asphalt Roof Cement, Asbestos-Free
ASTM D5147	Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material
ASTM D6164	Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
ASTM E108	Standard Test Methods for Fire Tests of Roof Coverings.
ASTM E408	Standard Test Methods for Emissivity
ASTM E907	Standard Test Method for Field Testing Uplift Resistance of Adhered Membrane Roofing Systems

Reference	Title
ASTM E1980	Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
FM 4450	Approval Standard - Class I Insulated Steel Roof Decks.
FM 4470	Approval Standard - for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction
ISO 9001	Quality Management Certification
NFPA 820	Standard for Fire Protection in Wastewater Treatment and Collection Facilities
NRCA	National Roofing Contractors Association
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
UL 580	Standard for Tests for Uplift Resistance of Roof Assemblies
UL 790	Standard Test Methods for Fire Tests of Roof Coverings.
UL 1256	Fire Test of Roof Deck Constructions.
UL 1897	Uplift Tests for Roof Covering Systems

1.03 PERFORMANCE REQUIREMENTS

- A. Wind Uplift Resistance: Performance testing shall be in accordance with ANSI/FM 4474, FM 4450, FM 4470, UL 580 or UL 1897. FM Global. Roofing system shall meet Seattle Building Code and FM Global windstorm classification of 75 uplift capacity in psf based on RoofNAV.com. Covers shall be torch-applied to ensure adequate adhesion and wind uplift resistance.
- B. Roof Slope: Finished roof slope for SBS modified bitumen surfaces shall be ¼ inch per foot (2 percent), minimum, for roof drainage.
- C. Impact Resistance: Performance testing for impact resistance shall be in accordance with FM 4450, FM 4470, ASTM D3746 to meet the specified impact resistance requirements. Meets requirements for FM-SH (Severe Hail), ASTM D3746.
- D. Fire Classification:
 1. Performance testing shall be in accordance with UL 790, ASTM E108, FM 4450 or FM 4470 to meet the roof slope requirement. Meets requirements of FM Class A.
 2. Performance testing shall be in accordance with UL 1256, FM 4470 to meet the specified requirements for interior flame spread and fuel contribution. Meets requirements of FM Class 1.
- E. Current International Building Code.
- F. Fire Protection in Wastewater Treatment and Collection Facilities, refer to Section 01 35 29.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 1. Product Data Sheets. Submit manufacturer's product data sheets, installation instructions and/or general requirements for each component.
 2. Material Safety Data Sheets. Submit manufacturer's Material Safety Data Sheets (MDS) for each component.
 3. Shop Drawings showing layout, details of construction including a cross section of the roofing system, and identification of materials.
 4. Tapered insulation layout identifying insulation thickness, slopes, and average R-value.
 5. Contractor Certification. Submit written certification from roofing system manufacturer certifying that the applicator is authorized by the manufacturer to install the specified materials and system.

6. Manufacturer Qualifications. Refer to 1.05B.
7. Contractor Qualifications. Refer to 1.05C.
8. Sample of material manufacturer's 10-year labor and material warranty.
9. Submit roof assembly shop drawings and details, product data sheets, fastening specifications and a RoofNav Contractor Package to Project Representative. The Project Representative will submit the package to FM Global for approval. .

1.05 QUALITY ASSURANCE

A. General:

1. Obtain primary roofing materials from a single manufacturer. Provide secondary materials as recommended by manufacturer and warrantor of primary materials.
2. Roofing materials, installation methods and workmanship shall be in strict accordance with the material manufacturer's recommendations, the latest edition of the Roofing and Waterproofing Manual, SMACNA manual, FM Global, Underwriters Laboratory and ASTM standards. The most stringent standards shall apply where these are in conflict or when the requirements of the Specifications and Drawings exceed those of the manufacturer. Roofing product must be listed on FM Global RoofNav and be in accordance with FM Global Property Loss Prevention Data Sheets 1-28, Wind Design; and 1-29, Roof Deck Securement for Above Deck Roof Component.
3. All components shall be products compatible with roof system and certified by the roofing material manufacturer as a single-source warranty roof system. All materials shall be certified as "asbestos free".

B. Manufacturer Qualifications:

1. All SBS modified bitumen membrane and flashing sheets shall be manufactured by a single manufacturer.
2. Manufacturer shall have 20 years of experience manufacturing SBS-modified bitumen roofing materials.
3. Trained Technical Field Representatives, employed by the manufacturer, independent of sales. Oversight deliverables required from Representative as required in this Section.
4. Provide specified warranty upon satisfactory project completion.
5. Manufacturer shall be an ISO 9001 registered company. A 'Quality Compliance Certificate' (QCC) for reporting/confirming the tested values of the SBS-Modified Bitumen Membrane Materials shall be supplied upon request.

C. Contractor Qualifications:

1. Contractor shall be authorized by the manufacturer to install specified materials prior to the bidding period through satisfactory project completion.
2. Applicators shall have completed projects of similar scope using same materials as specified herein.
3. Contractor shall provide full time, on-site foreman experienced with the specified roof system through satisfactory project completion.
4. Contractor shall maintain a daily record, on-site, documenting material installation and related project conditions.
5. Contractor shall maintain a copy of all submittal documents, on-site, available at all times for reference.

1.06 SAFETY

A. Contractor shall be responsible for complying with all project-related safety and environmental requirements.

- ### **B. Heat-welding shall include heating the specified membrane ply using propane roof torches or electric hot-air welding equipment. When conditions are determined, by King County's Project Representative, to be unsafe to proceed, equivalent SBS-modified bitumen materials and methods shall be utilized to accommodate requirements and conditions.**

- C. Heat-Welding Application: Take all necessary precautions and measures to monitor conditions to ensure all environmental conditions are safe to proceed with the use of torches and hot-air welding equipment. Combustibles, flammable liquids and solvent vapors that represent a hazard shall be eliminated and primers shall be fully dry before proceeding with heat-welding operations. Refer to NRCA CERTA recommendations, local codes and building owner's requirements for hot work operations.
- D. The Contractor shall refer to product Material Safety Data Sheets (MDS) for health, safety, and environment related hazards, and take all necessary measures and precautions to comply with exposure requirements.
- E. Refer to NFPA 820, Fire Protection in Wastewater Treatment and Collection Facilities, and to Section 01 35 29.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Refer to each product data sheet or other published literature for specific requirements.
- B. Deliver materials and store them in their unopened, original packaging, bearing the manufacturer's name, related standards, and any other specification or reference accepted as standard. Materials shall be delivered in sufficient quantity to allow continuity of work. Material received which is wet or is otherwise damaged shall be rejected. Any material which indicates 20% or greater (Wood Scale) moisture content on a Delmhorst moisture meter or is damp to the touch shall be deemed wet. All wet materials shall be removed from the work site and stored separately.
- C. Rolls of flashing and felts shall be stacked on their ends and never in contact with the ground. For felt rolls, slit the top of the plastic shrink wrap only. Cover top and sides of all stored materials with a properly secured tarpaulin. Discard rolls which have been flattened, creased, or otherwise damaged. Store roll goods on level pallets. Do not stack pallets.
- D. Proper storage on or off the site shall be the responsibility of the roofing Contractor. The Contractor shall cover all materials when project is not in progress and maintain the ability at all times to cover the materials when required.
- E. Any unused roofing felt remaining on the roof at the end of the workday shall be returned to storage. Materials shall be handled in a manner to avoid bending, tearing, or other damage during transportation and installation. Material handling equipment shall be selected and operated so as not to damage existing construction or applied roofing.

1.08 ROOFING VERIFICATION AND WARRANTY

- A. Contractor shall guarantee the workmanship and shall provide the County with the Contractor's warranty covering workmanship for a period of 2 years from completion date. The Contractor shall provide written warranty within 10-days of installation after every sequence of work. The same Roofing Installation Contractor shall be responsible for the full scope of roofing work, initial installation and later patching.
- B. At roofing of each roof level and afterward, at any patching of roofing no matter how small, the manufacturer's field technical representative shall inspect the installation and provide written verification that the work meets the manufacturer's requirements, all equipment flashing is correctly installed, and all patching is correctly installed to prevent water damage to the continuous operation of critical systems below.
- C. 10-Year single-source labor and material No Dollar Limit (NDL) Warranty provided by the roofing material manufacturer shall cover all labor and roof-related components installed under this Specification and shall not be limited to only those materials supplied by the manufacturer issuing the

warranty. This includes insulation, fasteners, membranes, base flashings, and sheet metal. If the manufacturer is a subsidiary company, the warranty shall be issued by the parent company. Warranty shall cover wind speeds up to and including 70 MPH. Wind speeds shall be based on National Weather Service Data from Seattle-Tacoma International Airport. The warranty shall not include routine roof inspection or maintenance services. The material manufacturer shall issue the warranty effective upon the date of Final Acceptance.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturer:
 - 1. Siplast.
 - 2. Soprema.
 - 3. Approved Equal.

2.02 SBS-MODIFIED BITUMEN MEMBRANES

- A. Vapor Barrier:
 - 1. Heat-Welded:
 - a. SBS-modified bitumen membrane with sanded side on top surfaces.
 - 1) Thickness: 138 mils.
 - 2) Elongation: 100%.
 - 3) Tear Strength @ 73.4 degrees F: 40 lbf.
 - 4) Meets or exceeds ASTM D6164, Type I, Grade S.
- B. Base Ply:
 - 1. Base Ply, Heat-Welded:
 - a. SBS-modified bitumen membrane with plastic burn-off film on top and bottom surfaces:
 - 1) Thickness: 138 mils.
 - 2) Elongation: 100%.
 - 3) Tear Strength @ 73.4 degrees F: 40 lbf.
 - 4) Meets or exceeds ASTM D6164, Type I, Grade S.
- C. Inter-ply/Inter-ply Flashing:
 - 1. Inter-ply, Heat-Welded:
 - a. SBS-modified bitumen membrane with plastic burn-off film on top and bottom surfaces:
 - 1) Thickness: 138 mils.
 - 2) Elongation: 100%.
 - 3) Tear Strength @ 73.4 degrees F: 40 lbf.
 - 4) Meets or exceeds ASTM D6164, Type I, Grade S.
- D. Cap Sheet/Flashing Cap Sheet:
 - 1. Cap Sheet/Flashing Cap Sheet, Heat-Welded:
 - a. SBS-modified bitumen membrane Cap Sheet with a burn-off film bottom surface and mineral granule top surface. UL Class A for specified roof slope requirements:
 - 1) Thickness: 157 mils (4.0 mm).
 - 2) Elongation: 30/35, ASTM D5147.
 - 3) Tear Strength @ 73.4 degrees F: 165/120 ASTM D5147.
 - 4) Meets or exceeds ASTM D6164, Type II, Grade G.
 - 5) Granule Surfacing: White mineral granules.
 - 2. The cap sheet shall be ENERGY-STAR compliant with reflectivity rated by the Cool Roof Rating Council (CRRC):
 - a. Energy Performance: Roofing system shall meet the following minimum requirements:
 - 1) Initial Solar Reflectance Index (SRI) not less than 86 when calculated according to ASTM E1980 based on testing identical products by a qualified testing agency.

- 2) High emissivity roofing of minimum 0.9 when tested in accordance with ASTM 408.
- 3) Listed on US Environmental Protection Agency's (EPA's) ENERGY STAR "Roof Products Qualified Products List" for low-slope products.

E. Cover-Board:

1. Asphaltic Roof Board:

- a. Mineral fortified, asphaltic roof substrate board with glass fiber facers. For use as roof cover-board and for vertical flashing substrate:
 - 1) Thickness: ¼ inch.
 - 2) Dimensions: 4 x 4 ft, 4 x 5 ft and 4 x 8 ft acceptable for mechanical attachment, insulation adhesive or asphalt application.

2.03 ACCESSORIES

A. Primers:

1. Asphalt cut-back primer. Primer for the preparation of roof membrane and flashing substrates for heat-welded applications:
 - a. Meets or exceeds ASTM D41.
 - b. VOC content: 350 g/L or less.

B. General Purpose Roofing Cement and Mastic:

1. SBS Mastic. Fiber-reinforced, roofing cement, packaged in 10.4 oz caulk tubes. General purpose roofing cement for low-slope roofing used for sealing membrane T-joints and membrane edges along terminations, transitions and at roof penetrations:
 - a. VOC Content: 190 g/L or less.
 - b. Meets or exceeds ASTM D4586, Type I, Class II.

C. General Purpose Sealant:

1. General purpose, paintable, gun-grade, elastomeric, polyether moisture curing for sealing horizontal and vertical construction joints:
 - a. VOC Content: 20 g/L or less.
 - b. Meets or exceeds ASTM C920, Type S, Grade NS, Class 50.
 - c. Standard color.

D. Liquid PMMA Flashing System:

1. Two-component, rapid curing Polymethyl Methacrylate resin to form roof system flashings:
 - a. VOC Content: 54.34 g/L.
 - b. Fleece: Non-woven, needle-punched polyester.
 - c. Color: Liquid Flashing to match adjacent SBS-modified bitumen cap sheet.

E. Walk Pads: Use Manufacturers Recommended Walk Pads.

F. Wood Blocking and Curbs:

1. Lumber: American Wood Protection Association (AWPA) Douglas Fir; free from warping and visible decay; pressure-treated according to AWP Standard U1 for lumber and timber with copper azole, CA-B/CA-C or Standard P25-10 (SBX), to a retention of 0.1 lb/ft³ for above ground use.
2. Lumber for wood blocking and curbs shall be 2 inch x 6 inch minimum.
3. Cedar siding: bevel 1 inch x 6 inch.
4. Cant strips shall be ASTM C728, perlite, 4 inch x 4 inch cut on bias.
5. Contractor shall furnish all sheet metal flashings, counter flashings, roof edge system, and all other related sheet metal flashings and associated fasteners necessary to flash and counter flash the specified roofing system.
6. Sheet metal flashing materials and fasteners shall be compatible with adjacent materials, to accommodate all project related exposures.

G. Sheet Metal, Roof Edge System:

1. Roof edge system shall include all components and associated fasteners included by the manufacturer to comply with specified performance requirements.
2. Contractor shall provide all other related fasteners and sealants not provided as part of the roof edge system, and required in the manufacturer's product data sheets.
3. Tested per ANSI/SPRI/FM 4435 ES-1 to meet or exceed design pressures at roof edge.

H. Mechanical Fasteners:

1. Meet the requirements as specified in Section 07 22 00 appropriate for the existing substrate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examination includes visual observations, qualitative analysis, and quantitative testing measures as necessary to ensure conditions remain satisfactory throughout the project.
- B. The Contractor shall examine all roofing substrates including, but not limited to: insulation materials, roof decks, walls, curbs, rooftop equipment, fixtures, and wood blocking.
- C. The applicator shall not begin installation until conditions have been properly examined and determined to be clean, dry and, otherwise satisfactory to receive specified roofing materials.
- D. During the application of specified materials, the applicator shall continue to examine all project conditions to ensure conditions remain satisfactory to complete the specified roofing system.
- E. Manufacturer's Trained Field Representative shall provide written verification that they have inspected all installation detailing at each sequence when the roof is initially installed or later patching occurs. The Representative is to inspect the work, all equipment flashing, and all patching of the work.

3.02 PREPARATION

- A. Before commencing work each day, prepare all roofing substrates to ensure conditions are satisfactory to proceed with the installation of specified roofing materials. Preparation of substrates includes, but is not limited to, substrate repairs, securement of substrates, eliminating all incompatible materials, and cleaning.
- B. Where conditions are found to be unsatisfactory, work shall not begin until conditions are made satisfactory to begin work. Commencing of work shall indicate Contractor's acceptance of conditions.

3.03 CARPENTRY

- A. Wood curb locations:
 1. Mechanically attach wood blocking to deck at all wood curb locations as shown in the Drawings. Minimum 2 fasteners per section.
 2. Offset blocking layers 12 inches, weave corners. Blocking thickness shall be equal to final insulation thickness including tapered edge. Blocking width: 4 inches, nominal.
 3. Install cants to blocking if required in the Drawings. Nail two (2) rows staggered to horizontal and vertical substrates. Spacing in any one (1) row shall not exceed 24 inches.
- B. Wood blocking fastening pattern: Secure continuous wood blocking to substrate with mechanical fasteners attached in two (2) staggered rows at two (2) feet on center.
- C. Wood Blocking Repairs and Modifications:
 1. Reattach loose blocking; replace warped or damaged blocking. Fasten new continuous wood blocking to the substrate with a minimum of two (2) fasteners per section. Countersink fasteners flush with blocking surface.

2. Blocking thickness: 2 inches nominal.
3. Blocking width: Flush with edges.

3.04 HEAT WELDING

- A. The Contractor is responsible for project safety. Where conditions are deemed unsafe to use open flames, manufacturer's alternate membrane application methods shall be used to install SBS modified bitumen membrane and flashings. Acceptable alternate installation method is hot SBS asphalt. Hot-air welding equipment may be used in lieu of roof torches to seal membrane side and end laps where heat welding the laps is necessary. Refer to NRCA CERTA, local codes and building owner's requirements for hot work operations.
- B. Single or multi-nozzle, hand-held propane roof torches shall be used to install heat-welded membrane and flashing plies. Multi-nozzle carts (dragon wagons) may also be utilized to install membrane plies. Seven (7) nozzle carts are recommended for more uniform heat application in lieu of five (5) nozzle carts.

3.05 FLASHING CEMENT APPLICATION

- A. The ambient temperature shall be above 50°F (10°C), and the flashing cement temperature shall be a minimum of 70°F (21°C) at the point of membrane application.
- B. To ensure the flashing cement is applied at 70°F (21°C), during cold weather, pails shall be stored in heated areas. Pails exposed to cold temperature on the roof shall be provided with heaters when necessary to ensure the minimum application temperature is maintained.
- C. Priming substrates is optional when solvent-based membrane adhesives are used. Primer may be applied to reduce adhesive consumption rates for some absorptive substrates.
- D. Application rates vary based on substrate porosity and roughness.

3.06 SBS MASTIC AND GENERAL PURPOSE ROOFING CEMENT APPLICATION

- A. Apply general purpose SBS mastic and roofing cement to seal drain leads, metal flanges, seal along membrane edge at terminations, and where specified and required in detail drawings.
- B. Do not use general purpose SBS mastics and roofing cement where flashing cement applications are required. Do not use SBS mastics and roofing cement beneath SBS-modified bitumen membrane and flashing plies.
- C. Apply general purpose SBS mastic and elastic roofing cement using caulk gun, or notched trowel at 2.0 – 2.5 gallons per 100 square feet on each surface. Application rates vary based on substrate porosity and roughness. Tool-in as necessary to seal laps.
- D. Embed matching granules into wet cement where exposed.

3.07 HEAT-WELDED, FULLY ADHERED MEMBRANE APPLICATION

- A. Follow material product data sheets and published general requirements for installation instructions.
- B. Ensure environmental conditions are safe and satisfactory, and shall remain safe and satisfactory, during the application of the heat-welded membrane and flashings.
- C. Install "torch-applied" roof covers in accordance with FM Global Property Data Sheet 1-33, Safeguarding Torch-Applied Roof Installation for accident fire prevention.

- D. Ensure all primers are fully dry before beginning heat-welding operations.
- E. Unroll membrane onto the roof surface and allow time to relax prior to heat welding.
- F. All vapor barrier seams, at minimum, shall be heat welded regardless of material.
- G. Starting at the low point of the roof, lay out the membrane to ensure the plies are installed perpendicular to the roof slope, shingled to prevent back-water laps.
- H. Ensure all roofing and flashing substrates are prepared and acceptable to receive the heat-welded membrane.
- I. Cut membrane to working lengths and widths to conform to rooftop conditions, and lay out to always work to a selvage edge.
- J. Ensure specified side-laps and end-laps are maintained. End-laps shall be staggered 3 feet apart.
- K. Direct roof torch on the roll as necessary to prevent overheating and damaging the membrane and substrates. Ensure the torch flame is passed back and forth across the leading edge of the roll, with most of the flame impinging on the leading edge of the roll, and only slight heating of the substrate below. Ensure the roll does not overheat, such as to cause excessive smoke.
- L. As the membrane is unrolled, apply heat to the underside of the membrane until the plastic burn-off film melts away. Continuously move the torch side-to-side across the underside of the roll to melt the bitumen on the underside of the sheet, while continuously unrolling membrane. Don't walk behind the heated roll.
- M. Allow the bitumen to pool slightly at the leading edge of the roll across its entire width as the sheet is unrolled.
- N. While unrolling and heating the sheet, ensure a constant flow hot bitumen approximately $\frac{1}{4}$ to $\frac{1}{2}$ in flows ahead of the roll as it is unrolled, and there is $\frac{1}{8}$ to $\frac{1}{4}$ in bleed out at all laps.
- O. Adjust the application of heat to the underside of the membrane and to substrate as required for varying substrates and environmental conditions.
- P. At the 6 inch end-laps, melt the plastic burn-off film from the top surface or embed granules and remove surfacing, where present, using a torch or hot-air welder.
- Q. At end-laps, cut a 45 degree dog-ear away from the selvage edge, or otherwise ensure the membrane is fully heat-welded watertight at all T-joints.
- R. Each day, physically inspect all side and end-laps, and ensure the membrane is sealed watertight. Where necessary, use a torch or hot-air welder and a clean trowel to ensure all laps are fully sealed.
- S. Inspect the installation each day to ensure the plies are fully adhered. Repair all voids, wrinkles, open laps and all other deficiencies.
- T. Offset cap sheet side and end-laps away from the base ply laps so that cap sheet laps are not located within 18 in of base ply laps.

3.08 FLASHING APPLICATION, HEAT WELDED

- A. Refer to SBS manufacturer's membrane application instructions, flashing detail drawings, and follow product data sheets and other published requirements for installation instructions. Refer to manufacturer's membrane flashing detail drawings.
- B. The Contractor is responsible for project safety. Refer to NRCA CERTA recommendations and building owner requirements for hot work operations.
- C. Where required to seal substrates for fire safety, install specified adhered, self-adhered or fastened backer ply to the substrate. Ensure backer-ply covers and seals all substrates requiring protection from exposure to torch operations.
- D. Ensure all flashing substrates that require primer are primed, and the primer is fully dry.
- E. Unroll the flashing base ply and flashing cap sheet onto the roof surface to their complete length.
- F. Once relaxed, cut the membrane to the required working lengths (4 – 6 feet maximum widths) to accommodate the flashing height, cants and the required over-lap onto the horizontal roof surface.
- G. Cut the flashing membrane from the end of the roll in order to always install flashings to the side-lap line or selvage edge line.
- H. Lay out the flashing base ply and flashing Cap Sheet to offset all side-laps a minimum of 12 inches so that side-laps are never aligned on top of the ply beneath. Shingle the flashing ply laps to prevent back-water laps.
- I. Install non-combustible cant strips at transitions where required.
- J. Ensure correct membrane and flashing sequencing to achieve redundant, multi-ply, watertight flashings.
- K. Roof Membrane:
 - 1. Before installing flashings, install the roof membrane base ply in the horizontal field of the roof, and extend the base ply, 2 inches minimum, above the top of the cant, where present, at roof terminations, transitions and penetrations.
 - 2. Intermediate ply shall be run to the top of the cant.
- L. Base Flashing Ply Sheets:
 - 1. Install the base flashing intermediate ply sheet starting at the top leading edge of the parapet (per drawings), down over the cant and onto the horizontal surface of the roof a minimum of 5 inches beyond the base of the cant onto the roof. Cut the base ply at corners to form 3 inch side-laps. Install gussets to seal corner transitions.
 - 2. Install one or more flashing base ply(s) at all roof terminations, transitions and penetrations.
- M. Roof Membrane Cap Sheet:
 - 1. Install the roof membrane Cap Sheet in the field of the roof over the flashing intermediate ply up to the top of the cant strip.
- N. Base Flashing Cap Sheet:
 - 1. Install the base flashing Cap Sheet starting at the low point of the roof. The base flashing Cap Sheet shall extend 6 inches minimum onto the field and terminate 8 inches minimum above the finished membrane.

- O. During the membrane and flashing installation, ensure all plies are completely adhered into place, with no bridging, voids or openings. Ensure bitumen or flashing cement bleed-out is present at all flashing side and end-laps.
- P. Use a damp sponge float or damp rag to press-in the heat-welded flashing plies during installation.
- Q. Where sufficient bitumen bleed-out is not present, and for all self-adhered plies, apply specified gun-grade sealant or mastic to seal the membrane termination along all roof terminations, transitions and penetrations. These include gravel stop edge metal, pipe penetrations, along the top edge of curb and wall flashing, and all other flashing terminations where necessary to seal flashings watertight.
- R. Fasten the top leading edge of the flashing 8 in on-centers with appropriate 1 in metal cap nails or other specified fasteners and plates. Seal fastener penetrations watertight using specified sealant or mastic.
- S. Manufacturer's liquid-applied, reinforced flashing systems shall be installed where conditions are not favorable to install SBS modified bitumen flashings and pre drawings. Such conditions include irregular shapes penetrating roof surfaces (I-beams), confined areas and low flashing heights. Manufacturer's liquid-applied, reinforced flashing systems are recommended in lieu of pitch pans and lead pipe flashings.

3.09 LIQUID-APPLIED PMMA FLASHING SYSTEM APPLICATION:

- A. Refer to manufacturer's details drawings, product data sheets and published general requirements for application rates and specific installation instructions.
- B. To be applied at all inside and outside corners and all flashing lap seams.
- C. Pre-cut reinforcing fleece to conform to roof terminations, transitions and penetrations being flashed. Ensure a minimum 2 in overlap of fleece at side and end-laps. Ensure the completed liquid-applied flashing membrane is fully reinforced.
- D. Apply the base coat of liquid-applied flashing resin onto the substrate using a brush or roller, working the material into the surface for complete coverage and full adhesion.
- E. Immediately apply the reinforcing into the wet base coat of resin. Using a brush or roller, work the fleece into the wet resin while applying the second coat of flashing resin to completely encapsulate the fleece with no fleece visible, and extend the liquid resin 1 inch beyond the fleece.

3.10 SHEET METAL FLASHING APPLICATION

- A. Refer to sheet metal flashing detail drawings, and follow product data sheets and published general requirements for installation instructions.
- B. Follow the most recent edition of the SMACNA Architectural Sheet Metal Manual for fabrication and installation requirements.

3.11 FIELD QUALITY CONTROL

- A. Manufacturer's Responsibilities: In addition to the field inspection requirements during construction, the manufacturer's technical representative shall be available within 24 hours' notice during the entire course of the project for site inspection and consultation.
- B. As directed by the Project Representative, conduct Post-Construction Moisture Survey and Final Inspection no sooner than 30 days after the manufacturer submits their warranty but prior to Final Acceptance of the roof.

- C. After work on the roof is started, no traffic shall be permitted on the roof other than that necessary for the roofing application and inspection. Materials shall not be piled on the roof to the extent that design live loads are exceeded. Roofing materials shall not be transported over unfinished or finished roofing or existing roofs unless adequate protection is provided. Any damage to existing roofs shall be repaired as directed by Project Representative and at no expense to the County.
- D. Monitor substrate temperature and material temperature, as well as all environmental conditions such as ambient temperature, moisture, sun, cloud cover, wind, humidity, and shade. The Contractor shall ensure conditions are satisfactory to begin work and ensure conditions remain satisfactory during the installation of specified materials. Materials and methods shall be adjusted as necessary to accommodate varying project conditions with the approval of King County's Project Representative. Materials shall not be installed when conditions are unacceptable to achieve the specified results.
- E. Precipitation and dew point: Monitor weather to ensure the project environment is dry before, and shall remain dry, during the application of roofing materials. Ensure all roofing materials and substrates remain above the dew point temperature as required to prevent condensation and maintain dry conditions.

3.12 POST-CONSTRUCTION MOISTURE SURVEY AND FINAL INSPECTION

- A. Moisture Survey Procedure as directed by the Project Representative
 - 1. Contractor Responsibilities: Provide access to roof, make core cuts, and make all repairs at its own expense. When the Post-Construction Moisture Survey and Final Inspection disclose material deficiency or wetness, correct deficiencies in accordance with manufacturer's instructions and specifications.
 - 2. King County's Responsibilities: Provide moisture survey map, determine random moisture test locations using www.random.org, provide Delmhorst moisture meter, and take moisture readings.
 - 3. If the sum of all roof areas on a selected building is:
 - a. <2,000 SF: Map 4 roughly equal-size areas onto the roof plan and randomly select 2 areas out of the 4 to test for moisture, provided that at least one test is conducted on each separate roof area.
 - b. >2,000 SF but <10,000 SF: Map 10 roughly equal-size areas onto the roof plan and randomly select 5 areas out of the 10 to test for moisture, provided that at least one test is conducted on each separate roof area.
 - c. >10,000 SF: Map 20 roughly equal-size areas onto the roof plan and randomly select 10 areas out of the 20 to test for moisture, provided that at least one test is conducted on each separate roof area.
 - 4. The roughly equal-size areas shall be mapped onto the roof plan accordingly:
 - a. At least one test area shall be mapped onto each roof area
 - b. Round or curved roofs shall be mapped with "pie slice" or similarly-shaped areas to achieve roughly equal-size.
 - 5. The inspector may choose the specific moisture test spot within each randomly selected test area (the spot most likely to be wet).
 - 6. 20% or greater moisture reading on a Delmhorst meter in any roof layer (base sheet, plies, insulation) or visible moisture on the deck is a positive test result and the entire test area shall be deemed wet.
 - 7. <20% moisture reading on a Delmhorst meter in all roof layers (base sheet, plies, insulation) and no visible moisture on the deck is a negative test result and the entire test area shall be deemed dry.
 - 8. For each positive moisture test the inspector shall select 1 more untested roof area to test until another dry reading is taken or until all roof areas have been tested.
 - 9. Repair core cuts and restore roofing system per contract and manufacturer's requirements.
 - 10. All test areas deemed wet shall be repaired or replaced at the contractor's expense. The contractor, at its own expense may perform their own moisture tests to define smaller areas to propose repair or replacement of these smaller roof areas. The Project Representative may accept or reject these proposals at their discretion.

11. If any portion of the roof is deemed wet the Project Representative may require a new Post-Construction Moisture Survey at their discretion.

B. Wind Uplift Test

1. If any portion of the roof is deemed wet the Project Representative may require an ASTM E907 wind uplift resistance test for any roof area at their discretion.
2. Contractor Responsibilities: Provide access to roof, make core cuts or roof membrane preparations as required, and make all repairs at the contractors' expense.
3. King County's Responsibilities: Hire wind uplift testing firm at its own expense.
4. All test areas that fail the Wind Uplift Test shall be repaired or replaced at the contractor's expense.

C. Warranty Inspection

1. Upon completion, inspections shall be made by all parties, including the material manufacturer's representative, to ascertain that the roofing system has been installed according to the roofing system warrantor's published specifications and details.

3.13 REPAIR OF DEFICIENCIES AND CLEAN-UP

A. Repair of deficiencies: Installations of details noted as deficient during final inspection shall be repaired and corrected by applicator, and made ready for re-inspection, within five (5) calendar days.

B. Clean-up:

1. Properly dispose of waste and debris resulting from these operations daily as required to prevent damages and disruptions to operations.
2. Immediately upon job completion, roof membrane and flashing surfaces shall be cleaned of debris. Clean drains, gutters, and downspouts of debris.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies flashing and sheet metal not specifically described in other Sections but required to prevent penetration of water through the exterior shell of the building.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM B29	Standard Specification for Refined Lead

- B. Perform the work in accordance with SMACNA: Architectural Sheet Metal Manual, as a minimum standard, and to normal good practice in the area except where in conflict with the Contract Documents, which shall govern.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data.

1.04 STORAGE AND HANDLING

- A. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation.

PART 2 PRODUCTS

2.01 SHEET METAL

- A. Coping, Counterflashing Reglets:
1. Shop Primed, Galvanized Steel: ASTM A123, Grade A, G90, minimum 24-gage core steel.
 2. Finish Coating: PVDF Resin.
 3. Acceptable Manufacturers:
 - a. PPG – DURANAR.
 - b. Valspar – Fluropon.
 - c. Arkema Inc. – KYNAR 500.
 - d. Solvay Solexis – HYLAR 5000.
 - e. Approved Equal.
- B. Parapet Continuous Cleats: Galvanized Steel, minimum 22-gage.
- C. Products are to be certified to comply with AIS, American Iron and Steel Act. The iron and steel is to meet the standards required for iron and steel products and be made in the US.

2.02 RUBBER FLASHING STRIPS

- A. Penetration Flashing Strips
 - 1. Dekstrip by DEKS Industries or approved equal
 - 2. Edges of aluminum sheet sandwiched between rubber sheets with ability to expand 25%.
 - 3. No lead content.
- B. Sealant
 - 1. As recommended by flashing manufacturer.
 - 2. Set flashing strip in mastic and seal edges per manufacturer's installation instructions for flashing.

2.03 ACCESSORIES

- A. General Fasteners: Same material and finish as flashing metal, with soft neoprene washers, or Type 304 stainless steel, with soft neoprene washers.
- B. Cleat Fasteners: Use ring shank nails for wood or 5/16-inch diameter Concrete Screws long enough to penetrate underlay concrete 1¼ inches for concrete.
- C. Underlayment: Per roofing system manufacturers recommendations.
- D. Sealant: Specified in Section 07 92 00.
- E. Plastic Cement: Asbestos-free asphaltic base cement.
- F. Termination bar: Extruded aluminum: 1/8-inch thick x 1 inch

2.04 FABRICATION

- A. Form components true to shape, accurate in size, square, and free from distortion or defects. Form pieces in longest practical lengths.
- B. Fabricate counter flashing cleats, minimum 2 inches wide, interlockable with flashing.
- C. Fabricate continuous coping cleats with a 'Kick-Up', creating a minimum of ½ inch per foot of slope.
- D. Hem exposed edges on underside ½-inch. Miter and seam corners. Fabricate vertical faces with bottom edge formed outward ¼-inch and hemmed to form drip edge.
- E. Form material with standing seam.
- F. Fabricate corners in one piece, 8-inch legs minimum. Seam for rigidity and seal with sealant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces to be covered are smooth, clean, and free from holes.
- B. Drive flush all projecting nails.
- C. Do not proceed with installation until discrepancies have been resolved.

3.02 INSTALLATION

- A. Separate flashings from dissimilar materials by a heavy bitumastic coating on the flashing.
- B. Expansion:
 - 1. Form, fabricate, and install sheet metal to adequately provide for expansion and contraction in the finished work.
 - 2. Unless otherwise indicated, provide suitable watertight expansion joints for all runs of more than 40 feet.
- C. Reglets:
 - 1. Reglets shall be Cast in Concrete or Surface Mounted as indicated on the Drawings.
 - 2. Install level and true in forms a minimum of 7 inches above cant strip.
 - 3. Tape cut ends before installation.
 - 4. After roofing is applied install flashing by snapping into reglet without screws.
 - 5. Lap all joints and miter corners.
- D. Fastening:
 - 1. Secure horizontal flange and vertical face of the continuous cleat, maximum 6 inches staggered on center and within 2 inches of each cleat end.

END OF SECTION

SECTION 07 71 23
GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies:
 - 1. Pre-finished aluminum gutters and downspouts.
 - 2. Precast concrete splash pads.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AAMA 2604	Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2021, with Errata (2022).
ASTM A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
ASTM B209/B209M	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.
SMACNA (ASMM)	Architectural Sheet Metal Manual 2012

1.03 SYSTEM DESCRIPTION

- A. Comply with SMACNA (ASMM) for sizing components for rainfall intensity determined by a storm occurrence of 1 in 5 years.
- B. Comply with applicable code for size and method of rain water discharge.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.
 - 2. Product Data: Provide data on prefabricated components.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope to drain.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Gutters and Downspouts:
 - 1. ATAS International, Inc; Water Control System.
 - 2. SAF Perimeter Systems, a division of Southern Aluminum Finishing Company, Inc

3. Approved Equal.

2.02 MATERIALS

- A. Galvanized Steel Sheet: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 0.02 inch (0.6 mm) thick base metal.
- B. Pre-Finished Galvanized Steel Sheet: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 0.02 inch (0.6 mm) thick base metal:
 1. Finish: Shop pre-coated with modified silicone coating.
 2. Color: As indicated.
- C. Pre-Finished Aluminum Sheet: ASTM B209/B209M, alloy, temper; 0.032 inch (0.8 mm) thick:
 1. Finish: Plain, shop pre-coated with modified silicone coating.
 2. Color: As indicated.
- D. PVC DWV: ASTM D2665, ASTM D2949, ASTM F 891.
 1. Finish: Coating
 2. Color: To match wall.
 3. Piping Support when running approximately horizontal on roof surface.
 - a. Transition downspout to horizontal piping with standard closed fittings.
 - b. Support pipes on Dura-Blok B-Line Series or approved equal sleeper product to provide an even drop of elevation from the downspout to the scupper.
- E. Products are to be certified to comply with AIS, American Iron and Steel Act. The iron and steel is to meet the standards required for iron and steel products and be made in the US.

2.03 COMPONENTS

- A. Gutters: CDA rectangular style profile.
- B. Downspouts: CDA rectangular profile.
- C. Anchors and Supports: Profiled to suit gutters and downspouts.
 1. Anchoring Devices: In accordance with CDA requirements.
 2. Gutter Supports: Brackets.
 3. Downspout Supports: Brackets.
- D. Fasteners: Galvanized steel, with soft neoprene washers.

2.04 FABRICATION

- A. Form gutters and downspouts of profiles and size indicated.
- B. Fabricate with required connection pieces.
- C. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.
- D. Hem exposed edges of metal.
- E. Fabricate gutter and downspout accessories; seal watertight.

2.05 FINISHES

- A. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604, multiple coat, thermally cured fluoropolymer finish system; color as indicated.
- B. Primer Coat: Finish concealed side of metal sheets with primer compatible with finish system, as recommended by finish system manufacturer.

2.06 ACCESSORIES

- A. Splash Pads: Precast concrete type, profiles size(s) as indicated; minimum 3,000 psi (21 MPa) compressive strength at 28 days, with minimum 5 percent air entrainment.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.
- B. Verify that surfaces are ready to receive work.

3.02 PREPARATION

- A. Paint concealed sheet metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.381 mm).

3.03 INSTALLATION

- A. Install gutters, downspouts, and accessories in accordance with manufacturer's instructions.
- B. Sheet Metal: Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts and accessories.
- C. Slope gutters 1/4 inch per foot minimum.
- D. Solder metal joints for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.
- E. Set splash pans under downspouts.

3.04 FIELD QUALITY CONTROL

- A. Inspect.
- B. Field Testing: Section 01 75 20.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies architectural firestopping. Filling around pipes and conduit is part of mechanical and electrical work using materials specified herein.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail:

Reference	Title
ASTM A653	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C665	Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM E84	Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	Test Methods for Fire Tests of Building Construction and Materials
NFPA 220	Types of Building Construction
Underwriters Laboratories, Inc. (UL)	Building Materials Directory

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product technical data, including:
1. Acknowledgement that products meet requirements of standards referenced.
 2. Manufacturer's installation instructions.
 3. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling and bond breaker.
 4. Detailed drawings of special conditions.
 5. Data sheet on each type of firestopping assembly being used:
 - a. Provide certification that assembly is UL listed.
 6. Operation and Maintenance Manuals.
 7. Certification from sealant manufacturer stating product being used is recommended for and is best suited for joint in which it is being applied.
 8. Provide written statement that all fire-rated penetrations have been sealed using products specified in accordance with UL requirements for required rating.
- C. Samples:
1. Cured samples of available colors for Project Representative's color selection.
 2. Color chart not acceptable.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver material in manufacturer's original, unopened containers with labels intact. Labels shall indicate contents and expiration date on material.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers.
 - 1. Safing insulation:
 - a. Thermafiber LLC.
 - b. Owens-Corning.
 - c. Fibrex.
 - d. Approved Equal.
 - 2. Expanding silicone elastomer:
 - a. Manufacturer UL listed for system used.
 - 3. Fire Stop Wrap:
 - a. 3M brand fire barrier strip FS195.
 - b. Hilti SC-2420, Intumescent Wrap.
 - c. Dow Corning Fire Stop Wrap Strip 2002.
 - d. Approved Equal.
 - 4. Firestop sealant:
 - a. Dow Corning.
 - b. 3M Company.
 - c. U.S. Gypsum Co.
 - d. Approved Equal.
 - 5. Moldable putty:
 - a. 3M Company.
 - b. Approved Equal.

2.02 MATERIALS

- A. Safing insulation:
 - 1. Inorganic mineral fibers and binders formed into semi-rigid blankets.
 - a. Density: 4.0 lb/CF.
 - b. ASTM C665, Type 1.
 - c. Rated noncombustible as defined by NFPA 220.
 - 2. ASTM E84 flame spread: 15 maximum, smoke developed 0.
 - 3. ASTM E119 tested for assembly and rating indicated.
 - 4. Thickness as required to maintain fire rating of assembly.
 - 5. Retainer: Minimum 20 GA, galvanized steel closure, ASTM A653, G60.
- B. Expanding Silicone Elastomer:
 - 1. Two part, liquid silicone elastomer.
 - 2. UL listed as "Fill, Void or Cavity Material (ZCPY)" for use in "Wall or Floor Opening Protective, Multiple Cable Systems (ZCOR)."
 - 3. Forming materials as described in applicable UL system.
 - 4. 3M "Fire Barrier 2001 Silicone RTV Foam."
- C. Fire Stop Wrap:
 - 1. Tested in accordance ASTM E814.
 - 2. Exposure to heat shall expand product 8 to 10 times its original volume into any cavities in wall opening (intumescence).
 - 3. UL listed.
- D. Firestop Sealant:
 - 1. One-part silicone.
 - 2. Capable of providing up to a 4 HR fire rating.
 - 3. Provide self-leveling grade for all horizontal slab conditions.
 - 4. 3M "Fire Barrier 2000, 2000+ and 2003" sealants.

- 5. UL listed.
- E. Moldable Putty:
 - 1. 100 percent solids material, single component.
 - 2. Intumescent and endothermic.
 - 3. UL listed.
- F. Plastic Pipe Fire Barrier:
 - 1. UL listed for floor or wall penetrations.
 - 2. Capable of providing up to 2 HR fire rating on a 4 IN pipe (outside diameter).
 - 3. Factory made, single component, ready to use device.
 - 4. 3M "Fire Barrier Plastic Pipe Device."

PART 3 EXECUTION

3.01 INSTALLATION

- A. Firestop all openings and penetrations through fire-rated floors, walls, ceilings, etc., in accordance with UL "Wall or Floor Opening Protective, Multiple Cable Systems (ZCOR)" latest edition, or as indicated in the Drawings.
 - 1. Install products in accordance with manufacturer's instructions.
- B. Expanding Silicone Elastomer:
 - 1. Remove all combustible form materials after installation.
 - 2. Thickness required to maintain fire rating indicated or required.
- C. Firestop Sealant:
 - 1. Completely seal opening to obtain required rating.
- D. Moldable Putty:
 - 1. Install in accordance with manufacturer's recommendations.
 - 2. Trowel to smooth finish, remove excess putty from surrounding surfaces.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies joint sealers and joint backing for general construction.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C919	Standard Practice for Use of Sealants in Acoustical Applications
ASTM C920	Specification for Elastomeric Joint Sealants
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

1.03 SYSTEM DESCRIPTION

- A. System performance: Achieve moisture and airtight joint seals.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's product data demonstrating compliance with the Specifications.
- C. Manufacturer's recommendations for storage, handling and application of sealants and primers.
- D. Samples of material proposed for use showing color range available.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform acoustical sealant application work in accordance with ASTM C919.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

PART 2 PRODUCTS

2.01 SEALANTS

- A. Use allyl-terminated or silyl-terminated polyurethane or polyether hybrid sealants for all applications, except immersion service:
1. ASTM C920, Type S, Grade NS, Class 50, Uses NT, M, A, and O.

2. ASTM D412 Tensile Strength 140 psi minimum.
 3. ASTM D412 Elongation 290% minimum.
 4. VOC <25 g/L.
 5. Compatible with Kynar 500 PVDF coated metals.
 6. Paintable.
 7. Acceptable Manufacturer:
 - a. BASF MasterSeal NP 150.
 - b. LymTal Iso-flex 825.
 - c. Titebond WeatherMaster Ultimate MP.
 - d. Approved Equal.
- B. Use two-part polysulfide sealant for wastewater immersion service:
1. ASTM D412 Tensile Strength 125 psi minimum.
 2. ASTM D412 Elongation 400% minimum.
 3. VOC 0 g/L; 100% solids.
 4. Acceptable Manufacturer:
 - a. Euclid Tammsflex NS-SL.
 - b. Pecora Synthacalk GC2+.
 - c. PolySpec Thiokol 2282.
 - d. WR Meadows Deck-O-Seal Gun Grade.
 - e. Approved Equal.

2.02 ACCESSORIES

- A. Primer: Recommended by the sealant manufacturer to suit application.
- B. Joint Cleaner: Recommended by sealant manufacturer, compatible with joint forming materials.
- C. Backer Rod: Closed cell polyethylene or polyurethane foam, cylindrical and oversized a minimum of 30 percent larger than joint width.
- D. Bond Breaker: Polyethylene or polyurethane with adhesive on one side as recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces and joint openings are ready to receive work.
- B. Remove loose materials and foreign matter, which might impair adhesion of sealant.
- C. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

- A. Prepare, clean and prime joints in accordance with manufacturer's recommendations. Apply primer only to the surfaces that will be covered by the sealant.
- B. Mask adjacent surfaces where necessary to maintain neat edge.

3.03 GENERAL

- A. Apply sealant in accordance with manufacturer's recommendations.
- B. Install joint backing when joints exceed the depth requirements. Insert backing to provide the joint depth specified. Provide full-length sections without splices where possible. Minimize number of splices.
- C. Install bond breaker where joint backing is not used.
- D. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- E. Seal joints around window, door and louver frames, expansion joints, miscellaneous penetrations and elsewhere as indicated.
- F. Tool joints concave unless indicated otherwise.

3.04 HYBRID SEALANT INSTALLATION

- A. Unless otherwise indicated, use on expansion joints and construction joints:
 - 1. Use non-sag formulation on all exposed joints.
- B. Joint dimensions: Unless otherwise indicated, construct joints to the following criteria:
 - 1. Width: Minimum ¼ inch and maximum 1 inch.
 - 2. Depth: one-half the width of the joint, but in no case less than ¼-inch deep. Measure sealant depth at the point of smallest cross section.

3.05 POLYSULFIDE SEALANT INSTALLATION

- A. Use at joints which will be immersed in wastewater.
- B. Joint Dimensions:
 - 1. Width at top: 1 inch.
 - 2. Width at base: ¾ inch.
 - 3. Depth: 2 inches.

3.06 CLEANING

- A. Clean adjacent surfaces of smears or other soiling resulting from sealant application.
- B. Replace or repair surfaces damaged by sealant application or cleaning.

3.07 PROTECTION

- A. Protect sealants until cured.

END OF SECTION

SECTION 08 11 00
STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies steel doors, frames and interior borrowed light frames including transoms; non-rated and fire rated.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revision of the following documents. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ANSI A117.1	Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People
ANSI/SDI 100	Standard Steel Doors and Frames
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc- Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process Standard
ASTM E413	Standard Steel Doors and Frames
UL 10C	Fire Tests of Door Assemblies
UL 1784	Standard of Safety of Air Leakage Tests of Door Assemblies.
SDI 117	Manufacturing Tolerances for Standard Steel Doors and Frames
SDI / ANSI A250.6	Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
SDI / ANSI A250.4	Nomenclature for Standard Steel Doors and Steel Frames.
SDI / ANSI A250.8	(formerly SDI 100), Recommended Specifications for Standard Steel Doors and Frames.
SDI / ANSI A250.10	Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
SDI / ANSI A250.11	Recommended Erection Instructions for Steel Frames.
AIS Compliance	American Iron and Steel Consolidated Appropriations Act

- B. National Association of Architectural Metal Manufacturers (NAAMM):
1. Hollow Metal Manufacturers Association (HMMA).
- C. International Code Council (ICC):
1. Seattle Building Code and associated standards, 2012 Edition including all amendments, referred to herein as Building Code.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product data sheets.
- C. Manufacturers' storage, handling, and installation instructions.
- D. AIS Certification showing compliance.

- E. Shop drawings, indicating:
 - 1. Door and frame elevations.
 - 2. Internal reinforcement.
 - 3. Cut-outs for glazing and finish.
 - 4. Identification of each door: Noted with the same reference indicated in the Drawings.
 - 5. Qualifications.

1.04 QUALITY ASSURANCE

- A. Manufacturer shall be current member of SDI, and NAAMM (HMMA).

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver doors and frames in packaging to prevent damage and deterioration.
- B. Store doors upright, in dry, protected area. Place at a minimum of 1 inch above ground and space at least ¼ inch apart.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide products of one manufacturer to achieve standardization of appearance, operation, and maintenance.
- B. Products are to be certified to comply with AIS, American Iron and Steel Act. The iron and steel is to meet the standards required for iron and steel products and be made in the US.
- C. Acceptable Manufacturers:
 - 1. Ceco Door Products.
 - 2. Curries Manufacturing.
 - 3. Overly Manufacturing Co.
 - 4. Republic Steel Corporation.
 - 5. Steelcraft Manufacturing Co.
 - 6. Approved Equal.

2.02 DOORS AND FRAMES

- A. General:
 - 1. SDI/ANSI A250.8.
 - 2. Fabricate rigid, neat in appearance and free from defects.
 - 3. Form to sizes and profiles indicated in the Drawings.
 - 4. Beveled edge.
 - 5. Fit and assemble in shop wherever practical.
 - 6. Mark work that cannot be fully assembled in shop to assure proper assembly at site.
 - 7. Continuously wire weld all joints, dress exposed joints smooth and flush.
 - 8. Fabricate doors and frames to tolerance requirements of SDI 117.
 - 9. Fit doors to SDI clearances:
 - a. Exterior doors: Seal weld top cap to door face and grind smooth and flush.
 - b. Interior doors:
 - 1) Attach top cap to door with concealed fasteners or by welding.
 - 2) Factory seal if attached with fasteners.
 - 3) No exposed fasteners will be accepted.
 - 10. Continuously wire weld all joints and dress, smooth and flush.

- B. Frames:

1. 16-gage, welded type.
2. Finished size, shape, cross section and profile as indicated in the Drawings.
3. Fabricate with hardware reinforcement welded in place.
4. Prepare frames for silencers and install.
5. Provide 4 inch face at head where indicated in the Drawings or required by wall construction.
6. 26 GA galvanized steel boxes welded to frame at back of all hardware cutouts.
7. Steel plate reinforcement welded to frame for hinge, strikes, closers and surface-mounted hardware reinforcing.
8. All plate reinforcement shall meet size and thickness requirements of SDI/ANSI A250.8.
9. Split type frames not acceptable.
10. Conceal all fasteners.
11. Frames shall be set up, all face joints continuously wire welded and dressed smooth.
12. Exterior (up to 4 feet wide): 16 GA.
13. Exterior (over 4 feet wide): 14 GA.

C. Doors:

1. Exterior:
 - a. SDI /ANSI A250.8 or HMMA 867, Level 3, and physical performance level A, Extra Heavy Duty 1 3/4" Model 2:
 - 1) Face sheet minimum thickness: 16 GA.
 - 2) Polyurethane core; Minimum R-Value of 6; Calculated in accordance with ASTM C518.
 - 3) Sound Transmission Class; STC 27 (minimum) per ASTM E90 & ASTM E413 (Fully Operable).
 - 4) Configure doors to receive recessed weather-stripping.
2. Interior:
 - a. SDI /ANSI A250.8 or HMMA 867, Level 2, and physical performance level "B", Heavy Duty 1-3/4" Model 2:
 - 1) Face sheet minimum thickness: 18 GA.
 - 2) Provide top and bottom flush closures.
 - 3) Fabricate with the required reinforcement for specified hardware.
3. Sound insulated, minimum STC-35.
4. Design and fabricate doors to requirements of the Building Code.
5. Fire Rated Doors:
 - a. Comply with requirements of UL 10C and UL 1784 for the standard of safety of positive-pressure fire tests and the limit of smoke migration through door assemblies
 - b. UL label each door and frame for class of rating scheduled. Provide an "S" on the fire-rating label of the door for those that comply with UL 1784.
6. Prepare for finish hardware in accordance with hardware schedule, templates provided by hardware supplier, and SDI/ANSI A250.6:
 - a. Locate finish hardware in accordance with SDI/ANSI A250.8.
 - b. See Specification Section 08 71 00 for hardware.
 - c. Prepare doors for swing direction indicated.
 - d. Preparing doors for non-handed hinges is not acceptable.
 - e. All doors shall be handed.
 - f. Hinge cut-out depth and size on doors and frames shall match hinge specified in Section 08 71 00.

D. Interior Windows: fabricated in the same manner as other frames and provided with glazing stops.

2.03 DOOR LOUVERS

- A. Stationary louvers: inverted "Y" design, 1 inch thick, of 18-gage steel, with metal molding on both sides.
- B. Acceptable Manufacturer:
 1. Airolite.
 2. Panelouvre.

- 3. Custom Architectural Products.
- 4. Approved Equal.

2.04 PROVISIONS FOR GLAZING

- A. Furnish doors with formed glazing strips of snap-in type to permit selection of secure side in the field.
No screws allowed.
- B. Accommodate glass of type and thickness indicated and as specified in Section 08 80 00.

2.05 FACTORY FINISH

- A. Steel Sheet: Hot-dipped galvanized steel, ASTM A653, A60 coating.
- B. Frames: Hot-dipped galvanized steel, ASTM A653, A60 coating.
- C. Supports and Reinforcing: Hot-dipped galvanized steel, ASTM A653, A60 coating.
- D. Inserts, Bolts and Fasteners: Manufacturer's standard.
- E. Primer: Manufacturer's standard coating meeting SDI/ANSI A250.10.
- F. Thermal Insulation: Polyurethane, CFC free.
- G. Sound Insulation: Fiberglass batt insulation or impregnated Kraft honeycomb.
- H. Frame Anchors:
 - 1. Jamb anchors:
 - a. Masonry wire anchors: Minimum 0.1875 inch wire, galvanized.
 - b. Existing wall anchor: Minimum 18 GA, galvanized.
 - c. Stud partition and base anchors: Minimum 18 GA, galvanized.
- I. Phosphate treat for paint adhesion.
- J. One coat, not less than one mil dry film thickness, baked-on rust inhibiting primer compatible with finish coating as specified in Section 09 90 00.

2.06 SUSTAINABILITY

- A. Sustainability Requirements: Section 01 33 29.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install doors and frames in accordance with ANSI/SDI 100, SDI / ANSI A250.11, the Building Code and manufacturer's instructions.
- B. Plumb, align, and brace frames securely until permanently anchored.
 - 1. After completion of walls, remove temporary braces and spreaders.
 - 2. Anchor frames with minimum of three (3) anchors per jamb:
 - a. Number and location of anchors shall be in accordance with SDI and frame manufacturer's recommendations.
- C. Maintain scheduled dimensions, hold head level, and maintain jambs plumb and square.

- D. Coordinate with masonry and wallboard wall construction for frame anchor placement.
- E. Fill frames installed in CMU or concrete construction with grout. Use horizontal spreaders to keep jambs from bowing in as frames are being filled with grout.
- F. Use plastic plugs to keep silencer holes clear during construction.
- G. Immediately after erection, sand smooth rusted or damaged areas.
 - 1. Touch-up with rust-inhibiting primer.
 - 2. Leave finish smooth for finish painting per Section 09 90 00.
- H. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb and anchors are securely attached.
- I. Install three (3) silencers on strike jamb of single door frame and two (2) on head of double door frame.
- J. Coordinate installation with installation of hardware specified in Section 08 71 00.
- K. Coordinate installation of glass and glazing.

3.02 ADJUSTING

- A. Adjust door for smooth and balanced door movement.

END OF SECTION

SECTION 08 22 00
FIBERGLASS REINFORCED PLASTIC DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies fiberglass doors and frames.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
SBC	Seattle Building Code
SDI A250.4/SDI A151.1/SDI 105	Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors
SDI A250.6	Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
SDI A250.11	Recommended Erection Instructions for Steel Frames
ASTM D 1761	Standard Test Methods for Mechanical Fasteners in Wood
ASTM F476	Standard Test Methods for Security of Swinging Door Assemblies
ASTM D256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
SFBC PA201/TS201	South Florida Building Code Testing Application Standard Impact Test Procedures

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Product data sheets showing how the doors meet the requirements of this Section.
 2. Manufacturer's storage, handling, and installation instructions.
 3. Shop drawings, indicating:
 - a. Door and frame elevations.
 - b. Internal reinforcement.
 - c. Glazing details.
 - d. Type of finish.
 - e. Identification of each door.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Deliver doors and frames in packaging to prevent damage and deterioration.
- B. Store doors upright, in dry, protected area. Place at a minimum of 1 inch above ground and space at least ¼ inch apart.

1.05 WARRANTY

- A. Manufacturer's standard 10-year warranty for defects, corrosion, and warping.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Chem-Pruf Door, CP1 Model.
 - 2. Edgewater Door, ES Model.
 - 3. Approved Equal.

2.02 GENERAL

- A. Provide products of one manufacturer to achieve standardization of appearance, operation, and maintenance.

2.03 DOORS AND FRAMES

- A. General:
 - 1. Fabricate rigid, neat in appearance and free from defects.
 - 2. Form to sizes and profiles indicated.
 - 3. Prepare doors for the hardware specified in Section 08 71 00 in accordance with hardware schedule, templates provided by hardware supplier, and SDI A250.6. Locate finish hardware in accordance with SDI A250.8.
 - 4. Prepare doors for swing direction indicated.
 - 5. Prepare doors and install glazing.
 - 6. All doors shall be handed.
 - 7. Fit and assemble in shop wherever practical.
 - 8. Mark work that cannot be fully assembled in shop to assure proper assembly at site.
 - 9. Design and fabricate doors to requirements of the Seattle Building Code.
- B. FRP Doors:
 - 1. Swing Cycle Test
 - 2. R-9.5
 - 3. SDI A250.4/SDI A151.1/SDI 105: 250,000 cycles minimum
 - 4. Fastener Pullout Test
 - 5. ASTM D 1761: 1,000 lbs minimum
 - 6. Meet the criteria of one of the three following impact tests:
 - a. ASTM F476: Pass.
 - b. SFBC PA201/TS201: Pass.
 - c. ASTM D256: >10 ft-lb per inch of notch.
 - 7. Core material: mineral, foam, or approved equal.
 - 8. 1¾ inch thick..
 - 9. Face sheet minimum thickness: .090 inch.
 - 10. Stiles and Rails: FRP materials compatible with face sheets.
 - 11. Color: Gray or as selected by Project Representative from manufacturer's standard colors.
- C. FRP Frames:
 - 1. Finished size, shape, cross section and profile as required to fit wall openings.
 - 2. FRP materials to be compatible with door panels.
 - 3. Prep for the hardware specified in Section 08 71 00.
 - 4. Frame Anchors: Corrosion resistant, as recommended by door manufacturer.
 - 5. Color: Gray or as selected by Project Representative from manufacturer's standard colors

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install doors and frames in accordance with SDI 250.8, SDI A250.11, the Seattle Building Code and manufacturer's instructions.
- B. Plumb, align, and brace frames securely until permanently anchored. Anchor frames with minimum of three (3) anchors per jamb. Number and location of anchors shall be in accordance with SDI and frame manufacturer's recommendations.
- C. Maintain scheduled dimensions, hold head level, and maintain jambs plumb and square.
- D. Fill frames with grout unless pre-filled at factory. Follow door manufacturer's recommendations for grout type and filling procedures. Use horizontal spreaders to keep jambs from bowing in as frames are being filled with grout.
- E. Use plastic plugs to keep silencer holes clear during construction.
- F. Sand smooth damaged areas and touch-up with manufacturer's recommended gel coat or paint.
- G. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb and anchors are securely attached.
- H. Install three (3) silencers on strike jamb of door frames.
- I. Coordinate installation with installation of hardware specified in Section 08 71 00.

3.02 ADJUSTING

- A. Adjust door for smooth and balanced door movement. Adjust door closer to prevent striking walls or other obstructions when opened.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies:
1. Overhead coiling doors.
 2. Support framing.

- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
NORTHEAST VESTIBULE OVERHEAD DOOR	704-RUD90AA011
SCREEN ACCESS HALL OVERHEAD DOOR	704-RUD90BB021

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AMMA	American Architectural Manufacturers Association
ASHRAE Standard 90.1	Energy Standard for Buildings
ASTM E330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
SBC	Seattle Building Code

1.03 SYSTEM DESCRIPTION

- A. General:
1. Overhead coiling door assembly includes curtain, curtain guides, brackets, post-installed concrete anchors, custom mounting supports to attach the complete coiling door assembly to the structure, counterbalance, hood, motor operators as specified, push button stations, steel structural supports and other accessories required for a complete installation.
- B. Design Requirements:
1. Wind loading:
 - a. Exterior overhead coiling doors, custom mounting supports, and post-installed concrete anchors to the structure shall be designed to withstand the greater of 20 pounds per square foot wind load or design wind loads indicated in this Section. Windlocks shall be insulated.
 2. Cycle life:
 - a. Rolling service doors shall be designed to a standard maximum of 20 cycles per day and an overall maximum of 50,000 operating cycles for the life of the door.
 3. Thermal Requirements:
 - a. Insulated R value: 8.0.
 - b. Air infiltration to comply with ASHRAE Standard 90.1-2007, 2010 & 2013 requirements of less than 0.3 CFM/FT².
 - c. Insulation to be chlorofluorocarbon (CFC) Free with an Ozone Depletion Potential (ODP) rating of zero.
 4. Structural Design:

- a. Loads used in design:
 - 1) Design loads shall meet the requirements of the City of Seattle Building Code (SBC):
 - a) Wind Load Factors on the overhead coiling door assembly:
 - (1) Exposure C as permitted by the City of Seattle Department of Construction and Inspections Wind Speed Up Areas Maps.
 - (a) $K_{zt} = 1.0$ as permitted by the City of Seattle Department of Construction and Inspections Wind Speed Up Areas Maps.
 - (b) Wind Speed: 104 mph.
 - b) Seismic anchorage design:
 - (1) Overhead coiling door assembly: In accordance the requirements of Section 01 73 00.
 - (2) All custom mounting supports and seismic anchorage: In accordance with the requirements of Section 01 73 00.
 - (3) Unless noted otherwise, $I_p = 1.0$ for all overhead coiling door assembly components, connections and attachment design.
 - b. System shall limit framing deflection to $1/175$ of the span under the design wind load.
 - c. Post-installed concrete anchors, custom mounting supports and inserts shall be designed to resist design gravity, wind and seismic loads, in combinations as specified in the SBC.
- 5. Dynamic Movement: System shall accommodate the following without damage to system components or performance:
 - a. Movement within the system.
 - b. Movement between the system and perimeter framing components.
 - c. Application and release of design wind or seismic loads.
 - d. Deflection of structural support framing.
 - e. Thermal movement caused by a temperature range of -20 degrees F. to + 160 degrees F. without detrimental effects to components, sealing systems, and surrounding construction.
- 6. Systems shall not exhibit vibration harmonics, wind whistles, and noises caused by thermal movement. Under the full range of design loads and conditions, the systems shall not exhibit loosening, weakening, or fracturing of attachments or components of the system, including glazing and sealants.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Product Data: Manufacturer's complete product information for components and systems proposed.
- C. Shop drawings:
 - 1. Elevations and system dimensions.
 - 2. Special and typical details.
 - 3. Jamb Support Framing profiles.
 - 4. Materials and finishes.
 - 5. Adjacent construction.
 - 6. Anchorage system details.
 - 7. Fastening methods.
 - 8. Calculations and design drawings demonstrating compliance with these specifications and the SBC shall be prepared, stamped, dated, and signed by a Professional Engineer registered in the state of Washington.
- D. Manufacturer's Assembly Instructions: Submit manufacturer's standard written and graphic assembly instructions for each system to be provided. Show assembly procedures and sequences recommended by the manufacturer to meet the performance requirements specified.
- E. Samples:
 - 1. Submit one sample of a typical section 12 inch x 12 inch.

- F. Quality Control Submittals:
 - 1. Test Reports: Submit copies of test reports which verify that each door meets operational performance requirements specified.
 - 2. Certification: Submit written certification that the framing system has been designed to meet the specified requirements.
 - 3. Tests supporting structural engineering calculations shall have been performed by an AAMA certified testing laboratory in accordance with ASTM E330 requirements.
- G. Welding data and weld inspection reports, as specified in Section 05 05 20.
- H. Energy Performance Certification: For each overhead door.
- I. Closeout Submittal
 - 1. Submit designing engineer's certification that products and installation comply with design requirements.

1.05 QUALITY ASSURANCE

- A. Installers: Trained and authorized by the door manufacturer.
- B. Manufacturer's representative shall be present during installation.
- C. Structural Design: Structural design of the structural support system and connections shall be performed by an Engineer registered in the state of Washington.
- D. Structural welding shall be performed by AWS Certified welders.
- E. Regulatory Requirements:
 - 1. Framing system shall meet the requirements of the Seattle Building Code and the City of Seattle Department of Construction and Inspections (SDCI).
 - 2. Furnish calculations and drawings stamped by an Engineer registered in the state of Washington, demonstrating compliance with these specification, the SBC and other items required by the SDCI to obtain approval of the installation.
- F. Pre-Installation Conference:
 - 1. Conduct in accordance with Section 01 31 19.
 - 2. Require in attendance:
 - a. General Contractor.
 - b. Project Representative.
 - c. Overhead door subcontractor.
 - d. Electrical subcontractor.
 - e. Others as may be affected by the work of this Section.
 - 3. Agenda: Address coordination, existing conditions, switch locations, connection points, access requirements, motor locations, and field testing procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. The Cookson Company.
 - 2. Overhead Door Corporation.
 - 3. Wayne Dalton Corporation.
 - 4. Cornell Iron Works Incorporated.
 - 5. McKean Rolling Door Company.
 - 6. Approved Equal.

2.02 MATERIALS

- A. General:
 - 1. Insulated, corrosion-resistant, motorized operation.
 - 2. Integral hollow metal exit door:
 - a. Northeast Vestibule Over Head Door (704-RUD90AA011) shall have a metal door and frame (Door 412-3) integrated into the overhead door curtain face as indicated in the Drawings.
 - b. Integral metal door to swing to provide clear width indicated. Isolate dissimilar metals.
 - 3. Hazardous Locations: Screen Access Hall Overhead Door (704-RUD90BB021) shall be spark resistant door rated for the area listed.
- B. Curtain Slats:
 - 1. Insulated.
 - 2. Aluminum.
 - 3. Corrosion Resistance:
 - a. Exterior Slat Finish: Clear anodized.
 - b. Interior Slat Finish: Clear anodized.
- C. Endlocks:
 - 1. Alternate slats each secured with two 1/4 inch stainless steel rivets.
 - 2. Fabricate interlocking sections with high strength stamped 304 series stainless steel.
 - 3. Provide endlocks/windlocks as required to meet specified wind load.
- D. Bottom Bar:
 - 1. Extruded Aluminum: Alloy 6063-T5.
 - 2. Finish: Clear anodized
- E. Guides:
 - 1. Fabrication:
 - a. Thermal break required.
 - b. Minimum 3/16 inch aluminum angles.
 - c. Provide windlock bars of same material when windlocks are required to meet specified wind load.
 - d. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides.
 - e. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.
 - f. Stainless steel fasteners to be used for assembly bolts.
 - g. Finish: Clear anodized
- F. Counterbalance Shaft Assembly:
 - 1. Barrel: Steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot of width
 - 2. Spring Balance:
 - a. Oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door to ensure that maximum effort to operate will not exceed 25 lbs.
 - b. Provide wheel for applying and adjusting spring torque.
 - 3. Finish: Corrosion Inhibitive: Zirconium treatment followed by a corrosion inhibitive baked-on zinc-rich gray polyester powder coat; minimum 2.5 mils cured film thickness.
- G. Brackets:
 - 1. Fabricate from minimum 3/16 inch stainless steel plate with permanently lubricated ball or roller bearings at rotating support points to support counterbalance shaft assembly and form end closures.
 - 2. Corrosion inhibitive zirconium treatment required for all bearings.
 - 3. Finish: Type 304 Stainless Steel Number 4 finish.

- H. Hood:
 - 1. Minimum 0.040 inch aluminum with reinforced top and bottom edges.
 - 2. Provide minimum 1/4 inch steel intermediate support brackets as required to prevent excessive sag.
 - 3. Finish: Clear anodized
- I. Weatherstripping:
 - 1. Provide weatherstripping at exterior doors.
 - 2. Bottom Bar: Motor Operated Doors: Sensing/weather edge with neoprene astragal extending full width of door bottom bar
 - 3. Guides: Replaceable vinyl strip on guides sealing against fascia side of curtain
 - 4. Lintel Seal: Double brush seal with EPDM sandwiched between the two brush seals at door header to impede air flow.
 - 5. Hood: Neoprene/rayon baffle to impede air flow above coil.
- J. Electrical and Controls:
 - 1. Motor Operator: Heavy duty gear head motor operator.
 - 2. Voltage/Phase: As indicated on the Drawings.
 - 3. Hazardous Locations: Equipment and devices rated for the area listed.
 - 4. Operator Control Stations:
 - a. Push button operated for open and close.
 - b. Conform with Section 26 09 16.
 - 5. Reversing foot piece;
 - a. Concealed self-winding electrical cord reel.
 - b. Located directly above connection point on bottom-bar.
 - c. Bottom-bar switch shall be detailed and mounted so as not to overhang the bottom-bar angle.
 - 6. Key operated switch:
 - a. Constant pressure (spring return) type.
 - b. Labeled "OPEN" and "CLOSE," with center off position.
 - c. Keyed cylinder to be furnished under Section 08 71 00.

2.03 SUPPORT FRAMING

- A. Provide steel framing as necessary to support the overhead coiling doors and meet requirements of this Section:
 - 1. All steel framing, attachments, and custom mounting support components shall be in conformance with the requirements of Section 05 50 00.
 - 2. All steel framing, attachments, and custom mounting support components shall be galvanized in conformance with the requirements of Section 05 50 00.
 - 3. All post-installed concrete anchors shall be stainless steel and shall be in accordance with the requirements of Section 05 05 19.
- B. Design the support framing.
- C. Provide bracing, custom mounting supports, attachments, and post-installed concrete anchors to secure the overhead coiling door assembly to adjacent structure to maintain the installation firmly in position.
- D. Framing shall be designed to accommodate deflection of at least 1/2 inch in any direction of the structure without damage to the coiling door assembly.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

- B. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence. Notify the Project Representative in writing of conditions detrimental to the proper and timely completion of the Work.
- C. Do not begin installation until unsatisfactory conditions are resolved. Beginning work constitutes acceptance of Site conditions and responsibility for defective installation caused by prior observable conditions.
- D. Verify that openings are prepared with headers level, jambs plumb, floor level, without projections, and are correctly dimensioned to receive door.

3.02 INSTALLATION

- A. Install door assemblies as indicated in accordance with manufacturer's installation instructions, and the labeling requirements. Labeling requirements take precedence over other requirements.

3.03 FIELD QUALITY CONTROL

- A. Verify that moving parts operate smoothly, coiling doors are free from warp, twists, or distortion, doors remain in required position, and safety features function properly.

3.04 ADJUST

- A. Adjust mechanism so moving parts operate smoothly.

END OF SECTION

SECTION 08 43 13
ALUMINUM STOREFRONT SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies:
1. Aluminum framed storefront systems.
 2. Aluminum framed glass entrance doors integral with aluminum framed glazing systems.
 3. Glazed-in operable windows and operators.
 4. Interior Aluminum Storefront Systems.
 5. Sealants within aluminum framed glazing systems.
 6. Related flashing and trim.
 7. Related anchor brackets and supports.
 8. Structural design of aluminum framed glazing systems, including framing and attachment to structure.
 9. Hardware for entry doors, including low energy operators.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AAMA 101	American Architectural Manufacturers Association. Voluntary Specification for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors.
AAMA 501.2	American Architectural Manufacturers Association. Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage.
AAMA 904.1	American Architectural Manufacturers Association. Voluntary Specification for Friction Hinges in Window Applications.
AAMA 2605	American Architectural Manufacturers Association. Voluntary Specification for Performance Requirements and Test Procedures for Superior Performance Organic Coatings on Project Architectural Extrusions and Panels.
ANSI A156.19	American National Standard for power Assist and Low Energy Power Operated Doors.
ANSI Z97.1	American National Standard for Performance Specifications and Test Methods for Safety Glazing Materials in Buildings.
ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate.
ASTM B221	Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
ASTM B633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C1401	Standard Guide for Structural Sealant Glazing.
ASTM E283	Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors.
ASTM E330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls.
ASTM E331	Test Method for Water Penetration of Exterior Windows, Curtainwalls, and Doors by Uniform Static Air Pressure Difference.
ASTM E1105	Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference

Reference	Title
SBC	Seattle Building Code
NFRC 100	Procedure for Determining Fenestration Product U-Factors.
NFRC 102	National Fenestration Rating Council: Test Procedure for Measuring the Steady- State Thermal Transmittance of Fenestration Systems
NFRC 200	National Fenestration Rating Council: Solar Heat Gain Coefficient and Visible Transmittance.

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Product Data: Manufacturer's complete product information for components and systems proposed.
- C. Shop drawings:
 - 1. Elevations, system dimensions, and expansion and contraction joint location.
 - 2. Special and typical details.
 - 3. Framing profiles.
 - 4. Materials and finishes.
 - 5. Adjacent construction.
 - 6. Anchorage system details.
 - 7. Fastening methods.
 - 8. Shop drawings shall be prepared, stamped, dated, and signed by a Professional Engineer registered in the state of Washington.
- D. Manufacturer's Assembly Instructions: Submit manufacturer's standard written and graphic assembly instructions for each system to be provided. Show assembly procedures and sequences recommended by the manufacturer to meet the performance requirements specified.
- E. Samples:
 - 1. Submit one sample of a typical corner section with minimum 12 inch long legs. Include typical glass unit and glazing system.
- F. Quality Control Submittals:
 - 1. Test Reports: Submit copies of test reports which verify that each aluminum framed glazing system meets the air and water infiltration performance requirements specified.
 - 2. Certification: Submit written certification that the framing system has been designed to meet the specified requirements.
 - 3. Tests supporting structural engineering calculations shall have been performed by an AAMA certified testing laboratory in accordance with ASTM E330 requirements.
- G. Welding data and weld inspection reports, as specified in Section 05 05 20.
- H. Energy Performance Certification: For each aluminum-framed glazing system and glazing combination.
 - 1. NFRC-certified energy performance values for each system, including U-value, Solar Heat Gain Coefficient (SHGC), and Visible Light Transmittance.
 - 2. Evidence for Certification:
 - a. NFRC Label with Certified Product Directory (CPD) number.
 - b. NFRC Label Certificate.
- I. Closeout Submittal
 - 1. Submit designing engineer's certification that products and installation comply with design requirements.

1.04 QUALITY ASSURANCE

- A. Manufacturer's representative shall be present during installation.
- B. Structural Design: Structural design of the aluminum framed glazing systems and connections shall be performed by an Engineer registered in the state of Washington.
- C. Structural welding shall be performed by AWS Certified welders.
- D. Regulatory Requirements:
 - 1. Framing system shall meet the requirements of the Seattle Building Code and the City of Seattle Department of Construction and Inspections (SDCI).
 - 2. Furnish calculations and drawings stamped by an Engineer registered in the state of Washington, and other items required by the SDCI to obtain approval of the installation.

1.05 SYSTEM DESCRIPTION

- A. Appearance: System shall conform to the general appearance as indicated in the Drawings, including without limitation, position, spacing, and location of framing members, plane of glazing, exterior frame general profile and shape, and dimension points.
- B. Energy Performance: Certify and label energy performance according to NFRC as follows:
 - 1. Thermal Transmittance (U-factor): Glazing and framing areas shall have U-factor of not more than the following, as determined according to NFRC 100.
 - a. Glazed Aluminum Entrance Doors: 0.60.
 - 2. Solar Heat Gain Coefficient:
 - a. Glazed entrance doors shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.
- C. Performance:
 - 1. Air Infiltration:
 - a. Aluminum Entrance Doors: Limit air infiltration through assembly to 1.0 cfm per square foot, measured at a static differential pressure of 1.57 psf as measured in accordance with ASTM E283.
- D. Structural Design:
 - 1. Loads used in design:
 - a. Design loads shall meet the requirements of the City of Seattle Building Code (SBC):
 - 1) Wind Load Factors on components and cladding:
 - a) Exposure C as permitted by the City of Seattle Department of Construction and Inspections Wind Speed Up Areas Maps.
 - (1) $K_{zt} = 1.0$ as permitted by the City of Seattle Department of Construction and Inspections Wind Speed Up Areas Maps.
 - (2) Wind Speed: 104 mph.
 - 2) Seismic anchorage design in accordance the requirements of Section 01 73 00. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00. Unless noted otherwise, $I_p = 1.0$ all Aluminum Storefront System components, connections and attachment design.
 - 2. System shall limit framing deflection to 1/175 of the span under the design wind load.
 - 3. Anchorages and inserts shall be designed to resist design loads, in combinations as specified in the SBC.
- E. Dynamic Movement: System shall accommodate the following without damage to system components or performance:
 - 1. Movement within the system.

2. Movement between the system and perimeter framing components.
 3. Application and release of design live loads.
 4. Deflection of structural support framing.
 5. Thermal movement caused by a temperature range of -20 degrees F. to + 160 degrees F. without detrimental effects to components, sealing systems, and surrounding construction.
- F. Systems shall not exhibit vibration harmonics, wind whistles, and noises caused by thermal movement. Under the full range of design loads and conditions, the systems shall not exhibit loosening, weakening, or fracturing of attachments or components of the system, including glazing and sealants.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. See Section 01 67 00.
- B. Deliver, store, and handle products using means and methods that will prevent damage and deterioration. Comply with manufacturer's written instructions.
- C. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 1. Kawneer.
 2. Approved Equal.

2.02 MATERIALS

- A. Extruded Aluminum: ASTM B221; 6063 T5 alloy and temper.
- B. Sheet Aluminum: ASTM B209; 5005-H32 alloy or Approved Equal.

2.03 EQUIPMENT FEATURES AND COMPONENTS

- A. Aluminum Storefront Doors: Kawneer "AA250," or Approved Equal; narrow stile; 10 inch bottom rail.

2.04 COMPONENTS

- A. Swing Door Hardware:
 1. Weatherstripping: Manufacturer's standard.
 2. Remaining hardware as specified in Section 08 71 00.
- B. Low Energy Operator:
 1. Manufacturer: Horton Automatics, or Approved Equal.
 2. Operating Mechanism: "Series 4800 LE Series Electric Operator"; concealed overhead mounting; isolated pivot; 90° opening.
 3. Pushbutton Switch: Horton "C1260 5 Push Plate Switch" and plate sub-assembly; recessed configuration in 4x4 junction box with 4.5" x 4.5" square brushed stainless steel push plate with engraved and contrasting color paint filled handicap insignia and message "PRESS TO OPEN"; weatherproof for exterior installations. Furnish two per opening. Provide signage to indicate which push plate operates which door.
 4. Header Housing: Provide manufacturer's standard extruded aluminum header to receive power assist operator.

- 5. Doors with low energy operators shall conform to the currently enforced edition of ANSI A156.19.
- C. Glazing Accessories:
 - 1. Gaskets for Stopped in Glazing: Furnish frame manufacturer's standard corner sealing resilient elastomeric, glazing gaskets for installation as a part of the work of Section 08 80 00.
 - 2. Remaining glazing accessories are specified in Section 08 80 00.
- D. Glass: As specified in Section 08 80 00.
- E. Prefinished Metal Infill Panel:
 - 1. MapeShape Panel by Mapes Industries Inc. or Approved Equal.
 - 2. 2 inch thickness.
 - 3. Polyisocyanurate foam core with high density polypropylene substrates.
 - 4. Aluminum faces both sides.
 - 5. Prefinished to match aluminum framed glazing system.
- F. Sealants: As specified in Section 07 92 00.
- G. Fasteners: ASTM B633; aluminum, stainless steel, or zinc plated steel.

2.05 ALUMINUM FRAMED GLAZING SYSTEMS FABRICATION

- A. Fabricate frames allowing for shim spacing around perimeter of assembly, yet enabling installation.
- B. Insofar as practical, fitting and assembly of the work shall be performed in the shop.
- C. Make joints flush, uniform, hairline (maximum 1/16 inch, except for expansion joints), and weatherproof. Seal joints with sealant.
- D. Rigidly fit joints and corners. Accurately fit and secure corners tight. Make corner joints flush, uniform, hairline (maximum 1/16 inch, except for expansion joints), and weatherproof. Seal joints with sealant.
- E. Provide drainage holes to allow water to flow to exterior.
- F. Prepare components to receive anchorage devices. Fabricate anchorage items.
- G. Provide internal reinforcement in mullions with members to maintain rigidity. Provide reinforcing at door strike jambs.
- H. Fabricate framing systems to accommodate hardware using templates furnished from the hardware supplier.
- I. Fabricate sill and other flashing to direct water to the exterior.
- J. At storefront systems, provide special extrusions or sealed backing plates as necessary to form a solid watertight surface to receive and support sealing systems as specified in Section 07 92 00.

2.06 FINISHES

- A. Color Anodized Finish: Apply at aluminum framing member surfaces exposed to view in installed position, and to sheet metal flashings.
 - 1. Conform to AAMA AA-M10C21A44.
 - 2. Architectural Class I, etched, medium matte, "Black" (Kawneer#29) color anodic coating, 0.7 mil thickness.
 - 3. Match finish of adjacent window and framing systems on existing south exterior wall.

- B. Steel Anchorages and Supports: Clean and apply rust resistant primer.
- C. Isolate aluminum from dissimilar materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence. Notify the Project Representative in writing of conditions detrimental to the proper and timely completion of the work.
- B. Do not begin installation until unsatisfactory conditions are resolved. Beginning work constitutes acceptance of site conditions and responsibility for defective installation caused by prior observable conditions.

3.02 PREPARATION

- A. Coordinate dimensions, tolerances, and method of attachment with the other work.
- B. Furnish inserts for placement by other trades. Coordinate locations and alignment.

3.03 INSTALLATION

- A. Install frames, doors, and hardware in accordance with manufacturer's instructions and the reviewed shop drawings.
- B. Use anchorage devices to securely attach framing systems to structure.
- C. Align frames plumb and level, free of warp or twist. Maintain dimensional tolerances, aligning with adjacent work.
- D. Perimeter sealant per Section 07 92 00.
- E. Low Energy Operators:
 - 1. Install operators and controls in accordance with manufacturer's instructions and ANSI requirements.
 - 2. Coordinate electrical service, wiring and connections with work of Division 26.
- F. Install additional framing as necessary to support the system components.
- G. Protect aluminum from dissimilar materials with a coating of bituminous paint, plastic separator materials, or isolation tape. Keep isolation materials unexposed to view.

3.04 INSTALLATION TOLERANCES

- A. Variation from plane: 0.06 inches every three feet maximum or 0.25 inches per 100 feet, whichever is less.
- B. Misalignment of two adjoining members abutting in plane: 0.015 inches.

3.05 FIELD QUALITY CONTROL

- A. Static Water Penetration Test:

1. Provide in-place performance testing of the exterior aluminum framed glazing systems in a minimum of two locations as directed by the Project Representative.
 2. Expedite work in the test areas in order to allow evaluation as early as possible during the construction schedule. Provide materials and personnel for prompt construction of test areas.
 3. The various stages of construction of work and the testing thereof are subject to observation by the Project Representative, so that components are reviewed and installation details evaluated prior to proceeding with the next sequence. Notify the Project Representative when construction commences in these areas.
 4. Test Description:
 - a. Test areas shall be within one floor. Provide access to the interior surface of the tested surfaces in order to observe possible water penetration.
 - b. Test a minimum of 100 square feet of area, unless approved otherwise.
 - c. Coordinate schedules directly with the Project Representative, and testing laboratory. Notify the Project Representative a minimum of 5 days prior to testing.
 - d. Test Procedure:
 - 1) Uniform Static Pressure in accordance with ASTM E1105 at 8 psf.
 - 2) Result: There shall be no observable uncontrolled water leakage into the interior of the space.
 5. Corrections:
 - a. Correct components and assemblies that do not conform to Contract requirements.
 - b. Retest corrected assemblies until no failures occur under test.
 - c. Incorporate reviewed corrective changes in the construction of existing and remaining work.
 - d. Where corrective changes have been incorporated into existing work, provide at least one additional test in an area as reviewed by the Project Representative and the envelope consultant.
- B. Engineer's Certification of Installation: The design engineer or authorized representative shall visit the Site to inspect the work. Verify and certify that the installation has been installed in accordance with the design requirements.
- C. Welded connections visual inspection and nondestructive weld testing:
1. As specified in Section 05 05 20.

3.06 CLEANING

- A. Remove protective material from prefinished aluminum surfaces if applicable.
- B. Wash down exposed surfaces using a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

3.07 FIELD INSPECTION

- A. The design engineer or an authorized representative shall visit the Site to inspect the work. Verify and certify that the installation has been installed in accordance with the design requirements.

END OF SECTION

SECTION 08 45 00
TRANSLUCENT WALL ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the insulated, translucent sandwich panel system and accessories as shown and specified. Work includes providing and installing:
1. Flat insulated, translucent sandwich panels.
 2. Aluminum clamp/tite installation system
 3. Aluminum sill flashing

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
UL 723	Flame Spread and Smoke Developed
ASTM D 635	Burn Extent
ASTM D 2244	Color Difference
UL 972	Impact Strength
ASTM C 297	Bond Tensile Strength
ASTM D 1002	Bond Shear Strength

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Submit manufacturer's product data. Include construction details, material descriptions, profiles, and finishes of components.
- C. Submit shop drawings. Include plans, elevations, and details.
- D. Submit manufacturer's color charts showing the full range of colors available for factory finished exposed aluminum.
1. When requested, submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below:
 - a. Sandwich panels: 7 inch x 12 inch units
 - b. Factory finished aluminum: 3 inch long sections.
- E. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.
- F. Submit product reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed reports will be acceptable if for current manufacturer and indicative of products used on this project.
- G. Closeout submittals:
1. Provide field maintenance manual to include in project maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope, and location. At least three of the projects shall have been in successful use for ten years or longer.
 - 2. Panel system shall be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural, and water infiltration testing of sandwich panel systems by an accredited agency.
 - 3. Quality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components, and production sandwich panels for conformance with AC177 "Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems" as issued by the ICC-ES.
- B. Installer's Qualifications: Installation shall be by an experienced installer, which has been in the business of installing Kalwall panel systems for at least two consecutive years and can show evidence of satisfactory completion of projects of similar size, scope, and type.

1.05 PERFORMANCE REQUIREMENTS

- A. The manufacturer shall be responsible for the configuration and fabrication of the complete panel system:
 - 1. When requested, include span analysis data.
 - 2. Standard panel system shall have less than 0.01 cfm/ft² air leakage by ASTM E 283 at 6.24 psf (50 mph) and no water penetration by ASTM E 331 at 15 psf; and structural testing by ASTM E 330.
 - 3. Structural Loads. Provide system capable of handling the following loads:
 - a. Positive Wind Load (psf): per structural drawings wind loading.
 - b. Negative Wind Load (psf): per structural drawings wind loading.
- B. Thermal Movements: Allow for thermal movements from ambient- and surface-temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 110 deg F (43 deg C), ambient; 150 deg F (66 deg C), material surfaces.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver panel system, components, and materials in manufacturer's standard protective packaging.
- B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

1.07 WARRANTY

- A. Provide manufacturer's and installer's written warranties agreeing to repair or replace panel system work, which fails in material or workmanship, within one year from the date of delivery. Failure of material or workmanship shall include deterioration of finish on metal in excess of normal weathering; and defects in accessories; insulated, translucent sandwich panels; and other components of the work.
- B. Extended Panel Warranty: Five years from date of delivery.
- C. Extended Manufacturer's factory applied Finish Warranty: Five years from date of delivery.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Kalwall Corporation, Tel: (800) 258-9777 – Fax: (603) 627-7905 – Email: info@kalwall.com
- B. Approved Equal.

2.02 PANEL COMPONENTS

- A. Face Sheets:
 - 1. Translucent faces: Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use:
 - a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
 - b. Face sheets shall not deform, deflect, or drip when subjected to fire or flame.
 - 2. Interior face sheets:
 - a. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 25 and smoke developed no greater than 450 when tested in accordance with UL 723.
 - b. Burn extent by ASTM D 635 shall be no greater than 1 inch.
 - 3. Exterior face sheets:
 - a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3 CIE Units DELTA E by ASTM D 2244 after 5 years outdoor weathering at 5° facing south as measured on a white sample, with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
 - b. Strength: Exterior face sheet shall be uniform in strength, impenetrable by hand held pencil and repel an impact minimum of 230 ft. lbs. without fracture or tear when impacted by a 3-1/4" diameter, 5 lb. free-falling ball per UL 972.
 - c. Erosion Protection: Integral, embedded-glass erosion barrier.
 - 4. Appearance:
 - a. Exterior face sheet: Smooth.
 - b. Interior face sheet: Smooth.
 - c. Face sheets shall not vary more than $\pm 10\%$ in thickness and be uniform in color.
- B. Grid Core:
 - 1. Aluminum I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16".
- C. Laminate Adhesive:
 - 1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives".
 - 2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.
 - 3. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions:
 - a. 50% Relative Humidity at 68° F: 540 psi
 - b. 182° F: 100 psi
 - c. Accelerated Aging by ASTM D 1037 at room temperature: 800 psi
 - d. Accelerated Aging by ASTM D 1037 at 182° F: 250 psi

2.03 PANEL CONSTRUCTION

- A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
 - 1. Thickness: 2-3/4 inches
 - 2. Grid Core Insulation: Fill panel cores with aerogel.
 - 3. Panel U-factor by NFRC certified laboratory:
 - a. 2-3/4 inch aluminum grid.
 - 4. Complete insulated panel system shall have NFRC certified U-factor of 0.30.
 - 5. Visible Light Transmittance (VLT):
 - a. Visible LT (NFRC 202) by NFRC certified laboratory: For Crystal/Crystal face sheet combinations.
 - 6. Solar heat gain coefficient 52.
 - 7. Grid pattern as viewed: Nominal size 12 inch wide ; pattern VertiKal.
- B. Standard panels shall deflect no more than 1.9 inches at 30 psf in 10'-0" span without a supporting frame by ASTM E 72.
- C. Panels shall meet the conditions of acceptance according to ASTM E2707 Fire Penetration of Exterior Wall Assemblies Using a Direct Flame Impingement Exposure:
 - 1. Absence of flame penetration through the wall assembly at any time.
 - 2. Absence of evidence of glowing combustion on the interior surface of the assembly at the end of the 60-min observation period.
 - 3. Absence of evidence of flame, glow, and smoke if the test is terminated prior to the completion of the 60-min observation period.
- D. Thermally broken, insulated panels: Minimum Condensation Resistance Factor of 80 by AAMA 1503 measured on the bond line.

2.04 ALUMINUM CLAMPTITE INSTALLATION SYSTEM

- A. Aluminum clamptite installation system:
 - 1. Standard-Flat extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system.
- B. Sealing tape: Manufacturer's standard, pre-applied to aluminum clamptite installation system at the factory under controlled conditions.
- C. Fasteners: 300 series stainless steel screws for aluminum clamptite installation system, excluding final fasteners to the building.
- D. Finish:
 - 1. Manufacturer's factory applied finish, which meets the performance requirements of AAMA 2604. Color to be selected from manufacturer's standards.
 - 2. Anodized .

PART 3 EXECUTION

3.01 EXAMINATION

- A. Installer shall examine substrates, supporting structure, and installation conditions.
- B. Do not proceed with panel installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Metal Protection:
 - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by sealant manufacturer for this purpose.
 - 2. Where aluminum will contact concrete, masonry, or pressure treated wood, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by sealant manufacturer.

3.03 INSTALLATION

- A. Install the panel system in accordance with the manufacturer's fabrication drawings and suggested installation instructions.
 - 1. Anchor component parts securely in place by permanent mechanical attachment system.
 - 2. Accommodate thermal and mechanical movements.
 - 3. Seal aluminum clampite installation system as shown on the manufacturer's fabrication drawings and suggested installation instructions.
- B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturers fabrication drawings and suggested installation instructions.

3.04 FIELD QUALITY CONTROL

- A. Water Test: Installer to test a representative section of installed materials according to procedures in AAMA 501.2.
- B. Repair or replace work that does not pass testing or that is damaged by testing and retest work.

3.05 CLEANING

- A. Clean the panel system, interior and exterior, immediately after installation.
- B. Refer to manufacturer's written recommendations.

END OF SECTION

SECTION 08 63 63

FALL PROTECTION SKYLIGHTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies fall protection skylights.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
OSHA	Occupational Health and Safety

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00
- B. Provide the following submittals:
1. Shop drawings showing skylight cross sections and installation details.
 2. Manufacturer's product data including test results demonstrating fall protection performance.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.

1.06 SPECIAL WARRANTY

- A. 5-year manufacturer's standard warranty against defects in material or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
1. American Skylites.
 2. Wasco Products.
 3. VELUX.
 4. Approved Equal.

2.02 FEATURES

- A. Units shall be factory assembled polycarbonate sheet heat formed double dome.
- B. Bronze anodized retaining frame and extruded curb frame with integral condensation and weepage gutter.

- C. Seattle Energy Code Compliance:
 - 1. U-factor shall be 0.45 or lower.
 - 2. SHGC shall be 0.32.
 - 3. U-factor and SHGC shall be rated in accordance with NFRC 100.
- D. Glazing Color:
 - 1. Outer Layer: Bronze.
 - 2. Inner Layer: Clear.
- E. Comply with OSHA 29 CFR 1910.29(e)(1) and 1926.502(i)(2).

2.03 FLASHING

- A. Specified in Section 07 62 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. Installation shall be in accordance with manufacturer's instructions for the conditions shown on the Drawings.
- B. Use skylight curb tape in all skylight installations.
- C. All installations shall be made water-tight.

3.03 FIELD QUALITY CONTROL

- A. Field Testing:
 - 1. Upon completion of the installation, perform a leakage test over all surfaces of each skylight.
 - 2. All testing shall occur in the presence of the Project Representative.
 - 3. The Project Representative shall be given five working days advanced notice of the testing to allow for proper scheduling.
 - 4. The leakage test shall consist of water spraying the entire surface of the skylight in an even manner with a garden-type hose nozzle for a minimum period of 10 minutes. The maximum distance between the skylight and the nozzle shall be 25 feet.
 - 5. At the conclusion of the test, there shall be no visible trace moisture found on any interior surface of the skylight. If trace moisture is found, correct the faulty work and re-test.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies finish hardware for doors.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
SBC	Seattle Building Code
IBC	International Building Code
DHI	Door and Hardware Institute
NFPA 101	Life Safety Code
BHMA A156.1	Butts and Hinges
BHMA A156.3	Exit Devices
BHMA A156.6	Architectural Door Trim
BHMA A156.16	Auxiliary Hardware
BHMA A156.21	Thresholds

1.03 DEFINITIONS

- A. AHC: Architectural Hardware Consultant, certified by DHI.
- B. BHMA: Builders Hardware Manufacturers Association.
- C. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 2. Installer and applicator are synonymous.
- D. All weather: Capable of operation from -50 to +120 Deg F.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Finish Hardware:
1. A complete schedule of finish hardware.
 2. Details including quantities, stock numbers, finishes and sizes.
 3. List each opening separately.
 4. A horizontal or coded form of schedule will not be accepted.
- C. Keying Schedule.
- D. Catalog cuts.
- E. As-built hardware schedule.
- F. Manufacturer's operations and maintenance information.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Marking:

1. Pack hardware items in their original factory shipping cartons.
2. Mark each item of hardware individually for each opening as to location of installation in accordance with approved hardware schedule.

PART 2 PRODUCTS

2.01 GENERAL

A. Fabrication:

1. Exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of other work as closely as possible.
2. Provide concealed fasteners unless thru bolted.
3. Through-bolt closers on all doors.
4. Furnish hardware for proper door swing.
5. Furnish lock devices which allow door to be opened from inside room without a key or any special knowledge, ANSI F84 Classroom Function.

B. Butt hinges:

1. Acceptable Manufacturers:
 - a. McKinney.
 - b. Ives.
 - c. Approved Equal.
2. Types: as listed under Hardware Groups:
 - a. BHMA A156.1.
 - 1) A5111: Stainless steel, 5 knuckle, full-mortise, heavy bearing, Grade 1.
 - b. Ball bearings.
 - c. Flat button tips.
 - d. Non-removable pins.
 - e. Full mortise.
3. Size: 4.5 IN X 4.5 IN. for doors up to 46 IN wide.
4. Quantities:
 - a. Doors under 84 inches: three butts per leaf.
 - b. Doors over 84 inches: one butt added for each 30 inches of height.

C. Lockset and Cylinder Housing:

1. Provide construction cores. Owner will install permanent cores at close out.
2. Door Hardware to be compatible with Stanley Best 6 pin Best Cores.

D. Trim:

1. Acceptable Manufacturer:
 - a. Corbin Russwin
 - b. Allegion
 - c. Approved Equal.
2. Type: Designed to work with Exit Device

E. Exit Device:

1. Acceptable Manufacturer:
 - a. Corbin Russwin
 - b. Allegion
 - c. Approved Equal.
2. Type:
 - a. A156.3 Panic-listed push pad rim exit device
 - b. Deadlocking style latch bolt
 - c. Escutcheon Lever Trim

- d. Nut and bolt hex fasteners (SNB)
 - e. Surface mounted 3/8" diameter roller strike.
- F. Closers:
 - 1. Acceptable Manufacturer:
 - a. Corbin Russwin
 - b. Allegion
 - c. Approved Equal.
 - 2. Types:
 - a. Body: Cast iron.
 - b. BHMA A156.3 Grade 1 heavy duty surface mount.
 - c. Arms and piston: Heavy duty parallel, non-hold open arm
 - d. Manufacturer's standard plastic cover.
 - e. Manufacturer's standard ten year warranty for mechanical defects.
 - f. Hex nut and bolt type fastening.
 - g. Integral back check.
 - h. Provide all weather fluid for all closers used in exterior doors.
 - i. Nut and bolt hex fasteners (SNB)
 - j. Functions as listed in the Hardware Group.
- G. Door Stops and Overhead Stops:
- H. Latch guards:
- I. Kickplates:
 - 1. Acceptable Manufacturer:
 - a. Rockwood K1050 10 X 34 630
 - b. Ives 8400 S32D 10 X 34
 - c. Approved Equal.
 - 2. Types:
 - a. BHMA A156.6.
 - b. 0.050 IN stainless steel with full threaded screws.
 - c. 10 inches high and 2 inches less than door width.
 - d. Beveled on all edges.
- J. Threshold:
 - 1. Acceptable Manufacturer:
 - a. Pemko
 - b. Allegion
 - c. Approved Equal.
 - 2. Types:
 - a. BHMA A156.21.
 - b. Mill finish aluminum 5 IN wide x 36 IN long saddle.
 - c. Provide required bolt cutouts.
 - d. Comply with types and functions listed under specific Hardware Groups.
- K. Door Bottom Sweep:
 - 1. Acceptable Manufacturer:
 - a. Pemko.
 - b. Allegion.
 - c. Approved Equal.
 - 2. Types:
 - a. Aluminum, face mount, 36 IN long, with vinyl sweep insert.
- L. Overhead Rain Drip Cap:
- M. Perimeter Gasket:

1. Acceptable Manufacturer:
 - a. Pemko.
 - b. Allegion.
 - c. Approved Equal.
2. Types:
 - a. Aluminum frame, silicone, 36 IN W x 84 IN H.

N. Silencers:

1. Acceptable Manufacturer
 - a. Hollow frames:
 - 1) Trimco 1229A
 - 2) Rockwood 608.
 - b. Self-adhesive silencers permitted if required by FRP door manufacturer.
 - c. Approved Equal.

O. Manual Flush Bolts:

P. STC sound reduction gaskets:

2.02 HARDWARE FINISHES

- A. Hardware Finishes as follow. Deviations from the listed finishes are called out next to the specific items involved under the Hardware Groups:
1. Butt hinges: US32D.
 2. Locksets: US32D.
 3. Strikes: US32D.
 4. Trim: US32D.
 5. Latch Guards: US32D.
 6. Concealed Flush Bolts, Head and Sill: US32D
 7. Exit devices: US32D.
 8. Push plates, pulls: US32D.
 9. Closers: 689/SBL-P.
 10. Kickplates: US32D.
 11. Thresholds: Mill, Alum.
 12. Door bottom sweeps: US28.
 13. Overhead Drip Caps: US28.
 14. Perimeter Gaskets: Mill, Alum.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Ensure proper installation and operation of hardware in locations specified.
- B. Protect exposed hardware surfaces during construction from damage.
- C. Fasteners: provide hardware with proper fasteners to meet conditions of the work.

3.02 MOUNTING LOCATIONS

- A. As recommended by the manufacturer.
- B. Measurements are from finish floor except top butt hinge:
 1. Butt hinges:
 - a. Top: 11-3/4 inches center of butt hinge to top of door.
 - b. Intermediate: Equal distance between top and bottom butt hinges.
 - c. Bottom: 13 inches center of butt.
 2. Lever Locks: 40-5/16 inches to center of strike.

3. Exit Devices: 40-5/16 inches to center of strike.
4. Door Closers: Per manufacturer's instructions.

3.03 ADJUSTMENTS

- A. Adjust moving parts to operate satisfactorily at time of substantial completion and during warranty period.
- B. Take into consideration wind conditions or mechanical ventilation systems when adjusting.
- C. Test and adjust closers for complete, silent, and smooth operation.
- D. Test and adjust locks and latches for smooth and easy operation.

3.04 HARDWARE GROUPS

- A. Refer to door schedule and previously listed instructions for related information concerning the following hardware groups:

Hardware Group -1 [Restroom 400]

Door Shall Have:	Hardware description
3	Butt Hinges
1	Privacy Lock
1	Escutcheon Lever Trim inside and outside
1	Kickplate
1	Closer
1	Wall Stop
1	Perimeter gasket

Hardware Group -2 [Janitor 401]

Door Shall Have:	Hardware description
3	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Store Room Lock
1	Kickplate
1	Wall Stop
1	Closer
1	Perimeter gasket

Hardware Group -3 [Exterior Main Entry 404]

Each Door Shall Have:	Hardware description
3	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Lockset
1	Exit Device
1	Overhead Stop
1	Kickplate

1	Closer
1	Threshold
1	Door bottom sweep
1	Perimeter gasket

Hardware Group -4 [Control Panel Access 407]

Each Door Shall Have:	Hardware description
3	Butt Hinges
2	Escutcheon Lever Trim each side
1	Store Room Lock
1	Kickplate
1	Overhead Stop
1	Closer
1	Perimeter gasket

Hardware Group -5 [Exterior South / North Battery Room 408, 409]

Each Door Shall Have:	Hardware description
3	Butt Hinges
1	Escutcheon Lever Trim interior side
1	Keyed Mortise Lock, Always Locked
1	Exit Device
1	Kickplate
1	Overhead Stop
1	Closer (on inside of door)
1	Threshold
1	Door bottom sweep
1	Perimeter gasket

Hardware Group -6 [Breakroom 410]

Each Door Shall Have:	Hardware description
3	Butt Hinges
2	Escutcheon Lever Trim each side
1	Latch
1	Kickplate
1	Closer
1	Wall Stop
1	Perimeter gasket

Hardware Group -7 [Exterior Pair Electrical Room Doors 411-1, 411-2]

Each Door Shall Have:	Hardware description
6	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Exit Device
1	Mortise Lockset
1	Concealed Flush Bolts, Head and Sill
2	Kickplate
2	Closer
2	Overhead Stops
1	Threshold (double doors)
2	Door bottom sweep
1	Overhead Drip Caps: (double doors)
1	Perimeter gasket (double doors)

Hardware Group -8 [Exterior NW Vestibule Door 412-2]

Each Door Shall Have:	Hardware description
3	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Exit Device
1	Mortise Lockset
1	Kickplate
1	Closer
1	Overhead Stop
1	Threshold
1	Door bottom sweep
1	Overhead Drip Cap
1	Perimeter gasket

Hardware Group -9 [Exterior NE Vestibule Door 412-3]

Each Door Shall Have:	Hardware description
3	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Exit Device
1	Kickplate
1	Closer

1	Overhead Stop
1	Threshold
1	Door bottom sweep
1	Overhead Drip Cap
1	Perimeter gasket

Hardware Group -11 [Tool Room 416]

Each Door Shall Have:	Hardware description
3	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Exit Device
1	Latch Set
1	Kickplate
1	Closer
1	Overhead Stop
1	Perimeter gasket

Hardware Group -12 [Airway 424]

Each Door Shall Have:	Hardware description
2	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Lockset
1	Closer
1	Perimeter gasket

Hardware Group -13 [Pump Room, Stair 429-1, 429-2]

Each Door Shall Have:	Hardware description
3	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Exit Device
1	Kickplate
1	Closer
1	Wall Stop
1	Perimeter gasket

Hardware Group -14 [Exterior Sampling Enclosure 431]

Each Door Shall Have:	Hardware description
3	Butt Hinges
1	Escutcheon Lever Trim exterior side
1	Exit Device
1	Closer
1	Overhead Stop
1	Threshold
1	Door bottom sweep
1	Perimeter gasket

3.05 COMPLETION

- A. Provide an as-built hardware schedule when all hardware installation is complete.

END OF SECTION

SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies glazing.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on and Iron and Steel Products
ASTM C1036	Standard Specification for Flat Glass
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM Z97.1	Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test
ANSI	American National Standards Institute
CPSC -16 CFR Part 1201	Consumer Product Safety Commission – Safety Standard for Architectural Glazing Materials
FGMA	Glazing manual published by Flat Glass Marketing Association, hereinafter referred to as FGMA; White Lakes Professional Bldg.; 3310 S.W. Harrison; Topeka, Kansas 66611; (913) 266-7013.
NFPA 80	Standard for Fire Doors, Fire Windows
SIGMA	Sealed Insulating Glass Manufacturers Association
UBC 2406	Safety Glazing
UL 263	Fire Tests of Building Construction and Materials

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Shop drawings.
- C. Product data for each product specified.
- D. Samples for each product specified.
- E. Manufacturer's installation instructions.
- F. Instructions for use of setting and sealing materials.
- G. Maintenance information.
- H. Sample and Final Warranty.

1.04 COORDINATION

- A. Coordinate with other trades affecting or affected by work of this Section.

1.05 REGULATORY REQUIREMENTS

- A. Comply with safety glazing requirements of IBC or local authority.

1.06 PRODUCT DELIVERY

- A. Provide original labels, showing manufacturer, quality, and thickness for each piece of glass. Where labels must be removed for glass cutting, save labels for Project Representative's review.
- B. Deliver other glazing materials in original containers with legible manufacturer's original labels.

1.07 ENVIRONMENTAL CONDITIONS

- A. Do no glazing when temperature is below 40 degrees F, when dust is present, or during wet weather except under cover.

1.08 WARRANTY

- A. Furnish the following extended warranties:
 - 1. Exterior glazing against air and water infiltration: 2 years.
 - 2. Insulating glass against edge seal failure: 5 years.

PART 2 PRODUCTS

2.01 FLOAT GLASS

- A. Acceptable manufacturers:
 - 1. Guardian Glass.
 - 2. Libbey, Owens, Ford.
 - 3. Saint-Gobain.
 - 4. Pittsburgh Plate Glass.
 - 5. Approved Equal.
- B. Manufacturing standard: ASTM C1036.
- C. Quality: Glazing select.
- D. Thickness: As shown in glass type schedule, on Drawing or as required by building code.

2.02 FIRE RESISTIVE GLASS

- A. Fire rated, impact safety-rated transparent wall panels:
 - 1. Meets ASTM E119 and UL 263.
 - 2. Fire-resistance ratings:
 - a. 60-minute fire rated.
 - 3. Shape, surface texture as selected by Owner:
 - 4. 7/8 inch nominal thickness.
 - 5. Daylight transmission 87%.
 - 6. STC rating 41.
 - 7. Maximum exposed area: 5,616 sq. in. (96" width or height).
 - 8. Acceptable manufacturers:
 - a. Pilkington, 60-101.

- b. Approved Equal.
- B. Aluminum frame:
 - 1. Meets ASTM E119 and UL 263.
 - 2. Fire-resistance ratings.
 - a. 60-Minute fire rated.
 - 3. Acceptable manufacturers:
 - a. Fireframes, Heat Barrier Series Frames.
 - b. Approved Equal.

2.03 INSULATING GLASS

- A. Manufacturing standard: SIGMA CB.
- B. Edge material: Sealant conforming to ASTM E-6-P3.
- C. Glass layers: 2.
- D. Air Inter-space: 1/2-inch, minimum.
- E. Glass type: Float glass.

2.04 TEMPERED GLASS

- A. Safety Performance Standard: CPSC -16 CFR Part 1201-C11.
- B. Type: Tong-free.

2.05 GLASS COLOR AND PATTERN

- A. Clear and smooth, unless otherwise specified herein.

2.06 SETTING BLOCKS

- A. Material: Unless otherwise indicated, EPDM or Neoprene Rubber.
- B. Shore A durometer hardness: 80-90.
- C. Width: 1/8 inch wider than glass unit to be supported and 1/16 to 1/8 inch narrower than glazing pocket.
- D. Length: Sufficient to support glass unit without excessive pressure on glass edge.

2.07 GLAZING COMPOUND

- A. Acceptable manufacturers:
 - 1. Gibson-Homans.
 - 2. PTI.
 - 3. Pacific Putty.
 - 4. 3-M.
 - 5. Norton.
 - 6. Approved Equal.
- B. For hollow steelwork: Butyl tape bedding with butyl caulking.
- C. For woodwork: Latex caulking.

- D. For insulating glass: Type compatible with edge sealant and recommended by insulating glass fabricator.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that openings to be glazed are accurately sized, shaped and located, and free of fasteners and other projections which will interfere with glazing.
- B. Verify that weep system is open.
- C. Verify that glazing surfaces are free of moisture, dirt, grease, oil or other deleterious material.
- D. Verify that steel or wood glazing rabbets and contacting dissimilar materials are painted.
- E. Do not start work until conditions are satisfactory.

3.02 PROTECTING WORK OF OTHER SECTIONS

- A. Protect against damage and discoloration caused by work of this Section.

3.03 PREPARATION

- A. Prior to starting work, clean, dry, and remove protective coatings from glass and surfaces to be glazed.

3.04 INSTALLATION

- A. Follow referenced Specifications and manufacturer's recommendations.
- B. Allow for glass expansion and contraction.
- C. Do not impact glass against framing.
- D. Install glass with setting blocks placed at sill quarter points.
- E. Do not set glass flares or bevels adjacent to setting blocks.
- F. Install glass surface waves running horizontal.
- G. Shift glass with suction cups; do not use pry bar.
- H. Remove identity labels immediately after installation; save for Project Representative's review.
- I. Install channel glass units, plumb, level, square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction and adjacent surfaces.
 - 1. Erect framing, vinyl spacer, and glass in accordance with manufacturer's printed installation instructions. Clean glass immediately before installing. Protect or seal all installed glass units daily on both sides of glass, between frame and glass, and between linear glass units to prevent infiltration of airborne debris.
 - 2. Perimeter Joint Sealant: Insure compatibility of joint components and adhesion of perimeter joint sealant to surfaces that receive sealant.
 - 3. Erection Tolerances – Framing Members:
 - a. Limit variations of jambs from plumb and horizontal frame members from level:
 - 1) 1/8 inch in 12 feet.
 - 2) 1/8 inch in 20 feet.

- b. Limit variations from Theoretical Locations: 1/4 inch for any member at any location.
 - c. Limit Offsets in End-To-End and Edge-To-Edge Alignment: 1/32 inch.
 - d. Maximum out of plane offset for horizontal and vertical glazing legs of framing members designed to be in the same plane.
4. Install in continuous lengths.

3.05 CLEANING

- A. Remove excess glazing compound from glazing and adjacent surfaces.
- B. Final glass cleaning specified in Section 01 74 23.
- C. Remove debris from project site upon work completion or sooner, if directed.
- D. Including work of other trades, clean, repair and touch-up, or replace when directed, products that have damage and discoloration caused by the work.

3.06 PROTECTION

- A. Protect installed glazing against breakage and staining.
- B. Identify glazed areas with streamers hanging from framing. Do not apply directly to glass.
- C. Prohibit material storage close enough to glass to create sufficient heat trap to cause glass breakage.

END OF SECTION

SECTION 08 90 00
LOUVERS AND VENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies aluminum louvers, frames, and accessories.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AMCA 500-L	Laboratory Methods of Testing Louvers for Rating 2012 (Reapproved 2015).
AMCA 511	Certified Ratings Program Product Rating Manual for Air Control Devices 2021.
ASTM A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

1.03 SUBMITTALS

- A. Procedures: Section 01 30 00.
- B. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.
- C. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, and tolerances; head, jamb and sill details; blade configuration, screens, blank-off areas required, and frames.
- D. Test Reports: Independent agency reports showing compliance with specified performance criteria.

1.04 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36. .
- B. Provide five year manufacturer's warranty against distortion, metal degradation, and connection failures of louver components.
- C. Finish: Include twenty year coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Louvers:
1. Construction Specialties, Inc; Acoustical Louver.
 2. Ruskin Company; Louvers.
 3. Approved Equal.

2.02 LOUVERS

- A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories.
 - 1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf (of 1.2 kPa) without damage or permanent deformation.
 - 2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft (3.1 g/sq m) water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
 - 3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
 - 4. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers. Inside mounted. ½ inch mesh.
 - 5. Finish: AA-M1022A41, clear anodized.
- B. Fixed Louver
 - 1. Frame: Extruded aluminum channel, 0.081 inch thick, 4 inches deep, with concealed mullions.
 - 2. Blades: Extruded aluminum, 0.081 inch thick, Z-shaped, 35 degrees to 45 degree pitch angle, spaced 3 inches to 4.25 inches on center.
 - 3. Pressure loss: AMCA certified rating of no greater than 0.10-in WC.
 - 4. Products:
 - a. Construction Specialties, Model 4110.
 - b. Dowco, Series LED-4.
 - c. Ruskin, Model ELF-375DXH.
- C. Adjustable Louver
 - 1. Frame: Extruded aluminum channel, 12-gauge B & S, 4 inches deep, with interior duct collars and support frame, and linkage suitable for attachment of motorized operator.
 - 2. Blades: Extruded aluminum, Z-shaped, minimum 0.081 inch thick, with vinyl gasketing on edges and nylon bearing guides.
 - 3. Pressure Loss: AMCA certified rating of no greater than 0.10 inch WC.
 - 4. Screen: Inside mounted aluminum.
- D. Transom Louver
 - 1. Frame: Extruded aluminum, 0.051 inch thick, 2 inches deep.
 - 2. Blades: Extruded aluminum, Z-shaped, stormproof, spaces 2 inches apart, 45 degree pitch angle.
 - 3. Pressure Loss: AMCA certified rating of no greater than 0.10 inch WC.
 - 4. Screen: Inside mounted aluminum, ½ inch mesh.
 - 5. Products:
 - a. Construction Specialties, Model 2251.
 - b. Dowco, Series LEZ-2.

2.03 ACCESSORIES

- A. Blank-Off Panels: Same material as louver, painted black on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.
- B. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.
- C. Insect Screen: 18 x 16 size aluminum mesh.
- D. Flashings: Of same material as louver frame, formed to required shape, single length in one piece per location.

- E. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.
- F. Coating: Where aluminum is in direct contact with concrete, coat the aluminum with coating system B-3, as specified in specification 09 90 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared openings and flashings are ready to receive this work and opening dimensions are as indicated on shop drawings.
- B. Verify where any aluminum will be in direct contact with concrete that the aluminum is coated with B-3 coating.

3.02 INSTALLATION

- A. Install louver assembly in accordance with manufacturer's instructions.
- B. Install louvers level and plumb.
- C. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- D. Secure louver frames in openings with concealed fasteners.

END OF SECTION

SECTION 09 06 90
SCHEDULES FOR PAINTING AND COATING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies finishes and colors for rooms, equipment and other items which are to be painted, coated, or have other architectural finishes.
- B. Other painting and coating finishes for rooms, equipment and other items not listed in this Section can be found in the Drawings and other specification Sections.

1.02 QUALITY ASSURANCE

- A. Referenced Standards: Federal Standard 595 Paint Specification.
- B. General: Unless otherwise specified, all materials and workmanship shall conform to the applicable requirements of Section 09 90 00.
- C. The Project Representative reserves the right to reselect any color, from the manufactures full range of available colors, during the submittal process. In case of conflict between requirements of this Section and the specified or listed documents, the requirements of this Section shall prevail.
- D. Onsite storage of paint waste materials is to be minimized.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. In the following schedule, the coating system for each specified surface shall comply with those listed in COATSPEC, Section 09 90 00. Coat surfaces indicated on this schedule unless specifically noted otherwise on the Drawings or in the Specifications. Color reference numbers are from the Federal Standard 595 Paint Spec.
- B. Special Equipment Colors: Paint equipment and piping as indicated, except as itemized below:
 - 1. Fire Protection Equipment, Pipes and Apparatus: OSHA Red.
 - 2. Physical hazards in normal operating area and energy lockout devices, included but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.
- C. Electrical conduit is not painted if coated with PVC or specifically noted otherwise on the Drawings or in the Specifications.

3.02 FINISH SCHEDULES

The following schedule covers surfaces not addressed in the Finish/ Coatings Schedule of the Drawings as well as coating callouts within the other specifications.

Surfaces	Service Environment	Coating System	Color
Miscellaneous metal-equipment, exposed conduit, piping, utilities, etc.	Submerged	A-1	# 36270

Surfaces	Service Environment	Coating System	Color
All Post-Installed Concrete Anchors) (Section 05 05 19)	All	None, unless indicated on the Drawings	N/A
All Metal Fastenings (Section 05 05 23)	Interior/Exterior	C-1	Match Adjacent Surface
All Cast-In Concrete Anchors (Section 03 15 19)	All	None, unless indicated on the Drawings	N/A
All Steel Decking (Top of Deck) (Section 05 31 00)	All	None, unless indicated on the Drawings	
Cold-Formed Steel Framing (Section 05 41 00)	All	None, unless indicated on the Drawings	
Miscellaneous concrete	Submerged	A-2	# 36270
Interior of RSP Discharge Piping	Submerged, Process Corrosive	A-4 ^A	# 36270
Interior of Formed Suction Inlet	Submerged, process corrosive, higher abrasion is expected in this area.	A-5	Light Blue
Miscellaneous metal-equipment, exposed conduit, piping, utilities, etc.	Interior wet, interior dry	B-1	# 34089
Miscellaneous concrete-dry wells, wash down areas	Interior wet	B-1	# 33711
Aluminum in contact with concrete or dissimilar metal	--	B-3	
Miscellaneous metal-equipment, exposed conduit, piping, utilities.	Outdoor	C-1	# 36270
Metal exhaust manifold, engine exhaust piping, and exterior surfaces of steel and stainless steel piping under insulation.	Temperature to 600 degrees F, continuously.	H-1	To be selected.
Concrete Floors	See Drawings	See Drawings	See Drawings
Concrete, gypsum board, and as shown or specified	Interior	L-1a	# 33711
Aluminum, including flashings, doors, louvers, frames, and site accessories	Interior/Exterior	Anodize	To be selected.

For Special Equipment Colors see 3.01B.

A – Finish schedule for RSP discharge piping to be A-4 if an epoxy finish is used. Alternatively, Contractor may use Geopolymer coating system per Section 33 01 30.71.

END OF SECTION

SECTION 09 20 00
PLASTER AND GYPSUM BOARD

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies metal stud wall framing, metal channel ceiling framing, acoustical insulation, gypsum board, gypsum sheathing, cementitious backer board and taped and sanded joint treatment.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C36	Specification for Gypsum Wallboard
ASTM C79	Specification for Treated Core and Nontreated Core Gypsum Sheathing
ASTM C645	Specification for Non Structural Steel Framing Membranes
ASTM C754	Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
GA-201	Gypsum Board for Walls and Ceilings
GA-216	Recommended Specifications for the Application and Finishing of Gypsum Board
IBC	International Building Code

- B. Perform work in accordance with the Gypsum Association Specification GA-201, GA-216 and ASTM C754.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.

1.04 SITE CONDITIONS

- A. During cold weather, in areas receiving gypsum board installation, maintain temperature range between 55 to 70 degrees F for 24 hours before, during and after gypsum board and joint treatment application.
- B. Provide ventilation during and following adhesives and joint treatment application:
1. Use temporary air circulators in enclosed areas lacking normal ventilation.
 2. Allow additional drying time between coats of joint treatment under slow drying conditions.
 3. Protect installed materials from drafts during hot, dry weather.

PART 2 PRODUCTS

2.01 METAL FRAMING MATERIALS

- A. Studs and Tracks:
1. ASTM C645.
 2. 25-gage or 20-gage, as indicated.
 3. For exterior use.
 4. In widths shown.
 5. Sheet steel formed with:
 - a. A flange, 1 1/4-inch.

- b. A knurled face.
 - c. Knock-out pass-through holes.
- 6. Galvanize to G60 or electro-galvanized.

B. Furring Channels:

- 1. ASTM C645.
- 2. 25-gage.
- 3. Sheet steel formed to a hat shape with:
 - a. Depth: 7/8-inch.
 - b. A knurled face.
- 4. Galvanize to G60 or electro-galvanized.

2.02 GYPSUM BOARD MATERIALS

A. Gypsum Board:

- 1. ASTM C36.
- 2. 5/8-inch.
- 3. Ends square cut, taper-edges.
- 4. Supply in 48-inch widths and in such lengths as will result in a minimum of joints.

B. Fire Rated Gypsum Board:

- 1. ASTM C36.
- 2. Fire resistive type, UL-rated.
- 3. 5/8-inch.
- 4. Ends square cut, taper-edges.
- 5. Supply in 48-inch widths and in such lengths as will result in a minimum of joints.

C. Gypsum Sheathing Board:

- 1. ASTM C79.
- 2. Moisture resistant type.
- 3. 5/8-inch.
- 4. Ends square cut, square edges.
- 5. Water repellent paper faces.
- 6. Supply in 48-inch widths and in such lengths as will result in a minimum of joints.

D. Cementitious Backing Board:

- 1. High density.
- 2. Glass fiber reinforced.
- 3. 1/2-inch thick.
- 4. 2 inches wide coated glass fiber tape for joints and corners.

E. Water-Resistant Gypsum Board:

- 1. ASTM C1396.
- 2. Mold-resistant.
- 3. 5/8-inch
- 4. Fire resistive type, UL-rated.

2.03 ACCESSORIES

A. Adhesives:

- 1. GA-201 and GA-216; types recommended in writing by the manufacturer.
- 2. Adhesives containing asbestos fibers are not permitted.
- 3. Joint and fastener concealment:
 - a. Embedding compound for first and second coats.
 - b. Finishing compound for final coat.

- B. Fasteners:
 - 1. GA-216.
 - 2. Screws for board attachment: shouldered flathead design for use with special power-driven tools.
 - 3. Metal screws: not less than 1-inch long with self-tapping threads and self-drilling points.
- C. Metal Trim:
 - 1. GA-201 and GA-216.
 - 2. Zinc-coated steel not lighter than 26-gage.
 - 3. Metal trim shall be in one of the following shapes and sizes:
 - a. Casing beads:
 - 1) Channel shaped with a concealed wing not less than 7/8-inch wide and an exposed wing.
 - 2) Exposed wing may be covered with paper cemented to metal and shall be suitable for joint treatment.
 - b. Corner beads:
 - 1) Angle-shaped with wings not less than 7/8-inch wide and perforated for nailing and joint treatment or with combination metal and paper wings bonded together.
 - 2) Not less than 1-1/4 inches wide and suitable for joint treatment.
 - c. Edge beads for use at perimeter of ceilings:
 - 1) Angle-shaped with wings not less than 3/4-inch wide.
 - 2) Concealed wing shall be perforated for screwing and exposed wing edge folded flat.
 - 3) Exposed wing may be factory finished in a white color.
- D. Reinforcing Tape: As recommended in writing by the manufacturer of the wallboard.

PART 3 EXECUTION

3.01 METAL STUD INSTALLATION

- A. General:
 - 1. Install studs, furring channels, and steel ceiling channels true vertical and level.
 - 2. Install ceilings to meet IBC requirements for suspended ceiling systems in local area.
 - 3. Studs:
 - a. Unless otherwise indicated, install at 24 inches on center, in a floor and ceiling track.
 - b. Secure tracks with powder-driven pins at 24 inches on center.
- B. Furring Channels:
 - 1. Install on walls at 24 inches on center and secure to the wall at 24 inches on center.
 - 2. Unless otherwise indicated, secure furring channels for ceilings to the steel channel with 9-gage wire clips at 24 inches on center.

3.02 BOARD INSTALLATION

- A. Install gypsum board in accordance with GA-201 and GA-216.
- B. Erect single layer standard gypsum board to minimize joints, with ends and edges occurring over firm bearing.
- C. Erect single layer fire rated gypsum board vertically, with ends and edges occurring over firm bearing.
- D. Erect exterior gypsum sheathing horizontally, with edges butted tight and ends occurring over firm bearing.
- E. Use screws when fastening gypsum board to metal furring or framing.
- F. Place corner beads at external corners. Use longest practical length. Place edge trim where gypsum board abuts dissimilar materials and as indicated.

- G. Install backing board over substrate in accordance with manufacturer's instructions.
- H. Control joints:
 - 1. Form control joints of casing bead trim installed back-to-back over separate framing or furring members.
 - 2. Maintain a spacing of 3/16-inch between opposite beads.
 - 3. Place control joints consistent with lines of building spaces or as indicated.

3.03 JOINT TREATMENT

- A. Tape, fill and sand exposed joints, edges and corners to produce smooth surface ready to receive finish.
- B. Feather coats onto adjoining surfaces so that camber is maximum 1/32-inch.

3.04 TOLERANCES

- A. Maximum variation of finished gypsum board surface from true flatness: 1/8-inch in 10 feet.

END OF SECTION

SECTION 09 30 13

CERAMIC TILING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies ceramic tile, base and wall finish.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/TCA A136.1	Installation of Ceramic Tile
ANSI/TCA A118.3	Chemical Resistant, Water-Cleanable Tile Setting and Grouting Epoxy and Water-Cleanable Tile Setting Epoxy Adhesive
ANSI A118.4.	Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive
TCA	Tile Council of America Handbook for Ceramic Tile Installation

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. 12-inch square samples of materials.

1.04 QUALITY ASSURANCE

- A. Installer: Company specializing in applying the work of this Section with documented experience.
- B. Comply with provisions of TCA Handbook for Ceramic Tile Installation.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in their original containers with seals unbroken and manufacturer's name and product identification clearly legible on each package.
- B. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Maintain minimum temperature of 50 degrees F during installation of mortar materials.
- B. Do not install adhesives in a closed, unventilated environment.

PART 2 PRODUCTS

2.01 TILE MATERIALS

- A. Provide end products of one manufacturer in order to achieve standardization for appearance, maintenance and replacement.
- B. Acceptable Manufacturer:
 - 1. American Olean Tile Co.
 - 2. Dallas Ceramic Co.
 - 3. Interpace.
 - 4. Summitville Tiles, Inc.
 - 5. DAL Tile.
 - 6. Approved Equal.
- C. Uniform Concrete Tile:
 - 1. Locations: Walls in Restroom and Janitors.
 - 2. Size: 12 inch x 24 inch.
 - 3. Finish: See drawing interior elevations, WP704-A-40002

2.02 SETTING MATERIALS

- A. Organic adhesive:
 - 1. ANSI/TCA A136.1, Type 1.
 - 2. Prolonged water resistance.
- B. Thinset mortar:
 - 1. ANSI/TCA A118.3, Formula 759.
 - 2. Gray.

2.03 GROUT MATERIALS

- A. Portland cement grout with latex additive.
- B. Resistant to shrinking.
- C. ANSI A118.4.

2.04 ACCESSORIES

- A. Sealant: Per Section 07 92 00.
- B. Sealer:
 - 1. Hillyard Chemical Co. - Cemseal II.
 - 2. Thompson's Water Seal 101.
 - 3. Approved Equal.
- C. Cleaner: Neutral tile cleaner solution acceptable to tile manufacturer.

2.05 GROUT MIX

- A. Mix and proportion setting bed and grout materials in accordance with manufacturer's instructions.
- B. Color should match the existing. The Contractor shall submit a sample for approval.

2.06 CURING PAPER

- A. Non-staining reinforced Kraft paper.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Verify that surfaces are ready to receive work.
- B. Protect surrounding work from damage or disfiguration.
- C. Vacuum clean existing surfaces and damp clean.
- D. Correct defects or adverse conditions affecting quality and execution of tile installation.
- E. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- F. Install grounds, anchors, plugs, hangers, bucks, electrical and mechanical work in or behind tile, prior to proceeding with tile work.

3.02 INSTALLATION

- A. Wall tile applied to backing board:
 - 1. Set tile in organic adhesive.
 - 2. TCA Method W223.
- B. Cut and fit tile tight to penetrations:
 - 1. Form corners and bases neatly.
 - 2. Align floor, base and wall joints.
- C. Grout tile joints. Make joints watertight without voids, cracks, excess mortar or excess grout.
- D. Apply sealant to junction of tile and dissimilar materials and at junction of dissimilar planes.
- E. Curing paper:
 - 1. Apply with perimeter and laps sealed.
 - 2. Maintain paper in perfect condition for a minimum of 5 days.

3.03 CLEANING

- A. Clean with clean water promptly during progress of work so as to minimize final cleaning.
- B. Do not leave mortar scum to dry on tile faces.

END OF SECTION

SECTION 09 51 13
ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies acoustical ceiling lay-in panels and support system, including lay-in panels and suspended metal grid system complete with wall and bulkhead trim.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C635	Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
ASTM C636	Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
Fed Spec SS-S-118B	Sound Controlling (Acoustical) Panels and Tiles
UBC Standard 47-18	

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's data for tile.
 2. Samples: 3 samples of each type of acoustical unit.
 3. Submit the anchorage design in accordance the requirements of 01 73 00.

1.04 QUALITY ASSURANCE

- A. Seismic Analysis
1. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 2. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.05 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation, and to protect the work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturer:
 - 1. Armstrong Cork Company.
 - 2. Celotex Corporation.
 - 3. Conwed Corporation.
 - 4. United States Gypsum Company.
 - 5. Approved Equal.

2.02 ACOUSTICAL CEILINGS

- A. Exposed suspended grid:
 - 1. General: Panel manufacturer's suspended exposed tee directly hung from the structure above and in accordance with requirements of ASTM C 635 (intermediate classification).
 - 2. Grid:
 - a. Fire and non-fire rated exposed grid suspension.
 - b. Armstrong Low-Gloss Heavy Duty type Main Runner Item 7301WH.
 - c. Cross Tees ML7343WH.
 - d. Wall Angle 7800RWH.
 - e. Grid of 24-gage electro-galvanized steel finished with low-sheen satin white.
 - 3. Accessories: Wire hangers.
- B. Acoustical lay-in panels:
 - 1. Size: 24 inches by 24 inches or 24 by 48 with 1-inch wide routing to simulate 24-inch squares.
 - 2. In compliance with Fed Spec SS-S-118B Type III Class A carrying UL, Inc. label, LR Grade 1.
 - 3. Non-fire rated: Minimum 5/8-inch thick.
 - 4. Noise control: NCR rating 0.50-0.60 range.
 - 5. Color: factory-applied washable white matte paint finish.
 - 6. Panel type: Armstrong - white, non-directional, fissured, non-rated or similar.
 - 7. Tile edges: square.

PART 3 EXECUTION

3.01 GENERAL

- A. Do not install acoustical ceilings until dust-generating activities have terminated and overhead mechanical work is completed, tested, and approved.
- B. Permit wet work to dry prior to commencement of installation.

3.02 SURFACE CONDITIONS

- A. Inspection: Prior to all work, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Coordination:
 - 1. Install ceiling support system to fit around mechanical and electrical systems and equipment as required.
 - 2. Make necessary adjustments in wire hanger locations to accomplish this work.
- C. Discrepancies:
 - 1. In the event of discrepancy, immediately notify the Project Representative.
 - 2. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.03 INSTALLATION OF EXPOSED GRID SYSTEM

- A. Directly hang, install the exposed grid system in accordance with ASTM C636. Deflection of any component shall not exceed 1/360 of the span.
- B. Install finish surfaces level and true within 1/8-inch per 12 feet of surfaces in any direction.
- C. Hang main tees spaced 24 inches O.C. with hanger wires spaced not over 48 inches along the length of the tees.
- D. Maximum runner rotation from plumb not to exceed 2 degrees.
- E. Attach cross-tees to main tees at 48 inches O.C.
- F. Provide perimeter angle moldings at intersection of ceiling panels and all vertical surfaces.
- G. Laterally brace ceiling areas exceeding 144 square feet in accordance with UBC Standard 47-18.

3.04 INSTALLATION OF LAY-IN PANELS

- A. Plan each layout to balance border widths at opposite edges of each ceiling area. Avoid use of less-than-half width units wherever possible.
- B. Orient each panel in the same direction to produce a uniform direction of pattern.
- C. Install edge moldings at intersection of ceiling, ceiling fan, and vertical surfaces, using maximum lengths, straight, true to line and level. Miter corners.
- D. Install after all above-ceiling work is complete.
- E. Coordinate the location of hangers with other work.
- F. Ensure the layout of hangers are located to accommodate fittings and units of equipment, which may be placed after the installation of ceiling grid system.
- G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest adjacent hangers and related carrying channels as required to span the required distance.
- H. Hang independently of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of the longitudinal axis or face plane of adjacent members. Hangers shall not pass through mechanical or electrical ductwork.
- I. Do not support fixtures from or on main runners or cross runners if weight of the fixture causes the total dead load to exceed the deflection capability. In such cases, support fixture loads by supplementary hangers located within 6 inches of each corner, or support the fixtures independently.
- J. Fit acoustic lay-in panels in place, free from damaged edges or other defects detrimental to appearance and function. Fit border units neatly against abutting surfaces.
- K. Install lay-in panels level, in uniform plane and free from twist, warp and dents.
- L. Do not install fixtures so that main runners and cross runners will be eccentrically loaded. Where fixture installation would produce rotation of runners, provide stabilizer bars.
- M. Adjust any sags or twists, which develop in the ceiling system(s) and replace any part that is damaged or faulty.

3.05 CLEANUP

- A. Completely remove all fingerprints and traces of adhesives or soil and damage from the surfaces of acoustical materials, using only those cleaning materials recommended for that purpose by the manufacturer of the material being cleaned.
- B. Replace damaged or marred units.

END OF SECTION

SECTION 09 65 00

RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies resilient base and accessories.

1.02 QUALITY ASSURANCE

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM F1861	Standard Specification for Resilient Wall Base.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Literature: Submit manufacturer's product literature for resilient base and adhesives.
- C. Samples: For each type and color of resilient base scheduled, submit 3 samples, not less than 12 inches in length.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Maintain minimum 70 degrees F air temperature at base installation area for three days prior to, during, and for 24 hours after installation.
- B. Store base materials in area of application; allow materials to acclimate to environmental conditions prior to installation.

1.05 MAINTENANCE

- A. Prior to project closeout, deliver 5 percent of installed quantity of each color and configuration of base material.
- B. Clearly identify each box or roll.

PART 2 PRODUCTS

2.01 RESILIENT BASE

- A. Acceptable Manufacturers:
 - 1. Roppe Rubber Corp.
 - 2. Flexco, Inc.
 - 3. Johnsonite.
 - 4. BurkeMercer Flooring Products / Burke Industries.
 - 5. Armstrong Floor Division.
 - 6. Approved Equal.

- B. Resilient Base: ASTM F1861, Type TS, 100 percent vulcanized rubber; 1/8 inch thick; roll stock; coved and straight base as specified; 6 inch height, color: match Johnsonite 23 "Vapor Grey".

2.02 OTHER MATERIALS

- A. Adhesives:
 - 1. Use adhesives as recommended by the wall base manufacturer for the application.
 - 2. Maximum VOC content of less than 50 grams/liter.
- B. Sealant: General purpose butyl rubber sealant; color as selected by the installer for match to base or flooring color.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
- B. Discrepancies: In the event of discrepancy, immediately notify the Project Representative. Do not proceed with installation in subject areas until discrepancies have been fully resolved. Beginning work constitutes acceptance of site conditions and responsibility for defective installation caused by prior observable conditions.

3.02 BASE INSTALLATION

- A. Adhesive install base materials. Install adhesive in a continuous bead behind top of base to ensure uniform contact with substrate, without gaps.
 - 1. Install coved style base where indicated in combination with hard surface or resilient flooring.
- B. Install base to walls and to wood casework toe kicks in areas where resilient base is scheduled, and where no other base finish is specifically noted or detailed.
- C. Install base in maximum practical lengths, with minimum number of joints in each run. Fit joints tight, vertical, and in accurate alignment.
- D. Field Installed Corners:
 - 1. Outside Corners: Score back of base material with grooving tool, at outside corners; maintain minimum leg length 18 inches where wall length permits. Mount base so that scored groove is accurately aligned with corner, and with base tightly adhered to wall at both sides of corner, with no visible gaps at top of base. Where cove base is formed around outside corners, stretch toe of cove for smooth transition around corner, with toe in uniform contact with the finish flooring.
 - 2. Inside Corners: Miter or cope inside corners for accurate fit.
- E. Scribe and fit to door frames, stairs, and other obstructions.
- F. Install straight and level to maximum variation of plus or minus 1/8 inch over 10 feet.
- G. Solvent or adhesive weld joints in base and seal toe of base to floor in janitor's closets.
 - 1. Where coved base is installed against hard surface or resilient flooring, install a continuous bead of sealant under the toe of the base; ensure complete contact to exclude moisture between the floor and the base. Remove squeezeout with xylol, mineral spirits, or other solvent as recommended by the sealant manufacturer.

3.03 CLEANING

- A. Upon completion of the installation, immediately remove surplus adhesive from base and adjacent surfaces.

END OF SECTION

SECTION 09 66 00
TERRAZZO FLOORING REFINISHING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies all terrazzo repair and refinishing.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C33	Standard Specification for Concrete Aggregates
NTMA	National Terrazzo and Mosaic Association, Inc.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product data
1. Sealer.
 2. Cement.
 3. Statement of refinishing procedures.
- C. 12-inch by 12-inch terrazzo topping samples
1. Sample for matching existing terrazzo where surface has been ground away.
 2. Sample using a section of existing terrazzo from area where terrazzo is to be demolished to show refinished condition.
- D. Maintenance Literature.

1.04 QUALITY ASSURANCE

- A. Suppliers: A firm experienced in manufacturing products in accordance with NTMA standards and with a record of successful in-service performance as well as sufficient production capacity to produce required materials.
- B. Terrazzo Contractor: A Contractor Member of NTMA whose work has resulted in construction with a record of successful in-service performance.
1. Installer shall have completed terrazzo installations within the past 5 years of scale and complexity similar to the proposed installation.

1.05 PRE-REFINISHING MEETING

- A. The Contractor shall conduct a conference at Project site before Terrazzo Contractor begins work:
1. The Contractor shall invite Terrazzo Contractor and representatives of the County.
 2. Review methods and procedures related to terrazzo repair including, but not limited to, the following:

- a. Inspect and discuss condition of existing terrazzo, refinishing procedures, and other preparatory work performed by other trades.
- b. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- c. Review approved samples.
- d. Coordination with the work of other construction in the area.

PART 2 MATERIALS

2.01 CEMENT

- A. Per Section 03 30 00.
- B. Under bed and bond cement: standard grey color.
- C. Topping cement: shaded white Portland cement.

2.02 WATER

- A. Potable water.
- B. Clean and free from injurious amounts of oil, acid, alkali and organic materials.

2.03 SAND

- A. Conform to ASTM C33.
- B. Per Section 03 30 00, graded to conform to the specifications for sand in grout.

2.04 MARBLE GRANULES

- A. Venetian 1 through 8.
- B. Match existing marble granules color and distribution.
- C. Acceptable manufacturer:
 - 1. North American Non-Metallic.
 - 2. Northwest Marble Products
 - 3. Approved Equal.

2.05 DIVIDING STRIPS

- A. Match existing where replacement required.
- B. 16-gage white alloy zinc.
- C. Depth: 1 1/4 inches.
- D. Width:
 - 1. Wide strips: 1/4-inch.
 - 2. Narrow strips: 1/16-inch.
- E. Strips shall form borders and divide floors into panels.

2.06 COLOR PIGMENTS

- A. Match existing.
- B. Lime-proof.
- C. Non-fading.

2.07 MISCELLANEOUS ACCESSORIES

- A. Clear Acrylic Sealer: Terrazzo Contractor shall provide a non-ambering, clear sealer that is chemically neutral; does not impair terrazzo aesthetics or physical properties; is recommended by terrazzo matrix manufacturer. Sealers shall comply with the following:
 - 1. Comply with requirements of authorities having jurisdiction.
 - 2. Comply with ASTM D 2047.
 - 3. Water Based Sealer Properties: With pH factor between 7 and 10.

PART 3 EXECUTION

3.01 TERRAZZO REFINISHING

- A. Grinding:
 - 1. Rough grind terrazzo 1/32 inches.
 - 2. Remove staining and scratches.
- B. Repair worn surfaces:
 - 1. Patch and repair areas having lost or heavily worn marble and cement surface.
 - 2. Match adjacent grout and marble chips.
 - 3. Place additional marble chips to match adjacent terrazzo.
- C. Polish:
 - 1. Polish with 200 grit.
- D. Sealer:
 - 1. Apply sealer.

3.02 CLEANING AND SEALING

- A. Clean the floor with a mild soap emulsion.
- B. Seal with an accepted terrazzo sealer.

END OF SECTION

SECTION 09 90 00
COATING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies coatings and their surface preparation for field and shop-applied coating systems.
- B. Furnish all labor, equipment, including safety equipment, superintendence, materials, tools and incidentals necessary to prepare and coat the work as specified in this Section.

1.02 DEFINITIONS

- A. Coating systems: Includes surface description, surface preparation, required dry film thickness, and the number and application procedure of the prime and finish coatings. Systems are as specified within this Section on the Coating System Specification Sheets (COATSPEC).
- B. Field coating: The application of the coating system after installation of the surface at the work site.
- C. Dry film thickness (DFT): The thickness of a fully cured coating or coating system.
- D. Wet film thickness (WFT): The thickness of a coating while wet.
- E. Volatile organic content (VOC): The portion of the coating that is a compound of carbon, is photo-chemically reactive and evaporates during drying or curing, expressed in grams per liter or pound per gallon as defined in ASTM D3960.
- F. Shop coat: One or more coats applied in a shop or plant prior to shipment to the site.
- G. Lead containing: Any coating that contains any detectable amount of lead.
- H. Stripe coat: A coat of the specified coating, applied prior to the final coat by brush to all edges (cut or fabricated) on steel shapes, crevices, projections, welds, nuts, bolts, pits, flanges, and splice plates.
- I. Hard to reach: Areas that may not be accessible with spray equipment but can be reached by brush, mitt or roller.
- J. Inaccessible areas: Areas such as back-to-back angles, skip welds, and other areas that a brush, mitt, or roller cannot contact the surface.
- K. Sand blasting: applying a dry abrasive grit blasted finish to concrete to an ICRI CSP profile required or recommended by the manufacturer of subsequent coatings.
- L. Brush-off sand blasting: applying a dry abrasive grit blasted finish to the exposed face of skim coated concrete at the locations shown on the Drawings to achieve an ICRI CSP 3 profile.

1.03 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM D3359	Standard Test Methods to Measure Adhesion by Tape Test
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4138	Standard Test Methods for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive Means
ASTM D 4258	Standard Practice for Surface Cleaning Concrete for Coating
ASTM D 4259	Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application.
ASTM D4263	Standard Test Method Indicating Moisture in the Concrete by the Plastic Sheet Method
ASTM D4285	Standard Test Method for Indicating Oil or Water in Compressed Air
ASTM D4417	Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Method for Pull-off Adhesion
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
ASTM E337	Standard Test Method for Measuring Humidity with a Psychrometer
EPA Method 1311	Toxicity Characteristic Leaching Procedure (TCLP) for Resource Conservation and Recovery Act (RCRA) 8 Metals
ICRI	International Concrete Repair Institute, Technical Guidelines
MIL-A-22262A (SH)	Military Specification, Abrasive Blasting Media, Ship Hull Blast Clean
NACE SP0188-2006	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP0274-2011	High Voltage Electrical Inspection of Pipeline Coatings
NAPF 500-03	Surface Preparation Standard For Ductile Iron Pipe And Fittings In Exposed Locations Receiving Special External Coatings And/Or Special Internal Linings
SSPC	Steel Structures Painting Council, Volume 1 - Good Painting Practices
SSPC-Paint Application-PA-2	Measurement of Dry Paint Thickness with Type 2 Gauges
SSPC-SP 1	Solvent Cleaning
SSPC-SP 2	Hand Tool Cleaning
SSPC-SP 3	Power Tool Cleaning
SSPC-SP 5	White Metal Blast Cleaning
SSPC-SP 7	Brush-Off Blast Cleaning
SSPC-SP 10	Near-White Metal Blast Cleaning
SSPC-SP 11	Power Tool Cleaning to Bare Metal
SSPC-SP 13/NACE 6	Surface Preparation of Concrete
SSPC-SP 16	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
SSPC-VIS 1-67T	Visual Plates Used to Determine Blasting Standards
SSPC	Good Painting Practice Volume 1
SSPC - Guide 6	Guide for Containing Debris Generated During Paint Removal Operations
SSPC - Guide 15	Field Methods for Retrieval and Analysis of Soluble Salts on Substrates
SSPC Publication 91-12	Coating and Lining Inspection Manual

1.04 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) FOR SHOP AND FIELD

A. General:

1. Manufacturer's printed instructions: Deviations from the manufacturer's printed instructions will not be allowed unless approved in writing by the manufacturer's representative and the Project Representative before execution of said change.
2. In the event of a disagreement between the manufacturer's printed instructions and the provisions of Section 09 90 00 the provisions of Section 09 90 00 shall prevail.

3. Test result disagreement: In the event of a discrepancy between the Contractor and Project Representative's testing equipment, both parties shall check equipment in question for proper function and calibration.
 4. Make available all locations and phases of the work for access for inspection by the Project Representative or the manufacturer's representative. Contractor shall provide ventilation, egress, staging and whatever other means are required to access the work area.
 5. Contractor QC personnel shall be certified as National Association of Corrosion Engineers, (NACE) CIP, Level 1, for coating work performed at the project site. Contractor QC personnel shall be certified as National Association of Corrosion Engineers, (NACE) CIP, Level 3 with Peer Review, for coating work performed away from the project site.
 6. The Project Representative may approve the application of coatings specified under this Section by the Contractor's fabricators and other suppliers without direct inspection by the County provided that the fabricators and suppliers meet the requirements of 1.04A.5 and 1.04B.
- B. Contractor's responsibilities:
1. Quality control: responsible for the quality control of the coatings applied and performing check points as specified in this Section.
 2. Schedule: prepare a schedule that is updated weekly or as necessary to show QC and QA Check Points as specified herein, and distribute to all parties related to installation of the coating system. The schedule shall allow time for remedial work to be completed as identified by inspection at the given checkpoints. The Project Representative shall be informed within 24 hours prior to the Contractor performing the tests specified.
 3. Reports: prepare daily inspection reports when any work is performed on site. Project Representative may require ambient conditions to be recorded as often as needed to insure specified application conditions are met, but not less than twice daily. Tests shall be conducted in accordance with ASTM E337 or surface temperature instrument and dew point instrument manufacturer's instructions. Use the "Daily Inspection Report" form found in Section 01 33 10. Submit copies of this report within 24 hours of coating application to the Project Representative for signature to acknowledge the report was produced in a timely manner. Submit all reports in bound form at the completion of coating work.
 4. Over coating: verify coating compatibility and primer quality to be equal to the specified primer when over-coating a primer or coating that was applied by others. Follow the coating manufacturer's recommendations for over coating primers beyond the recoat window.
 5. Provide testing equipment required in this Section and as required to verify compliance with the Specifications. Record of equipment calibration shall also be provided.
 6. Minimize onsite storage of coating waste materials.
- C. Project Representative's responsibility:
1. QA: determine acceptance or rejection of a coating based on the given specifications.
 2. Testing: may conduct tests on ambient conditions, surface temperature, coating(s) applied, target mil thickness, coating type (i.e. stripe coat), and coating batch numbers in accordance with SSPC Publication 91-12.
- D. Checkpoints: Contractor is responsible to perform the checkpoints specified below and as required in COATSPEC. The Project Representative may perform any or all of the checkpoints listed in addition to, but not replacement of, the requirement for the Contractor to perform the inspection checkpoints as specified below.
1. Blotter test: Upon start-up of abrasive blasting, compressed air shall be checked daily for oil and water by blotter test per ASTM D4285.
 2. Anchor profile: Anchor profile of an abrasively blasted surface shall be tested using Testex tape per ASTM D4417 or with a calibrated digital surface profile gauge. Test shall be conducted on the start-up of the abrasive blasting operation to insure proper selection of blast media and prior to prime coat application.
 3. Intermediate DFT readings: DFT readings shall be taken between coats to check consistency of the application and progress toward total system thickness.

4. Final DFT readings: DFT readings shall be taken per SSPC PA-2 on total system thickness as criteria for final acceptance of a coating. If recoat time has been exceeded or if recommended by the manufacturer, deficient areas shall be scarified prior to top coating. Dry film thickness measurements in excess of the amounts specified in SSPC PA-2 may be acceptable if approved by the Project Representative.
 5. Surface preparation: Shall be accepted by the Project Representative prior to the application of a coating.
 6. Ambient conditions: Perform tests for relative humidity, surface temperature, dew point and ambient temperature to ensure compliance for materials applied. Tests shall be conducted in accordance with ASTM E337 or surface temperature instrument and dew point instrument manufacturer's instructions
 7. Adhesion: perform adhesion tests per ASTM D4541, ASTM D3359 Test Method B, or ASTM D7234 depending upon the substrate. It is the responsibility of the Contractor to repair any damage to the coating resulting from adhesion testing.
 - a. Minimum adhesion values for coating systems A-1, A-2, A-3, A-4, and A-5: 400 psi with 20 mm dolly or 64 psi with 50 mm dolly
 - b. The minimum adhesion score for coating system L-1a using ASTM D3359 Test Method B shall be Classification 2B.
 8. Test to Determine Salt Contamination: Using the Bresle Method, the Contractor shall take 3 tests each day at randomly selected locations during surface preparation prior to coating application. For immersed surfaces, the reading shall not exceed 30 microsiemens/cm (30 us/cm). For non-immersed surfaces, the reading shall not exceed 70 microsiemens/cm (70 us/cm). If conductivity measurements exceed the respective values, the affected surfaces shall be cleaned until conductivity levels are acceptable. Tests shall be conducted in accordance with SSPC - Guide 15 or soluble salt test kit manufacturer's instructions. This test may be waived by the Project Representative if initial tests indicate low salt concentrations.
 9. Moisture in Concrete: perform ASTM 4263-88, Standard Test Method Indicating Moisture in the Concrete by the Plastic Sheet Method. If the presence of moisture is indicated, dry the substrate prior to coating application. Perform this test once for every 200 square feet of area to be coated and more frequently at darkened concrete areas. Perform Calcium Chloride Moisture Vapor Emissions Tests in accordance with ASTM F-1869 for all floors, containment, below grade applications or any other moisture tests required by the manufacturer. The Project Representative may approve adhesion testing of a small coating test patch per ASTM D7234 in lieu of moisture testing.
 11. Test for de-passivation of galvanized steel: After cleaning galvanized steel by pressure wash and soap or other manufacturer-approved method, test every 100 square feet by applying a drop of Copper Sulfate test solution. Black color indicates that the galvanized steel has been de-passivated. Refer to Section 09 90 00 3.01 B.5.
 12. Pressure washing QA/QC:
 - a. Wash water temperature verification: Dispense wash water into a 5 gallon bucket. Verify that wash water is between 120F and 130F with a calibrated infrared thermometer.
 - b. Pump flow rate- Spray wash water into a 5 gallon bucket. Water level shall rise to 3 gallon mark in 60 seconds or less.
 - c. Pump pressure- For a 3,000 PSI rated machine, the pressure at spray gun inlet shall be not less than 2,900 PSI with the trigger pulled and nozzle discharging water on a calibrated pressure gauge.
 - d. Nozzle orifice size: Example: A properly sized new #3.5 (.048") pressure washing nozzle will pass a # 56 (.0465") drill bit or drill blank but will not pass a # 55 (.052") drill bit or drill blank. A nozzle shall be replaced when its orifice passes a drill bit or drill blank .004" larger than the original orifice diameter.
- E. Disputes: If questions arise concerning the acceptability of an applied coating, Tooke, adhesion, and other destructive/non-destructive tests per ASTM D 4138 may be performed to aid in resolution of the dispute. If the coating is determined to be defective, the Contractor shall be responsible for the cost of repairs resulting from testing. If the coating is shown to be properly applied, the County will be responsible for the cost of inspection repairs.

1.05 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Contractor QC personnel qualifications.
- C. A list of materials shall be provided before materials are delivered to the worksite.
- D. A Waste Disposal Plan.
- E. For each primer and finish coating, provide the manufacturer's application instructions, which shall include the following:
 - 1. Surface preparation recommendations.
 - 2. Primer type, where required.
 - 3. Maximum dry and wet mil thickness per coat.
 - 4. Minimum and maximum curing time between coats, including atmospheric conditions for each.
 - 5. Curing time before submergence in liquid.
 - 6. Thinner to be used with each coating.
 - 7. Ventilation requirements.
 - 8. Allowable application methods.
 - 9. Maximum storage life.
 - 10. Material safety data sheets.
 - 11. Interpretation of batch code numbers.
 - 12. Minimum and maximum relative humidity requirements.
 - 13. Minimum and maximum surface temperature requirements.
 - 14. Minimum and maximum ambient temperature requirements.
 - 15. Manufacturers recommended application procedure.
 - 16. LEED Submittal.
 - 17. When color is not specified, provide manufacturer's range of standard colors.
 - 18. Contractor QC personnel qualifications.
- F. Provide information on new abrasive blasting media including lab test report for RCRA 8 heavy metals testing per EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP) and coating manufacturer's recommended grit/shot size for coating systems specified.
- G. Provide a copy of the Toxicity Characteristic Leaching Procedure (TCLP) lab test report of the spent blast material to the Project Representative prior to Final Acceptance of the work.
- H. Field and/or draw-down samples may be requested by the Project Representative.
- I. For Systems A-2 and C-3, submit manufacturer's details for construction joints, penetrations, crack repair, and details at floor penetrations, wall bases, equipment bolts, embedded angle frames, transitions and terminations of the system and all other details specific to the structure being coated.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials for field application to the job site in their original, unopened containers. Each container shall bear the manufacturer's name brand, batch number, date of manufacture, and storage life.
- B. Coatings shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Coatings, exceeding storage life recommended by the manufacturer or that have been visibly damaged shall be removed from the site. Flammable materials shall be stored in accordance with state and local codes.

1.07 SITE CONDITIONS

- A. Coatings shall be applied only to surfaces that are dry, and only under such combination of humidity and temperatures of the atmosphere and surfaces to be coated as will cause evaporation rather than condensation.
- B. During coating and for a period of at least 8 hours after the coating has been applied, the temperature of the surface and the atmosphere shall be maintained at a minimum of 5 degrees above the dew point unless the curing schedule for the coating permits otherwise.
- C. Provide environmental controls such as heaters and/or dehumidification if atmospheric requirements as specified in this Section are not met or workdays are lost due to weather.
- D. Provide ventilation if the cure time of the coating is slowed by the presence of coating or solvent vapor.

1.08 CONTAINMENT

- A. Containment shall conform to SSPC-Guide 6. Level of containment shall be as specified to capture abrasive material used in sand blasting and brush-off sand blasting, debris, contain dust, protect from adverse weather, control overspray, and provide means to control ambient conditions, and shall be as specified for the material and service conditions in the COATSPEC.
- B. Containment Class 1A is required whenever sand blasting and brush-off sand blasting or other abrasive blasting is performed. The Contractor is responsible for any damage resulting from surface preparation or painting operations.

SSPC-GUIDE 6 - TABLE A COMBINATIONS OF CONTAINMENT AND VENTILATION SYSTEMS COMPONENTS											
Containment Classification	CONTAINMENT SYSTEM (5.3 of Guide)						VENTILATION (5.4 of Guide)				
	5.3.1 Containment Materials	5.3.2 Penetrability	5.3.3 Support Structure	5.3.4 Joints	5.3.4 Joints	5.3.5 Entryway	5.4.1 Make-up	5.4.2 Input Air Flow	5.4.3 Air Pressure	5.4.4 Air Movement	5.4.5 Exhaust Dust Filtration
Class 1A		B1-Air Impenetrable	C1-Rigid C2-Flexible	D1-Full Seal	D1-Full Seal	E1-Airlock E2-Resealable	F1-Controlled	G1-Forced G2-Natural	H1-Instrument Verification H2-Visual Verification	I1-Minimum Specified	J1-Air Filtration
Class 2A	A1-Rigid A2-Flexible	B1-Air Impenetrable	C1-Rigid C2-Flexible	D1-Full Seal	D1-Full Seal	E2-Resealable E3-Overlap	F1-Controlled F2-Open	G1-Forced G2-Natural	H2-Visual Verification	I1-Minimum Specified	J1-Air Filtration
Class 3A	A1-Rigid A2-Flexible	B1-Air Impenetrable B2-Air Penetrable	C1-Rigid C2-Flexible	D1-Full Seal D2-Partial Seal	D1-Full Seal D2-Partial Seal	E4-Open Seam	F1-Controlled F2-Open	G1-Forced G2-Natural	H3-Not required	I2-Not specified	J1-Air Filtration
Class 4A	A1-Rigid A2-Flexible	B1-Air Impenetrable B2-Air Penetrable	C3-Minimal	D2-Partial Seal	D2-Partial Seal	E4-Open Seam	F2-Open	G2-Natural	H3-Not required	I2-Not specified	J2-No Controls on Exhaust

Note:

- The information in this table is provided for guidance only and does not guarantee that any specific levels of containment will be achieved by following the suggestions. The type of structure, wind conditions, soundness of the materials of construction, and many other factors play a role in containing dust and debris.
- The table occasionally identifies two options for a given component. For example, containment materials (5.3.1) are shown as being either rigid or flexible. If the specifier requires the use of rigid materials only, this restriction shall be specified separately.
- The design suggestions made in this table are based on the use of open abrasive blast cleaning inside containment. The classifications are ordered from the greatest degree of dust and debris containment (Class 1A). Normally, the higher the degree of containment, the higher the cost.

4. *Many other combinations of the components beyond those suggested above can be used to provide similar results. The method preparation can also be adjusted to reduce or eliminate dust emissions.*
5. *Certain combinations of components within which each class may not be suitable when removing hazardous paints (e.g., forced air input in combination with penetrable containment materials in Class 3A).*
6. *When designing a ventilation system, care shall be taken to balance the static pressure with the input air flow to avoid collapsing the containment due to high negative pressure.*

1.09 WARRANTY

- A. For the Work of this Section, provide all warranties as described in Section 00 72 00 General Terms and Conditions, Section 01 78 36, and special warranties as specified in the Technical Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Standardization:
 1. Materials, supplies, and articles provided shall be the standard products of manufacturers. Coatings in a particular system shall be the products of a single manufacturer.
 2. The standard products of manufacturers other than those specified may be accepted when it is demonstrated that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for substitutions will be considered when submitted per Section 01 33 00 provided the following minimum conditions are met:
 - a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required dry film thickness.
 - b. The proposed coating system shall use coatings of the same generic type. The directions for application and descriptive literature which includes generic type, non-volatile content by volume, material safety data sheets, VOC's by grams per liter, and other information confirms that the substitution is equal to the specified coating system.
- B. All coating materials shall be benzene and lead free and shall not, exceed 250 grams per liter of volatile organic compounds (VOC).
- C. Abrasive blasting material shall meet MIL-A-22262A (SH) and shall contain RCRA 8 heavy metal concentrations for Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver below EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP) regulatory limits. Abrasive blasting material shall not be reused. The Contractor is responsible for removing and legally disposing of the spent abrasive blasting material from the job site.
- D. Nonskid additive shall be 20 to 40 mesh alumina oxide, unless alternate nonskid media is recommended by the manufacturer.

2.02 EQUIPMENT

- A. The Contractor is responsible for ensuring that all King County equipment including mechanical working parts and/or moving parts within the work area are protected from damage. Protection of equipment will be coordinated with the Project Representative.

PART 3 EXECUTION

3.01 PREPARATION

- A. General:
 1. The surface preparation instructions Section 09 90 00-3.01 are general only and are not intended to replace the specific requirements of the individual COATSPECS or coating manufacturer's

requirements.

2. Surfaces to be coated shall be clean. Before applying coating, oil and grease shall be removed per SSPC-SP 1. All dirt, rust, loose mill scale, old and weathered coatings, and other foreign substances shall be cleaned according to the SSPC standards specified in the COATSPEC. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded, and free of contaminants, which might interfere with the adhesion of the coatings.
3. Clean cloths and clean fluids shall be used in solvent cleaning. Cleaning and coating shall be scheduled so that dust and spray from the cleaning process will not fall on wet, newly coated surfaces. Ensure that field coating is compatible with factory applied or existing coatings.

B. Metallic surfaces:

1. Metallic surfaces shall be prepared in accordance with applicable portions of the NACE, SSPC, or ASTM surface preparation specifications. Specific applicable standards are specified in each coating system. The solvent in solvent cleaning operations shall be as recommended by the manufacturer.
2. Preparation of metallic surfaces shall be based upon comparison with SSPC-VIS-1-67T, or as described herein. To facilitate inspection on the first day of abrasive blasting operations, abrasive blast a sample area to the standards specified. Plates of light metal steel shall measure a minimum of 8-1/2 inches x 11 inches. The blasted sample area meeting the requirements of the Specifications shall be initialed by the Contractor and the Project Representative and covered with clear plastic and tape. One of these sample areas shall be prepared for each type of abrasive blasting and shall be used as the comparison standard throughout the work.
3. Profile of abrasive blasted surfaces of new steel or previously coated steel shall be per the manufacturer's recommendation for each coating system but be no less than two mils. Tightly adhered, existing coating remaining on surface following SSPC-SP-7, cleaning shall have a minimum surface profile of 2 mils.
4. Surface preparation for aluminum, copper, brass, and stainless steel shall be as specified for the coating in the COATSPEC.
5. Surface preparation for galvanized metal shall include a pressure wash with a cleaning solution recommended by the coating manufacturer, mixed and rinsed with 130-degree water and applied at 3000 psi, 2.8 GPM minimum. When the surface is dry, prepare for coating application by providing a cleaning per SSPC-SP 2 or 3. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application. Perform de-passivation test listed in Section 09 90 00 1.04 D.11.
6. Areas not accessible or appropriate for blast cleaning may be hand or power tool cleaned with written approval of the Project Representative.

C. Concrete, masonry and plaster surfaces:

1. Surfaces, which are to be coated shall be allowed to age for at least 28 days or longer, to dry to the moisture content recommended by the coating manufacturer. Moisture content shall be tested per ASTM D4263. The presence of moisture indicates additional cure time will be required. Retest as required until concrete is sufficiently dry for coating.
2. Muriatic acid solution shall not be used.
3. Loose concrete and laitance shall be removed by blasting or chipping. Voids and cracks shall be repaired as specified in Section 03 30 00 or applicable COATSPEC. When repair work in Section 03 30 00 is complete, prepare the surface per the following:
 - a. Concrete floors shall be prepared with "blast track" style equipment or an Approved Equal.
 - b. All concrete surfaces shall be inspected per SSPC-SP 13 to ICRI Technical Guideline #310.2 and per the manufacturer's recommendations.
4. Surfaces shall be dry and clean and free from grit, loose plaster, and surface irregularities.
5. Cracks, voids and holes in new or existing concrete to be coated, shall be repaired as specified in Section 03 30 00.
6. Surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.

7. Steam cleaning shall be used to clean wall surfaces of existing process channels, structures and tanks to be coated.
 8. Surfaces to be coated shall be repaired as specified in the COATSPEC, and cleaned and finished to the standards as specified herein.
- D. Concrete surfaces to receive a polymer modified mortar skim coat:
1. Loose concrete and laitance shall be removed by blasting or chipping.
 2. Cracks shall be repaired as specified in Section 03 30 00. When repair work in Section 03 30 00 is complete, prepare the surface per the following:
 - a. Sand blast to the ICRI CSP as recommended or as required by the polymer modified mortar skim coating manufacturer.
 - 1) Remove all epoxy used to seal the crack and install injection ports prior to sandblasting the underlying concrete to the required ICRI CSP.
 3. Surfaces shall be clean and free from grit, debris, epoxy and surface irregularities.
 4. Surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.
- E. Surfaces, which are to receive a polymer modified mortar skim coat shall be Saturated Surface Dry (SSD) condition at the time of application of the mortar skim coat. Existing painted surfaces:
1. In accordance with Section 09 90 05.
- F. Plastic surfaces:
1. Clean with solvent compatible with the specified primer and hand sanded with a medium grit sandpaper to provide sufficient profile for the coating system.
 2. Large areas may be power sanded or brush off blasted provided sufficient controls are employed so the surface is roughened without removing excess material.

3.02 APPLICATION

- A. Workmanship: Coating shall be conducted in accordance with the requirements of SSPC, Good Painting Practice Volume 1.
1. Coated surfaces shall be free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied so as to produce an even film of uniform thickness.
 2. Coating equipment shall be designed for application of the materials specified.
 - a. Compressors shall have traps and filters to remove water and oils.
 - b. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes and functioning in a manner suitable to perform the work.
 3. Each coat of paint shall be applied evenly and sharply cut to line.
- B. Workmanship: Polymer modified mortar skim coating shall be conducted in accordance with the requirements of the manufacturer.
- C. Coating properties, mixing, and thinning:
1. Coating shall provide a satisfactory film with smooth even surface. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Orange Peel, overspray, pinholes and other surface defects shall be repaired.
 2. Coating shall be thoroughly stirred, strained, and kept at a uniform consistency during application.
 3. Coatings shall be mixed in accordance with the manufacturer's instructions.
- D. Polymer modified mortar skim coating properties, mixing:
1. Mix in accordance with the manufacturer's instructions.
- E. Method of coating application:
1. Prime coatings may be shop or field applied. Shop-applied primer shall be as specified in each system.

2. Provide mechanical equipment, including, but not limited to, pumps, valves, pipe, blowers, fittings, and miscellaneous appurtenances, with shop-applied primer and shop-applied finish coats.
 3. If the shop coating meets the requirements of this Section, the field coating may consist of touching up the shop prime coat to achieve the film thickness, continuity, and coating specified in the COATSPEC. Damaged and poorly applied shop coatings that do not meet the specified requirements shall be removed, surface prepared, and then recoated in accordance with the COATSPEC.
 4. Where two or more coats are required, alternate coats shall contain sufficient compatible color additive, to act as indicator of coverage or the alternate coats shall be of contrasting colors.
 5. Mechanical equipment on which the manufacturer's shop-applied coating is acceptable shall be touch-up primed and coated with the specified coating system to match the color scheduled.
 6. Coating shall not be applied to a surface until it has been prepared as specified.
 7. A stripe coat shall be applied by brush to all edges (cut or fabricated), crevices, projections, nuts, bolts, pits, welds, flanges and splice plates. Subsequent coats may be either brush or spray applied.
 8. Where nonskid surface is scheduled, broadcast nonskid additive at 5 pounds per 30 square feet. Back-roll on horizontal surfaces.
 9. Prime surfaces to receive a polymer modified mortar skim coating with the primer recommended by the manufacturer.
 10. Apply polymer modified mortar skim coating in accordance with the manufacturer's recommendations. Allow mortar to set to desired stiffness then finish with a wood or sponge float to a smooth finish. Moist cure in accordance with the manufacturer's recommendations for a minimum of 7 days.
- F. Film thickness and continuity:
1. Coating system thickness is the total thickness of primer and finish coats and does not include sealers, patching mortars or galvanized coatings.
 2. Coatings shall be applied to the thickness specified. No less than two coats shall be applied.
- G. Polymer modified mortar skim coat thickness and continuity:
- H. Polymer modified mortar skim coat shall receive a brush-off sand blast finish (ICRI CSP 3) no sooner than 28 days following application.
1. The brush-off sand blast finish shall provide a uniform appearance to the entire polymer modified mortar, skim coat surface.
 2. Unsatisfactory application:
 - a. If an item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
 - b. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
 - c. Repair defects in accordance with written recommendations of coating manufacturer.
- I. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repair in accordance with recommendations of paint manufacturer.
 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
 3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.03 CLEANUP AND WASTE DISPOSAL

- A. Minimize onsite storage of paint waste materials. At the end of each shift, remove surplus materials, protective coverings, and accumulated rubbish.

- B. Thoroughly clean all surfaces and repair any overspray or other paint-related damage when the work is complete.
- C. All solvents, unused coatings and cleaning solutions shall be removed from the site and disposed of legally when coating work is complete or if directed by the Project Representative.
- D. Prepare a Waste Disposal Plan to demonstrate all waste material is to be properly disposed; Include:
 - 1. Specify the Contractor is the generator of all waste materials generated by their business activities.
 - 2. Provide details on procedures to be used for properly managing and disposing of waste materials in accordance all applicable laws and regulations.
 - 3. Procedures to document waste types and quantities generated and their disposition.
 - 4. Appoint an employee who is qualified and authorized to enforce proper waste disposal and document the disposal.
- E. Submit completed Waste Disposal Plan and supporting documentation to demonstrate quantities and proper disposal of wastes.
- F. Provide a copy of the Toxicity Characteristic Leaching Procedure (TCLP) lab test report of the spent blast material to the Project Representative prior to Final Acceptance of the work. The lab test report shall be within the lab's current TCLP certification period.

3.04 PROTECTION

- A. Where protection is provided for coated surfaces, such protection shall be preserved in place until the coating film has properly dried, and removal of the protection is authorized by the Project Representative. Items, which have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard.
- B. Hardware, electrical fixtures, nameplates, shims and similar accessories shall be removed or masked during preparation and coating operations or shall otherwise be satisfactorily protected. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and coating of equipment and walls and, following coating, shall be replaced and reconnected. Any removal or disconnecting of equipment shall be coordinated with the Project Representative.

3.05 MANUFACTURER'S SERVICES

- A. Coating manufacturer's representative shall be present at site as follows:
 - 1. Within 48 hours of first application of any coating system.
 - 2. As required to resolve field problems attributable to or associated with manufacturer's product.
 - 3. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.06 COATING SYSTEMS

- A. Surfaces to be coated, surfaces not to be coated, coating systems to be used, and required finishes and colors are specified in drawings, various specifications and Section 09 06 90.

3.07 COATING SYSTEM SPECIFICATION SHEET - COATSPEC

- A. Coating Systems specified for use appear on the following pages. Each of the Coating Systems and their requirements appear on individual pages or as shown on the Drawings.

Coating System Identification:	A-1
Coating Material:	High Build Epoxy, 16 mils DFT nominal, 250 g/l max VOC
Surfaces:	Metal
Available Colors:	Gray, White, or Beige
Service Condition:	Immersed, highly corrosive environment.
Surface Preparation:	
Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 10. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces in accordance with SSPC-SP 2. Damaged shop coated areas shall be cleaned in accordance with SSPC-SP 11 and recoated with the primer specified. Previously coated surfaces shall be feathered in at the edges. Shop primed surfaces shall receive light abrasive blasting prior to application of finish coats.
Non-Ferrous and Galvanized Metal:	Non-ferrous and galvanized metal shall be cleaned using a 3,000 PSI minimum, 2.8 GPM minimum, 110F minimum (130F maximum) hot water pressure washer using a new 15 degree or 25 degree fan tip held at 12" or less from the surface. Use a phosphate-free biodegradable cleaner in the wash water such as Simple Green House & Siding Cleaner Pressure Washer Concentrate, Hotsy Enviro-Clean, or Krud Kutter House & Siding Pressure Washer Concentrate. Hard to reach areas shall be cleaned using a solvent wipe or scrubbing with a firm bristle deck brush using 110F minimum wash water mixed with biodegradable cleaner. When the surface is dry, prepare for coating application by providing a SSPC SP 7, 11, or 16. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Inspection Check Points:	Check points 1, 2, 6, 7, 11, and 12.
Application:	Shop or field.
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check Points:	Check points 3-5, 7 and 8.
System Thickness:	16 mils dry film minimum.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Primer:	One coat of Carboline Carboguard 635 VOC Epoxy
Stripecoat:	One coat of Carboline Carboguard 635 VOC Epoxy
Intermediate:	One coat of Carboline Carboguard 635 VOC Epoxy
Finish:	One or more coats of Carboline Carboguard 635 VOC Epoxy
ALTERNATIVE 2	
Primer:	One coat of Devoe Bar Rust 235 or 236 Multi-Purpose Epoxy
Stripecoat:	One coat of Devoe Bar Rust 235 or 236 Multi-Purpose Epoxy
Intermediate:	One coat of Devoe Bar Rust 235 or 236 Multi-Purpose Epoxy
Finish:	One or more coats of Devoe Bar Rust 235 or 236 Multi-Purpose Epoxy
ALTERNATIVE 3	
Primer:	One coat of ENECON Chemclad SC
Stripecoat:	One coat of ENECON Chemclad SC
Intermediate:	One coat of ENECON Chemclad SC
Finish:	One or more coats of ENECON Chemclad SC
ALTERNATIVE 4	
Primer:	One coat of Sherwin Williams Macropoxy 646 B58-600
Stripecoat:	One coat of Sherwin Williams Macropoxy 646 B58-600
Intermediate:	One coat of Sherwin William Macropoxy 646 B58-600
Finish:	One or more coats of Sherwin Williams Macropoxy 646 B58-600
ALTERNATIVE 5	
Primer:	One coat of Tnemec Series V69 Epoxoline.
Stripecoat:	One coat of Tnemec Series V69 Epoxoline
Intermediate:	One coat of Tnemec Series V69 Epoxoline
Finish:	One or more coats of Tnemec's Series V69 Epoxoline
ALTERNATIVE 6	
	Approved Equal.

Coating System Identification:	A-2
Coating Material:	High Build Epoxy , 16 mils DFT nominal, 250 g/l max VOC
Surfaces:	Concrete, masonry
Available Colors:	Gray, White, or Beige
Service Condition:	Immersed, highly corrosive environment.
Surface Preparation:	For concrete, masonry and plaster.
	Surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Moisture content will be tested by the Contractor and witnessed by the Project Representative. Loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces and voids and cracks shall be repaired per Section 03 30 00. When repair work in Section 03 30 00 is complete, prepare concrete per SSPC-SP 13 to ICRI Technical Guideline #03732 CSP 3 minimum profile. Holes or other joint defects shall be filled with mortar and re-pointed. Loose or splattered mortar shall be removed by scraping and chipping.
	Surfaces shall be cleaned with a minimum 5,000 PSI pressure wash using a new turbo nozzle in accordance with SSPC-SP 13. Muriatic acid shall not be used. After cleaning, apply skim coat of specified patching mortar to 100% of the surface to repair bugholes, other imperfections and provide a monolithic surface.
Inspection Check Points:	Check points 2, 6, 7, and 10-12.
Application:	<ol style="list-style-type: none"> 1. Field. 2. Patching mortar shall dry a minimum of 48 hours prior to primer application. 3. Prime coat shall be applied as recommended by the coating manufacturer, provided the coating as applied, complies with prevailing air pollution control regulations. 4. Drying time between coats shall be as recommended by coating manufacturer.
Inspection Check points:	Check points 3-5, 7 and 8.
System Thickness:	16 mils dry film, excluding patching mortar.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Patching Mortar:	One or more coats of Carboline Carboguard 501 Epoxy Filler.
Primer:	One coat of Carboline Carboguard 635 VOC Epoxy, applied at 10 mils wet film.
Finish:	One Three or more coats of Carboline Carboguard 635 VOC Epoxy, applied at 5 mils wet film each coat.
ALTERNATIVE 2	
Patching Mortar:	One or more coats of Devoe Devfil 145 Epoxy Filler. Note that epoxy filler shall be applied after application of primer.
Primer:	One coat of Devoe's Pre-Prime 167, applied at 3 mils wet film.
Finish:	Three or more coats of Devoe Bar Rust 236 Multi-Purpose Epoxy, applied at 5 mils wet film each coat.
ALTERNATIVE 3	
Patching Mortar:	One or more coats of ENECON Enecrete DuraQuartz.
Primer:	One coat of ENECON Chemclad SC, applied at 10 mils wet film.
Finish:	Two or more coats of ENECON Chemclad SC, applied at 10 mils wet film each coat.
ALTERNATIVE 4	
Patching Mortar:	One or more coats of Sherwin-Williams Dura-Plate 2300.
Primer:	One coat of Sherwin Williams Macropoxy 646 B58-600, applied at 10 mils wet film.
Finish:	Two or more coats of Sherwin Williams Macropoxy 646 B58-600, applied at 10 mils wet film each coat.
ALTERNATIVE 5	
	Approved Equal.

Coating System Identification:	A-4
Coating Material:	High Build Abrasion Resistant Epoxy, 60 mils DFT nominal, 250 g/l max VOC
Surfaces:	Metal
Available Colors:	Gray, White, or Beige
Service Condition:	Immersed, abrasive raw sewage, corrosive environment
Surface Preparation:	
Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 5.
Non-Ferrous and Galvanized Metal:	
Inspection Check Points:	Check points 1, 2, 6, 7, and 9.
Application:	Field.
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check Points:	Check points 3-5, and 7.
System Thickness:	60 mils dry film minimum.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Finish:	Two coats of Carboline Plasite 4550 S
ALTERNATIVE 2	
Finish:	One or two coats of Sherwin Williams Duraplate 6000
ALTERNATIVE 3	
Finish:	One or two coats of Tnemec's Perma-Glaze Series G435
ALTERNATIVE 4	
Finish:	Approved Equal.

Coating System Identification:	A-5
Coating Material:	100% Solids Abrasion Resistant Epoxy, 120 mils DFT nominal, 250 g/l max VOC
Surfaces:	Metal
Available Colors:	Light Blue
Service Condition:	Submerged, abrasive raw sewage, highly corrosive environment
Surface Preparation:	
Ferrous Metal:	Clean the surface prior to surface preparation in accordance with "Solvent Cleaning" (SSPC SP- 1) to remove oil, grease, and other soluble contaminants. Surfaces to be coated should then be prepared according to SSPC SP-5/NACE No. 1 White Metal Blast Cleaning for immersion service. The resulting angular anchor profile shall be 3.0-5.0 mils and be relative to the coating thickness specified.
Non-Ferrous and Galvanized Metal:	
Inspection Check Points:	Check points 1, 2, 6, 7, and 9.
Application:	Field.
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check Points:	Check points 3-5, and 7.
System Thickness:	120 mils dry film minimum.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Finish:	One coat of Raven 405
ALTERNATIVE 2	
Finish:	Two coats of Sauereisen SewerGard 210S or 210T
ALTERNATIVE 3	
Finish:	Approved Equal.

Coating System Identification:	B-1
Coating Material:	Surface Tolerant Epoxy, 8 mils DFT nominal, 299 g/l max VOC
Surfaces:	Metal, concrete, masonry, previously painted surfaces
Available Colors:	Fully tintable custom colors
Service Condition:	Interior, mild corrosion service or washdown areas
Surface Preparation:	
Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 6.
Galvanized Metal:	Non-ferrous and galvanized metal shall be cleaned using a 3,000 PSI minimum, 2.8 GPM minimum, 110F minimum (130F maximum) hot water pressure washer using a new 15 degree or 25 degree fan tip held at 12" or less from the surface. Use a phosphate-free biodegradable cleaner in the wash water such as Simple Green House & Siding Cleaner Pressure Washer Concentrate, Hotsy Enviro-Clean, or Krud Kutter House & Siding Pressure Washer Concentrate. Hard to reach areas shall be cleaned using a solvent wipe or scrubbing with a firm bristle deck brush using 110F minimum wash water mixed with biodegradable cleaner. When the surface is dry, prepare for coating application by providing an SSPC-SP 7, 11, or 16. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Non-Ferrous Metal:	Prepare surfaces in accordance with SSPC-SP 7, 11, or 16. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Concrete and masonry	Prepare surfaces in accordance with ASTM D4259 Paragraph 6 Mechanical Abrading and ASTM D4258 Paragraph 6.5 Detergent Water Cleaning. The prepared surface shall be as described in ASTM D 4259.
Previously painted surfaces	Previously painted surfaces shall be prepared in accordance with SSPC-SP 2 or SP 3.
Inspection Check Points:	Check points 6, 7, and 10-12.
Application:	Shop or field.
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check points:	Check points 3, 4, and 7.
System Thickness:	8 mils dry film minimum.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Primer:	One coat of Carboline Carboguard 60 Epoxy
Finish:	One or more coats of Carboline Carboguard 635 VOC Epoxy
ALTERNATIVE 2	
Primer:	One coat of Devoe Devran 203 Epoxy
Finish:	One or more coats of Devoe Bar Rust 235 Multi-Purpose Epoxy
ALTERNATIVE 3	
Primer:	One coat of International Ceilcote 680M
Finish:	One or more coats of International Interseal 670HS
ALTERNATIVE 4	
Primer:	One coat of Sherwin Williams Macropoxy 5000
Finish:	One or more coats of Sherwin Williams Dura-Plate 235 Multi-Purpose Epoxy with LV Hardener, B67V240
ALTERNATIVE 5	
	Approved Equal.

Coating System Identification:	B-3
Coating Material:	Epoxy, 8 mils DFT nominal
Surfaces:	Aluminum
Service Condition:	Interior, exterior, where aluminum is in contact with concrete or dissimilar metals
Surface Preparation:	Surface preparation for nonferrous and galvanized metal shall include a pressure wash with a cleaning solution recommended by the coating manufacturer, mixed with 160-degree water and applied at 2500 psi. Rinse with 160 degree water 2500 psi. When the surface is dry, prepare for coating application by providing a SSPC-SP 7. See Preparation paragraph within this Section for alternative methods.
Inspection Check points:	Check points 1 through 9 apply.
Application:	Shop or field.
Coatings:	
ALTERNATIVE 1	
Primer:	One coat of Carboline Carboguard 60 Epoxy, 2 to 3 mils dry film.
Finish:	One coat of Carboline Carboguard 635 VOC Epoxy, 4 to 6 mils dry film.
ALTERNATIVE 2	
Primer:	One coat of Devoe Devran 203 WB Epoxy, 2 to 3 mils dry film.
Finish:	One coat of Devoe Bar Rust 236 Multi-Purpose Epoxy, 6 to 8 mils dry film thickness.
ALTERNATIVE 3	
	Approved Equal.

Coating System Identification:	B-4
Coating Material:	Fusion Bonded Epoxy
Surfaces:	Steel Dowels
Service Condition:	Steel expansion dowels embedded in concrete.
Surface Preparation:	SSPC-SP-10
Application:	Shop
General:	TFE lube shall be shop applied. Grease lube alternative shall be field applied just prior to installation.
System Thickness:	7 mils dry film, minimum for fusion-bonded epoxy. Apply one coat of TFE lube or grease lube, as required to provide a slip surface.
Coatings:	
ALTERNATIVE 1	
Coating:	3M Skotchkote 413, 1 or 2 coats. DuPont NapGuard 7-2719, 1 or 2 coats.
Lube:	TFE liquid coating compatible with fusion bonded epoxy. RL 736 manufactured by Amrep, Inc., Marietta, GA.
ALTERNATIVE 2	
	Approved Equal.

Coating Systems Identification:	C-1
Coating Material:	Epoxy primer, polyurethane finish
Surface:	Metal
Service Condition:	Non-immersed, exposure to moisture and sunlight, color required.
Surface Preparation:	
Ferrous Metal:	<ol style="list-style-type: none"> 1. Ferrous metal surfaces shall be prepared in accordance with SSPC-SP-10. 2. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces in accordance with SSPC-SP 2. Damaged shop coated areas shall be cleaned in accordance with SSPC-SP 11 and recoated with the primer specified. Previously coated surfaces shall be feathered in at the edges.
Nonferrous and Galvanized Metal:	Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Inspection Check Points:	Check points 1, 2, 6, 7, and 10-12.
Application:	Shop or field.
General:	Drying time between coats shall be as specified by the manufacturer for the site conditions.
Inspection Check Points:	Check points 3, 4, 5, 7, and 8.
System Thickness:	8 mils dry film minimum.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Primer:	One coat of Carboline Carboguard 635 VOC Epoxy
Finish:	One or more coats of Carboguard Carbothane 8845 Polyurethane
ALTERNATIVE 2	
Primer:	One coat of Devoe Devran 203 Epoxy
Finish:	One or more coats of Devoe Devthane 379H Polyurethane
ALTERNATIVE 3	
Primer:	One coat of Sherwin Williams Macropoxy HS
Finish:	One or more coats of Sherwin Williams Hi-Solids Polyurethane 250
ALTERNATIVE 4	
	Approved Equal.

Coating System Identification:	EP-1
Coating Material:	Epoxy resinous floor coating.
Surfaces:	Existing Concrete Subfloor. Prepared Concrete Subfloor.
Service Condition:	Interior, non-process areas: restroom, breakroom.
Surface Preparation:	
Concrete:	<p>Prepare in accordance with SSPC-13/NACE 6 and ICRI Technical Guidelines. Abrasive Blast, shot-blast or mechanically abrade concrete surfaces to provide a minimum ICRI-CSP 3 or greater surface profile.</p> <p>Examine the areas and conditions under which the resinous floor coating Work is to be performed in accordance with NACE SP0892 and SSPC-SP13/NACE No. 6.</p> <p>Surfaces to receive resinous floor coatings must be clean, dry and free of oil, grease and other contaminants, prior to preparation in accordance with NACE No. 6/SSPC-SP13. Concrete surfaces must be sound and capable of supporting the resinous floor coating system. CI 301.</p> <p>Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Shot-blast or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers, existing coatings, and other contaminants and to provide the recommended ICRI-CSP Profile.</p> <p>Cracks, voids, and other surface imperfections should be filled with the recommended filler or surfacer prior to the installation of the materials.</p> <p>Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through the resinous floor coating system according to manufacturer's written recommendations.</p>
Quality Assurance	<p>Applicator shall be qualified by manufacturer prior to bid date.</p> <p>Hold pre-installation conference on-site with Project Representative, general contractor, applicator, and representative of the manufacturer to review substrate and procedures.</p> <p>Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.</p>
Application:	Apply and finish to manufacturer's recommendations.
Colors:	Submit for approval color that is complimentary to existing terrazzo.
Coatings:	

ALTERNATIVE 1	<p>A. Tnemec epoxy Deco Fleck 224 system: Flake to refusal</p> <ol style="list-style-type: none"> 1. Primer Coat: Series 201 Epoxoprime at 160 - 200 square feet per gallon. Field tint Series 201 with Series 820 Field Tint in a color complimentary to the flake blend. 2. Broadcast Coat: Series 224 Deco-Flake at 120 - 160 square feet per gallon. 3. Immediately broadcast to refusal with Decorative Flake at a rate of 4 -5 square feet per pound into the wet Series 224. 4. Grout Coat: Series 284 Deco-Clear at 80 - 160 square feet per gallon 5. Finish Coat: Series 284 Deco-Clear at 160 – 200 square feet per gallon.
ALTERNATIVE 2	<p>B. Euclid Epoxy Floor System:</p> <ol style="list-style-type: none"> 1. EucoFloor Epoxy Primer (16-20 mils) 2. Quartz Broadcast 3. Level Top Polish self-leveling overlayment (3/8"-1/2") 4. Ultrasil Li+ liquid densifier, sealer, dustproofer. 5. Increte Urethane Water-Based Protective Floor Coating
ALTERNATIVE 3	<p>C. Approved Equal. Equal products must not decrease film thickness or offer a change in the generic type of coating specified.</p>

Coating System Identification:	H-1
Coating Material:	High temperature silicone, 1.5 mils DFT nominal
Surface:	Metal
Service Condition:	Temperature to 600 degrees F, continuous
Surface Preparation:	Metal surfaces shall be prepared in accordance with SSPC-SP 10 (Near White Metal Blast Cleaning).
Inspection Check points:	Check points 1 through 9 apply.
Application:	1. Field 2. Curing as required by coating manufacturer.
Coatings:	
ALTERNATIVE 1	Three coats of International Intertherm 50
ALTERNATIVE 2	Two coats of Sherwin-Williams KEM HI-TEMP HEAT-FLEX II 450
ALTERNATIVE 3	Approved Equal.

Coating System Identification:	J-1
Coating Material:	Clear acrylic urethane.
Surfaces:	Concrete floors, interior.
Surface Preparation:	
New Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Moisture content shall be tested by the Contractor and witnessed by the Project Representative in accordance with ASTM D4263, or approved equal. If the floor is trowel-finished the surface shall be etched with a non-acid etching chemical such as NewLook QuickEtch or Eco Safety Eco-Etch Pro and then cleaned by 2,500 psi minimum pressure wash. If the floor is broom-finished the surface shall be cleaned by 2,500 psi minimum pressure wash.
Existing Concrete:	Previous coatings shall be removed with a "blastrac" and then cleaned by 2,500 psi minimum pressure wash. Voids and cracks shall be repaired.
Application:	<ol style="list-style-type: none"> 1. Field. 2. Sealer or filler shall dry a minimum of 48 hours prior to application of prime coat. 3. Prime coat shall be thinned and applied as recommended by the coating manufacturer, provided the coating as applied complies with prevailing air pollution control regulations.
Inspection Check points:	Checkpoints 6, 7, and 10 apply.
System Thickness:	Two coats at 3 mils wet film each.
Coatings:	
ALTERNATIVE 1	Two coats Rainguard Clear-Seal Low Gloss Acrylic Urethane Sealer
ALTERNATIVE 2	Two coats of Eagle Armor Seal
ALTERNATIVE 3	Approved Equal.

Coating System Identification:	J-3
Coating Material:	Water reducible epoxy, 5 mils DFT nominal
Surfaces:	Concrete floors, interior.
Service Condition:	Traffic area, some standing water.
Surface Preparation:	
New Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Moisture content shall be tested by the Contractor and witnessed by the Project Representative in accordance with ASTM D4263, or approved equal. Loose concrete, form oils, surface hardeners, curing compounds and laitance shall be removed. Surface shall be cleaned by steam cleaning and abraded with a "blastrac". Voids and cracks shall be repaired.
Existing Concrete:	Loose concrete, form oils, surface hardeners, curing compounds and laitance shall be removed. Surface shall be cleaned by steam cleaning and abraded with a "blastrac". Voids and cracks shall be repaired.
Application:	Field.
General:	Follow manufacturer's instructions for mixing and "sweat-in" time.
Inspection Check points:	Checkpoints 6, 7, and 10 apply.
System Thickness:	Two coats at 5 mils wet film each.
Color:	As selected by Project Representative from manufacturer's standard colors.
Coatings:	
ALTERNATIVE 1	Two coats of International 4426/4428 TruGlaze WB Epoxy or Two coats of PPG Aquapon WB epoxy
ALTERNATIVE 2	Two coats of Carbolite Sanitile 555
ALTERNATIVE 3	Two coats of Rust-Oleum Sierra S40 Epoxy
ALTERNATIVE 4	Approved Equal.

Coating System Identification:	J-5
Coating Material:	Silane water repellent clear sealer.
Surfaces:	Unpainted CMU and Concrete
Service Condition:	Non-corrosive environment.
Surface Preparation:	
New Concrete and Masonry:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Pressure wash or solvent wipe to ensure that surfaces are free from laitance, dust, paint, grease, and oil.
Existing Concrete and Masonry:	Loose concrete, form oils, surface hardeners, curing compounds and laitance shall be removed. Surface shall be cleaned by pressure washing. Voids, holes and cracks shall be repaired as specified in Section 09 90 00, 3.01. C. 5.
Application:	Field.
General:	Follow manufacturer's instructions.
Inspection Check points:	Checkpoints 6, 7, and 10 apply.
System Thickness:	Coat to surface saturation.
Color:	Clear.
Coatings:	
ALTERNATIVE 1	One coat of BASF MasterProtect H 1000
ALTERNATIVE 2	One coat of OKON S-20
ALTERNATIVE 3	Approved Equal.

Coating System Identification:	J-7
Coating Material:	Anti-Slip Coating
Surfaces:	Any primed surface.
Service Condition:	Any wastewater environment.
Surface Preparation:	
New Concrete:	Prepare and prime per manufacturer's instructions.
Previously Painted or Primed Surfaces:	Pressure wash or solvent wipe to ensure that surfaces are free from laitance, dust, paint, grease, and oil.
Application:	Field.
General:	Follow manufacturer's instructions.
Inspection Check points:	Checkpoints 6, 7, and 10 apply.
System Thickness:	Follow manufacturer's instructions.
Color:	Gray or as selected by Project Representative from manufacturer's standard colors.
Coatings:	
ALTERNATIVE 1	American Safety Technologies AS-175
ALTERNATIVE 2	Sherwin Williams EPIDEX M339
ALTERNATIVE 3	Approved Equal.

Coating System Identification:	L-1a
Coating Material:	100% Acrylic semi-gloss or eggshell/satin, 4.5 mils DFT nominal
Surfaces:	Concrete, masonry, plaster, gypsum board, metals, fiber-reinforced plastic (FRP), and previously painted surfaces.
Surface Preparation:	
Concrete and Masonry:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Moisture content shall be tested by the Contractor and witnessed by the Project Representative per ASTM D4263, or approved equal. Loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by grinding and chipping, and voids and cracks in concrete surfaces shall be repaired as specified in Section 09 90 00, 3.01, C, 5. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be cleaned and filled with block filler compatible with the specified primer.
Previously painted surfaces:	Clean using a 3,000 PSI, 2.8 GPM minimum, 110F minimum (130F maximum) hot water pressure washer using a new 15 degree or 25 degree fan tip held at 12" or less from the surface. The pressure washing nozzle orifice size shall be selected from industry standard nozzle charts for the rated flow and pressure of the pump. Use a phosphate-free biodegradable cleaner in the wash water such as Simple Green House & Siding Cleaner Pressure Washer Concentrate, Hotsy Enviro-Clean, or Krud Kutter House & Siding Pressure Washer Concentrate. Follow the additional requirements of ASTM D 4258 Detergent Water Cleaning. Hard to reach areas and all areas where pressure washing will cause damage shall be cleaned using a solvent wipe or scrubbing with a firm bristle deck brush using 110F minimum wash water mixed with a biodegradable cleaner listed in L-1a for "Previously painted surfaces". Rinse with potable water after pressure washing or scrubbing.
Plaster:	Plaster surfaces shall be dry and clean and free from grit, loose plaster and surface irregularities. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sanded smooth. Surfaces shall be cleaned with clean water by washing and scrubbing to remove foreign substances. After cleaning, surfaces shall be sealed with a compatible sealer.
Gypsum Wallboard:	Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer.
Plastic and FRP Surface Preparation	Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.
Inspection Checkpoints:	Checkpoints 6, 7, 11, and 12 apply.
Application:	Sealer or filler shall cure according to manufacturer's recommendations prior to priming. Drying time between coats shall be as recommended by the coating manufacturer. Apply coats at Wet Film Thicknesses equal to or greater than manufacturer's minimum recommended thicknesses.
Inspection Checkpoints:	Checkpoints 6 and 7 apply.
System Thickness:	4.5 mils dry film, minimum, for 1 prime coat and 2 topcoats.

Coatings:	
Sheen: SEMI-GLOSS	
ALTERNATIVE 1	
Primer: Concrete, Metals, and previously painted surfaces	One coat of PPG-Glidden Hydrosealer Primer 6001.
Finish:	Two coats of PPG-Devco Devflex 4216HP.
ALTERNATIVE 2	
Primer: Concrete and previously painted surfaces	One coat of Sherwin-Williams Loxon Concrete & Masonry Primer #A24W8300.
Primer: Metals	One coat of Sherwin-Williams DTM Acrylic Primer #B66W1.
Finish:	Two coats of Sherwin-Williams Sher-Cryl HPA Acrylic #B66-350.
ALTERNATIVE 3	
	Approved Equal.
Sheen: EGGSHELL/SATIN	
ALTERNATIVE 1	
Primer: Concrete, Metals, and previously painted surfaces	One coat of PPG-Glidden Hydrosealer Primer 6001.
Finish:	Two coats of PPG Pitt-Tech Plus 90-1110.
ALTERNATIVE 2	
Primer: Concrete and previously painted surfaces	One coat of Sherwin-Williams Loxon Concrete & Masonry Primer #A24W8300 tinted to near-topcoat color if possible.
Primer: Metals	One coat of Sherwin-Williams DTM Acrylic Primer #B66W1.
Finish:	Two coats of Sherwin-Williams Pro Industrial Acrylic #B66-660.
ALTERNATIVE 3	
	Approved Equal.

Coating System Identification:	PMC-1
Coating Material:	Two-component, polymer modified, Portland cement-based, fast-setting, non-sag mortar.
Surfaces:	Existing Concrete
Colors:	Gray
Service Condition:	Exterior, mild corrosion service or washdown areas
Surface Preparation:	
Concrete:	<p>Surface must be clean and sound. Remove all deteriorated concrete, dirt, oil, grease, and other bond-inhibiting materials from the area to be repaired.</p> <p>Cracks, voids, and holes shall be repaired as specified in Section 09 90 00, 3.01.D.1.</p> <p>Prepare surface by sand blasting to obtain an exposed aggregate surface profile of $\pm 1/16"$ (1.6 mm) (CSP-5).</p> <p>After sand blasting, surfaces shall receive a final cleaning with clear water by washing and scrubbing to remove foreign and deleterious substances.</p> <p>Substrate should be Saturated Surface Dry (SSD) with clean water prior to application.</p>
Priming:	Prime as recommended by the manufacturer
Application:	Apply and finish to a smooth, trowel free finish in accordance with the manufacturer's recommendations.
General:	Moist cure in accordance with the manufacturer's recommendations for a minimum of 7 days
System Thickness:	1/8" to 3/16"
Properties:	<p>Compressive Strength: 2000 psi minimum @ 1 day (ASTM C109 modified)</p> <p>Compressive Strength: 5000 psi minimum @ 28 days (ASTM C109 modified)</p> <p>Flexural Strength: 1300 psi minimum at 28 days (ASTM C293)</p> <p>Bond Strength: 1800 psi minimum at 28 days (ASTM C882 Modified)</p> <p>Shrinkage: $\leq 0.05\%$ at 28 days (ASTM C157 modified, 1" x 1" x 11 1/4" specimen)</p> <p>Recommended Application Thickness: 1/8" min to 1.5" max</p> <p>Recommended by the manufacturer for vertical, horizontal or overhead application.</p>
Level of Containment:	Class 1A

END OF SECTION

SECTION 09 90 05
TOUCH-UP OF EXISTING PAINT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies coatings and their surface preparation for touch-up of existing paint. This Section is intended to be used only where 10% or less of the equipment's or pipe segment's painted area is to be recoated. Refer to Section 09 90 00 where recoating greater than 10% of any equipment's or a pipe's painted area is required.
- B. Furnish all labor, equipment, including safety equipment, superintendence, materials, tools and incidentals necessary to prepare and coat the work as specified in this Section.
- C. Refer to Section 02 26 00 for hazardous material assessments.

1.02 DEFINITIONS

- A. Coating systems: Includes surface description, surface preparation, required dry film thickness, and the number and application procedure of the prime and finish coatings. Systems are as specified within this Section on the Coating System Specification Sheets (COATSPEC).
- B. Field coating: The application of the coating system after installation of the surface at the work site.
- C. Dry film thickness (DFT): The thickness of a fully cured coating or coating system.
- D. Wet film thickness (WFT): The thickness of a coating while wet.
- E. Volatile organic content (VOC): The portion of the coating that is a compound of carbon, is photo-chemically reactive and evaporates during drying or curing, expressed in grams per liter or pound per gallon as defined in ASTM D3960.
- F. Shop coat: One or more coats applied in a shop or plant prior to shipment to the site.
- G. Lead containing: Any coating that contains any detectable amount of lead.
- H. Scratch: a shallow and narrow cut in the existing coating which is visible from at least three feet from the surface.
- I. Peeling and Chipping: A piece of paint that has come loose from a surface which is visible from at least three feet from the surface.

1.03 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM D3359	Standard Test Methods to Measure Adhesion by Tape Test
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
SSPC	Steel Structures Painting Council, Volume 1 - Good Painting Practices
SSPC-Paint Application-PA-2	Measurement of Dry Paint Thickness with Type 2 Gauges
SSPC-SP 1	Solvent Cleaning
SSPC-SP 2	Hand Tool Cleaning

1.04 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) FOR SHOP AND FIELD

- A. General:
 - 1. Manufacturer's printed instructions: Deviations from the manufacturer's printed instructions will not be allowed unless approved in writing by the manufacturer's representative and the Project Representative before execution of said change.
- B. Contractor's responsibilities:
 - 1. Quality control: responsible for the quality control of the coatings applied and performing check points as specified in this Section.
 - 2. Over coating: Apply a new coating test patch onto the existing coating to verify coating compatibility.
 - 3. Provide testing equipment required in this Section and as required to verify compliance with the Specifications. Record of equipment calibration must also be provided.
- C. Project Representative's responsibility:
 - 1. Quality Assurance: determine acceptance or rejection of a coating based on the given specifications.
 - 2. Testing: may conduct tests on ambient conditions, surface temperature, coating(s) applied, target mil thickness, coating type (i.e. stripe coat), and coating batch numbers in accordance with SSPC Publication 91-12.
- D. Checkpoints: Contractor is responsible to perform the checkpoints specified below and as required in COATSPEC. The Project Representative may perform any or all of the checkpoints listed in addition to, but not replacement of, the requirement for the Contractor to perform the inspection checkpoints as specified below.
 - 1. Surface preparation: Shall be accepted by the Project Representative prior to the application of a coating.

1.05 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. A list of materials shall be provided before materials are delivered to the worksite.
- C. For each primer and finish coating, provide the manufacturer's application instructions, which shall include the following:
 - 1. Surface preparation recommendations.
 - 2. Primer type, where required.
 - 3. When color is not specified, provide manufacturer's range of standard colors.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials for field application to the job site in their original, unopened containers. Each container shall bear the manufacturer's name brand, batch number, date of manufacture, and storage life.

- B. Coatings shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Coatings, exceeding storage life recommended by the manufacturer or that have been visibly damaged shall be removed from the site. Flammable materials shall be stored in accordance with state and local codes.

1.07 SITE CONDITIONS

- A. Coatings shall be applied only to surfaces that are dry, and only under such combination of humidity and temperatures of the atmosphere and surfaces to be coated as will cause evaporation rather than condensation.

1.08 WARRANTY

- A. For the Work of this Section, provide all warranties as described in Section 00 72 00 General Terms and Conditions, Section 01 78 36, and special warranties as specified in the Technical Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Standardization:
 - 1. Materials, supplies, and articles provided shall be the standard products of manufacturers. Coatings in a particular system shall be the products of a single manufacturer.
 - 2. The standard products of manufacturers other than those specified may be accepted when it is demonstrated that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for substitutions will be considered when submitted per Section 01 33 00 provided the following minimum conditions are met:
 - a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required dry film thickness.
 - b. The proposed coating system shall use coatings of the same generic type. The directions for application and descriptive literature which includes generic type, non-volatile content by volume, material safety data sheets, VOC's by grams per liter, and other information confirms that the substitution is equal to the specified coating system.
- B. All coating materials shall be benzene and lead free and shall not, exceed 250 grams per liter of volatile organic compounds (VOC).

2.02 EQUIPMENT

- A. The Contractor is responsible for ensuring that all King County equipment including mechanical working parts and/or moving parts within the work area are protected from damage. Protection of equipment will be coordinated with the Project Representative.

PART 3 EXECUTION

3.01 PREPARATION

- A. General:
 - 1. Prepare and recoat all scratches, peeling, and chipping on existing paint.
 - 2. Surfaces to be coated shall be clean. Before applying coating, oil and grease shall be removed per SSPC SP-1. All dirt, rust, loose mill scale, loose coatings, and other foreign substances shall be cleaned according to the SSPC standards specified in the COATSPEC. Oil and grease shall be removed before mechanical cleaning is started.
 - 3. Clean cloths and clean fluids shall be used in solvent cleaning. Cleaning and coating shall be scheduled so that dust and spray from the cleaning process will not fall on wet, newly coated surfaces. Ensure that touch-up coating is compatible with existing coatings.

3.02 APPLICATION

- A. Workmanship: Coating shall be conducted in accordance with the requirements of SSPC, Good Painting Practice Volume 1.
 - 1. Coated surfaces shall be free from runs, drips, ridges, waves, laps and brush marks. Coats shall be applied so as to produce an even film of uniform thickness.
 - 2. Each coat of paint shall be applied evenly. Masking is not required except where the new coating meets a coating of a different color or an uncoated area.
- B. Coating properties, mixing, and thinning:
 - 1. Coating shall be thoroughly stirred, strained, and kept at a uniform consistency during application.
 - 2. Coatings shall be mixed in accordance with the manufacturer's instructions.
- C. Method of coating application:
 - 1. Prime and topcoat as specified in the coating system description.
 - 2. Stripe coating is not required.
- D. Unsatisfactory Application:
 - 1. Evidence of runs and drips is cause for rejection.
- E. Damaged Coatings, Pinholes, and Holidays:
 - 1. Apply touch-up coats in a manner that will present a uniform texture and color-matched appearance.

3.03 CLEANUP AND WASTE DISPOSAL

- A. At the end of each shift, remove surplus materials, protective coverings, and accumulated rubbish.
- B. Thoroughly clean all surfaces and repair any overspray or other paint-related damage when the work is complete.
- C. All solvents, unused coatings and cleaning solutions shall be removed from the site and disposed of legally when coating work is complete or if directed by the Project Representative.

3.04 PROTECTION

- A. Where protection is provided for coated surfaces, such protection shall be preserved in place until the coating film has properly dried, and removal of the protection is authorized by the Project Representative. Items, which have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard.
- B. Hardware, electrical fixtures, nameplates, shims and similar accessories shall be removed or masked during preparation and coating operations or shall otherwise be satisfactorily protected.

3.05 COATING SYSTEMS

- A. Surfaces to be coated are specified in the COATSPEC.

3.06 COATING SYSTEM SPECIFICATION SHEET - COATSPEC

- A. Coating Systems specified for use appear on the following pages.

Coating System Identification:	L-1a
Coating Material:	100% Acrylic semi-gloss
Surfaces:	Previously painted equipment and piping.
Service Condition:	Interior/Exterior Non-corrosive environment.
Surface Preparation:	
Previously painted equipment and piping:	Degrease to SSPC-SP1. Wire brush, sand, or scrape scratched, peeling, and chipped areas to remove all loose material. Remove sanding dust by wiping with manufacturer-approved solvent.
Inspection Checkpoints:	Checkpoint 1 applies.
Application:	Brush or roller.
Color:	Match existing.

Coatings:	
ALTERNATE 1	
Primer:	Not used.
Finish:	One coat of PPG-Devco Devflex 4216HP.
ALTERNATE 2	
Primer:	Not used.
Finish:	One coat of Sherwin-Williams Pro Industrial Acrylic #B66-650.
ALTERNATE 3	
	Approved Equal.

END OF SECTION

SECTION 10 14 00

SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies informational and accident prevention signs. Exit signs are not covered in this Section.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
29 CFR 1910.145	OSHA Specification for Accident Prevention Signs and Tags
ANSI Z535.1	Safety Color Code
ANSI Z535.2	Environmental and Facility Safety Signs
IFC	International Fire Code
WAC 296-24 (Part B-2)	WISHA Marking Physical Hazards
NFPA	SIGNS REQUIRED BY NFPA 704

1.03 DESIGN REQUIREMENTS

- A. General:
- Accident prevention signs shall conform to requirements of WISHA Chapter 296-24 WAC (Part B-2), OSHA 29 CFR 1910.145, ANSI Z535.1 and ANSI Z535.2.
 - Exit signs shall conform to the requirements of IFC 1011 and the local administrative authority.
 - All signs shall have rounded corners and four mounting holes.
 - Number, size, type and placement of signs shall be as indicated in the schedules.
 - The hazardous material numerical grading signs shall be provided and installed on the material storage room entry door and storage container per NFPA 704 requirements.
- B. Sign Location:
- Door Nameplates
 - Material: plastic with rounded corners
 - Thickness: 1/8 inch
 - Finish: Nondirectional matte
 - Background: As scheduled
 - Letters: Raised
 - Style: Helvetica regular
 - Message: As shown on schedule
 - Braille text: Domed or rounded as required by ADA regulations with 3/8-inch minimum clearance on all sides
 - Fabricate in accordance with shop drawings and samples
- C. Sign Types:
- Type A (Plastic):
 - Exterior: Laminated plastic subsurface image type, 3/16 inch thick with high-gloss finish.
 - Interior: Plastic, 1/8 inch thick with nondirectional matte finish and raised letters.
 - Rounded corners.

2. Type B (Metal):
 - a. Material: Baked enamel finished 20-gauge (minimum) steel or 18-gauge (minimum) aluminum signs.
 3. Type C (Fiberglass):
 - a. Material: Three-ply laminated fiberglass, minimum 1/8 inch thick, with contrasting color core message layer between two clear weather-resistant surface layers.
 4. Type G (Exit Sign):
 - a. Illuminated product specified by Electrical. See Electrical
 5. Type H (Hazardous Material Sign):
 - a. Conform to NFPA 704 and NFPA HAZ-01.
 - b. Material:
 - 1) Fiberglass 1/8 inch thick.
 - 2) Reflective sheeting applied to 0.040-inch-thick aluminum.
 - 3) Adhesive vinyl for curved surfaces.
 - c. Background, Letters, and Numbers: Die-cut vinyl with pressure sensitive adhesive.
- D. Sign Ancillaries:
1. Fasteners: Stainless steel screws or bolts of appropriate sizes.
 2. Wood posts: Preservative treated 4 by 4 wood as specified in Section 06 10 00.
 3. Pipe posts: 2 1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.
 4. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.
 5. Manufacturer's standard brackets for wall mounting of two-sided exit signs.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Samples of sign materials, mounting hardware, and shop drawings of all signs.

1.05 SCHEDULE

- A. Distribute signs as listed in the following schedules.
 1. Schedule 1: Informational and Accident Prevention Signs:

No.	Location	Sign Type	QTY	Size Width/ Height	Message	Mounting Location/ Method	Lettering (Ht./ Color)	Height to Top	Color	Detail Ref.
S-1	SAMPLER ENCLOSURE	B	1	10 in x 5 1/2 in	Sampler Enclosure 431	Wall/ Screws	1in/ white	5 ft - 6 in	brown	B/WP704-A-40006, 7/WP704-A-90004
S-2	ELECTRICAL ROOM	B	2	10 in x 5 1/2 in	Electrical Room 411	Door/ Adhesive	1in/ white	5 ft - 6 in	brown	7/WP704-A-90003; 1(2-doors)/ WP704-A-90004; 1/WP704-A-90007
S-3	ELECTRICAL ROOM	B	2	14 in x 10 in	Notice – Authorized Personnel Only	Door/ Adhesive	1 inch/ white	5 ft - 6 in	white/blue	5/WP704-A-90003; 1(2-doors)/ WP704-A-90004; 1/WP704-A-90007;

No.	Location	Sign Type	QTY	Size Width/ Height	Message	Mounting Location/ Method	Lettering (Ht./ Color)	Height to Top	Color	Detail Ref.
S-4	ELECTRICAL ROOM	B	2	14 in x 10 in	Notice – Keep This Door Closed	Door/ Adhesive	1 inch/ white	5 ft - 6 in	white/blue	5/WP704-A-90003; 1(2-doors)/WP704-A-90004; 1/WP704-A-90007;
S-5	ELECTRICAL ROOM	B	2	14 in x 10 in	Safety First – Protective Gear Required While Servicing	Door/ Adhesive	1 inch/ white	5 ft - 6 in	white/blue	5, 8/WP704-A-90003; 1(2-doors)/WP704-A-90004; 1/WP704-A-90007;
S-7	ELECTRICAL ROOM	B	2	14 in x 10 in	Danger – High Voltage	Door/ Adhesive	1 inch/ white	5 ft - 6 in	white/red	1 /WP704-A-90003; 1(2-doors)/WP704-A-90004; 1/WP704-A-90007;
S-8	NORTH BATTERY ROOM	B	1	10 in x 5 1/2 in	North Battery Room (409)	Door/ Adhesive	1 inch/ white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1-door)/WP704-A-90004; 1/WP704-A-90007;
S-9	SOUTH BATTERY ROOM	B	1	10 in x 5 1/2 in	South Battery Room (408)	Door/ Adhesive	1 inch/ white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1-door)/WP704-A-90004; 1/WP704-A-90007;
S-10	N BATTERY ROOM/ S BATTERY ROOM	B	1/ room	14 in x 10 in	Danger- Do Not Enter When Lights are Flashing	Door/ Adhesive	1 inch/ black	5 ft - 6 in	red, black	1 /WP704-A-90003; 1(1-door)/WP704-A-90004; 1/WP704-A-90007;
S-11	N BATTERY ROOM/ S BATTERY ROOM	B	1/ room	14 in x 10 in	Lithium Ion Storage Batteries	Door/ Adhesive	1 inch/ white	5 ft - 6 in	yellow	2/WP704-A-90003; 1(1-door)/WP704-A-90004; 1/WP704-A-90007;
S-12	N BATTERY ROOM/ S BATTERY ROOM	B	1/ room	14 in x 10 in	Energized Electrical Circuits	Door/ Adhesive	1 inch/ white	5 ft - 6 in	red / white	2/WP704-A-90003; 1(1-door)/WP704-A-90004; 1/WP704-A-90007;

No.	Location	Sign Type	QTY	Size Width/ Height	Message	Mounting Location/ Method	Lettering (Ht./ Color)	Height to Top	Color	Detail Ref.
S-13	N BATTERY ROOM/ S BATTERY ROOM	B	1/ room	14 in x 10 in	Safety First – Protective Gear Required While Servicing	Wall/ Adhesive	1 inch/ white	5 ft - 6 in	green / white	8/WP704-A-90003; 1(1-door)/WP704-A-90004; 1/WP704-A-90007;
S-14	N BATTERY ROOM/ S BATTERY ROOM	B	1/ room	14 in x 10 in	Notice – Authorized Personnel Only	Wall/ Adhesive	1 inch/ white	5 ft - 6 in	blue/ white	5/WP704-A-90003; 1(1-door)/WP704-A-90004; 1/WP704-A-90007;
S-15	N BATTERY ROOM/ S BATTERY ROOM	B	1	14 in x 10 in	Notice – Keep This Door Closed	Wall/ Adhesive	1 inch/ white	5 ft - 6 in	blue/ white	5/WP704-A-90003; 1(1-door)/WP704-A-90004; 1/WP704-A-90007;
S-16	BOILER ROOM 507	A (int)	1	10 in x 5 1/2 in	Boiler Room 507/ Boiler Room 503	Door/ Adhesive	1 inch/ white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1 & 2-door)/WP704-A-90004; 1/WP705-A-10001;
S-16A	BOILER ROOM 507	B	2	10 in x 5 1/2 in	Boiler Room 507/ Boiler Room 503	Door/ Adhesive	1 inch/ white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1&2-door)/WP704-A-90004; 1/WP705-A-10001;
S-16B	BOILER ROOM	A (int)	2	14 in x 10 in	Notice – Keep This Door Closed	Door/ Adhesive	1 inch/ white	5 ft - 6 in	blue/ white	5/WP704-A-90003; 1(1 & 2-door)/WP704-A-90004; 1/WP705-A-10001;
S-16C	BOILER ROOM	B	2	14 in x 10 in	Notice – Keep This Door Closed	Door/ Adhesive	1 inch/ white	5 ft - 6 in	blue/ white	5/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP705-A-10001;
S-17	BOILER ROOMS	B	4	10 in x 5 1/2 in	Boiler 1, 2, 3, 4 (as applicable)	Hanging/ Chain	1 inch/ white	6 ft - 8 in	brown	7/WP704-A-90003; 1/WP705-A-10001;
S-18	MOTOR ROOM	B	2 EA	14 in x 10 in	Safety First – Emergency Eyewash	Wall/ Screws	1 inch/ white	5 ft - 6 in	brown	8/WP704-A-90003; 1/WP704-A-90006;

No.	Location	Sign Type	QTY	Size Width/Height	Message	Mounting Location/Method	Lettering (Ht./Color)	Height to Top	Color	Detail Ref.
S-19	MOTOR ROOM	C	5	14 in x 10 in	Danger – 480 Volts	Hanging/Chain	1 inch/white	5 ft - 6 in	red	1/WP704-A-90003; 1/WP704-A-90006;
S-20	MOTOR ROOM	A	2 EA at doors ; 1 at stair	14 in x 10 in	Caution – Hearing Protection Required	Door Adhesive; Chain at Stair	1 inch/yellow	5 ft - 6 in; 6 ft – 8 at stair	yellow / black	2/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90006;
S-21	MOTOR ROOM	A	2 EA	10 in x 5 1/2 in	Motor Room (420)	Door Adhesive;	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90006;
S-22	RSP BUILDING ROOFS	B	1	10 x 5 1/2"	Building Stair Roof	Hanging/Chain	1 inch/white	5 ft - 6 in	brown	1/WP704-A-90007;
S-23	MOTOR ROOM	A	4	14 in x 10 in	Caution – Automatic Equipment May Start at Any Time	Hanging/Chain	1 inch/yellow, black	5 ft - 6 in	yellow	2/WP704-A-90003; 1/WP704-A-90006;
S-24	PUMP ROOM	A	4	14 in x 10 in	Caution – Automatic Equipment May Start at Any Time	Hanging/Chain	1 inch/white	5 ft - 6 in	yellow	2/WP704-A-90003; 1/WP704-A-90005
S-25	PUMP ROOM	A	3	10 in x 5 1/2 in	Pump Room (429)	Door Adhesive; Chain at Stair	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90005
S-26	REST ROOM	A	1	9 in x 9 in	Rest Room (400)	Door Adhesive;	1 inch/white	5 ft - 6 in	brown	6/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90005
S-27	Not Used									
S-28	PUMP ROOM	B	4	14 in x 10 in	Caution – Hearing Protection Required	Hanging/Chain	1 inch/white	5 ft - 6 in	yellow	2/WP704-A-90003; 1/WP704-A-90005

No.	Location	Sign Type	QTY	Size Width/Height	Message	Mounting Location/Method	Lettering (Ht./Color)	Height to Top	Color	Detail Ref.
S-29	STAIR 430S	A	1	10 in x 5 1/2 in	Stair 430S	Door Adhesive;	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90005
S-30	BOILER ROOMS	B	4	14 in x 10 in	Caution – High Temperature	Hanging/Chain	1 inch/yellow, black	5 ft - 6 in	yellow/black	2/WP704-A-90003; 1/WP705-A-10001
S-31	BOILER ROOMS	B	4	14 in x 10 in	Caution – Automatic Equipment May Start at Any Time	Hanging/Chain	1 inch/white	5 ft - 6 in	yellow/black	2/WP704-A-90003; 1/WP705-A-10001
S-32	CRANE HALL	A	3	10 in x 7 in	Crane Hall (412)	Door/Adhesive	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90007
S-33	CONTROL ROOM	A	1	10 in x 7 in	Control Room (412)	Wall/Screws	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1/WP704-A-90007
S-34	EAST FAN ROOM	A	1	10 in x 7 in	East Fan Room (423)	Wall/Screws	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1/WP704-A-90006
S-35	EAST STORAGE ROOM	A	1	10 in x 5 1/2 in	East Storage Room (428)	Door/Adhesive	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1(2 - door)/WP704-A-90004; 1/WP704-A-90006
S-36	EMPTY	A	1	10 in x 5 1/2 in	Unassigned (417)	Door/Adhesive	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90006
S-37	ENGINE MAIN ROOM	A	1	10 in x 5 1/2 in	Engine Main Room (421)	Door/Adhesive	1 inch/white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90006
S-38	LIVE LOAD	A	31	7 in x 4 in	Live Load Limit (See Below for PSF values)	Wall/Screws	1 inch/white	5 ft - 6 in	brown	1(1 - door)/WP704-A-90004; 1/WP704-A-90006

No.	Location	Sign Type	QTY	Size Width/ Height	Message	Mounting Location/ Method	Lettering (Ht./ Color)	Height to Top	Color	Detail Ref.
S-39	TOOL ROOM	A	2	10 in x 5 1/2 in	Tool Room (416)	Door/ Adhesive Wall/ Screws	1 inch/ white	5 ft - 6 in	Brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90007
S-40	Break Room	A	1	10 in x 5 1/2 in	Break Room (410)	Door/ Adhesive	1 inch/ white	5 ft - 6 in	Brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90007
S-41	Janitor	A	1	10 in x 5 1/2 in	Janitor (401)	Door/ Adhesive	1 inch/ white	5 ft - 6 in	Brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90007
S-42	Not Used									
S-43	West Storage Room	A	1	10 in x 5 1/2 in	West Storage Room 427	Door/ Adhesive	1 inch/ white	5 ft - 6 in	Brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90005
S-44	Unoccupied Storage	A	1	10 in x 5 1/2 in	Unoccupied Storage 430	Wall/ Screws	1 inch/ white	5 ft - 6 in	brown	7/WP704-A-90003; 1/WP704-A-90005
S-45	Storage Room	A	1	10 in x 5 1/2 in	Storage Room 422	Door/ Adhesive	1 inch/ white	5 ft - 6 in	brown	7/WP704-A-90003; 1(1 - door)/WP704-A-90004; 1/WP704-A-90005
S-46	Airway	A	1	10 in x 5 1/2 in	Airway 424	Door/ Adhesive	1 inch/ white	-	Brown	7/WP704-A-90003; 11/WP704-A-90006
S-47	Break Room	A	1	10 in x 5 1/2 in	Maximum Occupants 10	Wall/ Screws	1 inch/ black	5 ft - 6 in	White	5/WP704-A-90003; SIM

2. Schedule 2: Live Load Signs, 4" x 7 1/4" , Type A for interior locations, Type B for exterior locations.

FACILITY		ROOM NO.	ROOM NAME	Posted Live Load
704	Raw Sewage Pump Building	400	Washroom	150 PSF

		401	Janitor	150 PSF
		402	Server Room	150 PSF
		403	Telephone Equip Room	150 PSF
		404	Hallway	150 PSF
		405	Control Room	250 PSF
		406	Panel Access	250 PSF
		407	Panel Access	250 PSF
		408	South Battery Room	250 PSF
		409	North Battery Room	250 PSF
		410	Break Room	150 PSF
		411	Electrical Room	250 PSF
		412	Crane Hall	250 PSF
		412NW	Northwest Vestibule	250 PSF
		412NE	Northeast Vestibule Screen Access Hall	H20 TRUCK OR 250 PSF
		416	Tool Storage Room	150 PSF
		417	Unassigned	250 PSF
		419	Old Battery Room	250 PSF
		420	Motor Room	250 PSF
		421	Engine Maintenance Room	100 PSF
		422	Storage Room	150 PSF
		423	East Fan Room	150 PSF
		424	Airway	100 PSF
		425	Screenings Grinder Room	250 PSF
		426	Gallery	150 PSF
		427	West Storage Room	150 PSF
		428	East Storage Room	150 PSF
		429	Pump Room	250 PSF
		431	Sampling Enclosure	150 PSF
705	Grit/Screenings Handling, Boilers		Equipment Platform Live Load	125 PSF

3. Allowance for additional signs as requested by the Project Representative

Location	Quantity	Size	Type	Mount
TBD	4	10 x 5 ½"	A	TBD
TBD	4	14" x 10"	B	TBD
TBD	4	14" x 10"	C	TBD

4. All utility stations shall be equipped with a sign saying "CAUTION – NON-POTABLE WATER DO NOT DRINK", size B as shown on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
1. Brady.

2. Seton.
3. Approved Equal.

2.02 FABRICATION

- A. Sign lettering shall be single stroke and shall contrast in color with the background. For those messages for which there are international symbols, those symbols shall be used.
- B. Accident prevention signs: fade-proof graphic permanently embedded 1/8-inch thick fiberglass reinforced plastic. Guaranteed not to chip, fade, or peel for 15 years.
- C. Informational signs:
 1. Signs shall be fiberglass with fade-proof graphic permanently embedded 1/8 -inch-thick fiberglass reinforced plastic. Guaranteed not to chip, fade, or peel for 15 years.
 2. Brown background with a white border and white lettering.
 3. Helvetica light of medium lettering.
 4. Upper case lettering: 3 inches high.
 5. Lower case lettering: 2¼-inches high.
 6. Identical in appearance to the existing building signs.
- D. Blade-type signs: Wall or ceiling mounted, projecting outward with information on both sides.
- E. Chain-mounted signs: Provide information on both sides.
- F. Rest room signs shall be raised 1/32 inch white lettering on brown background, with minimum 3"x14" size. The rest room signs shall have both wording and the standard rest room symbol. Rest room signs shall conform to current ADA regulation and requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Do not begin production until all shop drawings of the signs have been approved.
- B. Fasten surface-mounted signs to wall with expansion bolts or suitable anchors. Fasten to walls, posts, or hang per schedule.
- C. Conceal all fasteners as much as possible.
- D. Use backup materials as required to achieve concealed mounting.
- E. Mount posts in accordance with Drawings.
- F. All signs fasteners shall be stainless steel type 316.
- G. Door nameplates and pictorial symbols: Attach to doors or walls adjacent to doors with Phillips head screws. See schedule for locations and messages. Mount with bottom of nameplate 5 feet 6 inches above floor.

END OF SECTION

SECTION 10 28 00
TOILET AND BATH ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies toilet accessories:
 - 1. Surface-mounted seat-cover dispenser.
 - 2. Surface -mounted multi-roll toilet tissue dispenser.
 - 3. Recessed paper towel dispenser and waste receptacle.
 - 4. Surface-mounted soap dispenser.
 - 5. Grab bars
 - 6. Surface-mounted mirror
 - 7. Mop rack

1.02 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI A117	Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data: Provide product data for each toilet accessory item specified, including details of construction relative to materials, dimensions, gauges, profiles, method of mounting, specified options, finishes, installation instructions, and service and parts manual.
- C. Schedule: Indicating types, quantities, sizes, and installation locations (by room) for each toilet and bath accessory item to be provided for the Contract.
- D. Setting Drawings: Where cutouts are required in other work, provide substrate preparation instructions, and directions for preparing cutouts and for installation of anchorage devices.
- E. Samples: Upon request submit one sample of each item specified. If more than one manufacturer is specified, submit one sample of each item for architect's review.

1.04 QUALITY ASSURANCE

- A. Manufacturers:
 - 1. Model numbers for toilet room accessories manufactured by Bobrick Washroom Equipment, Inc. are listed to establish a standard of quality for design, function, materials, workmanship, and appearance. The following manufacturers may be submitted for evaluation by the Project Representative as equals:
 - a. American Specialties, Inc.
 - b. Bradley.
 - c. Approved Equal.
 - 2. Accessories shall be the products of a single manufacturer. Accessories with tumbler locks shall be keyed alike.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver items in manufacturer's original unopened protective packaging.
- B. Store materials in original protective packaging to prevent physical damage or wetting.
- C. Handle so as to prevent damage to accessories.

1.06 WARRANTY

- A. Furnish one year guarantee against defects in material and workmanship on all accessories. In addition to the above the following shall apply:
 - 1. Welded stainless steel framed mirrors shall have a fifteen-year guarantee against silver spoilage.

PART 2 PRODUCTS

2.01 TOILET ROOM ACCESSORY SCHEDULE

- A. Provide the following toilet and bath accessories in the locations indicated on the Drawings and Schedules.

MARK	MODEL/SERIES	DESCRIPTION
T1	B-221	Surface-mounted seat cover dispenser
T2	B-2888	Surface-mounted multi-roll toilet tissue dispenser
T3	B-3944	Recessed paper towel dispenser & waste receptacle
T4	B-254	Surface-mounted sanitary napkin disposal
T5	B-2221	Surface-mounted soap dispenser
T6	B-165 1836	Surface-mounted mirror
T7	B-5897	One-piece toilet grab bars
T8	B-5806 X 18	18" Grab bar
T9	B-223 X 36	Mop Rack
T10	B-2620t	Surface-mounted paper towels

2.02 MATERIALS

- A. All cabinets shall be constructed of 18-8, Type-304 stainless steel.
- B. All waste receptacles shall be constructed of 18-8, Type-304 stainless steel or rigid molded leak-proof plastic.
- C. All tumbler locks to be fastened to accessories with lock nuts. Fastening locks to units with spring clips is not acceptable.

2.03 ACCESSORIES

- A. Mounting Devices: Provide manufacturers standard mounting devices.
 - 1. Exposed Fasteners: Use fasteners of sufficient length to securely engage backing materials.

2.04 FABRICATION

- A. General:
 - 1. Names and labels are not permitted in exposed locations of accessories provided under this Section.
 - 2. Provide printed waterproof; stamped; or etched nameplate indicating manufacturer name and model number for each accessory:
 - a. Install identification on interior; not exposed to view; or on the back of the accessory.
- B. Templates and Concealed Anchors:
 - 1. Provide to each trade as required for each accessory.
 - 2. Work with others to review the approved Shop Drawings, including mounting locations and heights coordinated with other items including plumbing rough-ins, and other items.
- C. Surface Mount Accessories:
 - 1. Fabricate units with tight seams and joints.
 - 2. Roll exposed edges.
 - 3. Provide full length, continuous, stainless steel hinges only.
 - 4. Provide concealed mounting where possible.
- D. Recessed Mounted Accessories:
 - 1. Fabricate of all welded construction, without mitered corners.
 - 2. Provide full length, continuous, stainless steel hinges only.
 - 3. Provide anchorage that is fully concealed when unit is closed.

PART 3 EXECUTION

3.01 INSPECTION

- A. Check wall open for dimensions, plumbness of blocking or frames that would affect installation of recessed accessories. For surface mounted accessories check condition of wall and confirm installation of backing within wall.
- B. Verify spacing of plumbing fixtures and toilet compartments that affect installation of toilet room accessories.

3.02 INSTALLATION

- A. Install accessories at locations and heights indicated, straight, plumb and level and in accordance with manufacturer's installation instructions.
- B. Install items with non-corrosive anchoring devices.
- C. Installation methods shall conform to manufacturers recommendations for backing and proper support.
- D. Conceal evidence of drilling, cutting, and fitting to room finish.
- E. Fit flanges of accessories snugly to wall surfaces.

3.03 ADJUSTMENT AND CLEANING

- A. Upon completion of the work, or when directed, remove all traces of protective coatings or paper.
- B. Adjust accessories for proper operation. Test mechanisms, hinges, locks and latches and where necessary adjust and lubricate.

- C. Clean and polish exposed surfaces prior to final installation.
- D. Deliver accessories schedule, keys, and parts manual as part of project closeout documents. For project representative's permanent records, provide two sets of the following items of manufacturer's literature:
 - 1. Technical data sheets of each item used for the project.
 - 2. Service and parts manuals.
 - 3. Name of local representative to be contacted in the event of need of field service or consultation.

END OF SECTION

SECTION 10 44 21
PORTABLE FIRE EXTINGUISHERS AND CABINETS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies fire extinguishers and semi-recessed cabinets.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
UL 299	Fire Extinguishers, Dry Chemical
NFPA 10	Standard for Portable Fire Extinguishers

1.03 DESIGN REQUIREMENTS

- A. Type: Fire extinguishers shall be of the multi-purpose dry chemical type as specified in this Section.
- B. The fire extinguisher system shall meet the requirements of the local Fire Department whose jurisdiction governs this project: City of Seattle.
- C. The multipurpose dry chemical fire extinguishers shall be UL and ULC rated at 4A-80-B:C.
- D. All fire extinguishers shall comply with Underwriters Laboratory Standard 299, shall bear Factory Mutual Certification Underwriters Laboratories Certification, and shall be listed by the State Fire Marshal.
- E. Distribution and installation of all fire extinguishers shall be in conformance with NFPA No. 10.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Provide manufacturer's technical data and application information.
 2. Written verification from the local Fire Department that installation of the extinguishers meet permit and code requirements.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Amerex.
- B. No substitution for the above manufacturer. The equipment in this Section has been pre-selected by the County for system standardization.

2.02 MATERIALS AND CONSTRUCTION

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:
 - 1. Doors of fire extinguisher cabinets:
 - a. 0.062 inch extruded aluminum etched to a satin finish and anodized to prevent corrosion.
 - b. Tubular construction with an aluminum continuous hinge and a positive cam catch.
 - 2. Frames of fire extinguisher cabinets:
 - a. 0.062 inch extruded aluminum etched to a satin finish and anodized to prevent corrosion.

2.03 EQUIPMENT

- A. Type A: cabinet mounted.
- B. Type B: column or wall mounted.
 - 1. Extinguishers shall be 10 pounds.
- C. Wall brackets:
 - 1. Bracket type to fit specified extinguisher.
 - 2. Furnish bracket for each extinguisher not in cabinet.
 - 3. Bracket to be finished in red or black enamel.
- D. Fire Extinguisher Signage:
 - 1. Single faced: SETON #21999.
 - 2. Double faced: SETON #22001.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fire extinguishers as shown on the Drawings, and/or as described in this Section.
 - 1. Obtain final location approval from Project Representative.

Room	Type of Extinguisher
North Battery Room 409	2-A
South Battery Room 408	2-A
Control Room 405	2-A
Electrical Room 411	2-A
NE Vestibule 412NE	2-A
NW Vestibule 412NW	2-A
Crane Hall 412	2-A
Hallway 404	2-A
Break Room 410	2-A
Tool Room 416	4-A
Sample Enclosure 431	2-A
Screen Access Hall 413	2-A
Motor Room 420 (2)	2-A
Engine Main Room 421	4-A
Storage Room 422	4-A
East Fan Room 423	2-A
Pump Room 429	2-A

Pipe Gallery	2-A
Unoccupied Storage 430W	4-A
Unoccupied Storage 430E	2-A
East Storage Room 428	4-A

2. Refer to the Drawings for locations.

END OF SECTION

SECTION 10 51 13
METAL LOCKERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies all steel lockers. All lockers shall be of the single-person type. Unless otherwise indicated, lockers shall be power ventilated.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog data for products.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Lyon Metal Products.
- B. Penco.
- C. Republic Steel.
- D. Approved Equal.

2.02 TOOL STORAGE CABINET

- A. Materials:
1. All-Welded 36 inches wide x 21 inches deep x 82 inches high Steel Industrial Storage Cabinet.
 2. Heavy-Duty Construction:
 - a. 14-gauge steel construction.
 - b. Doors to include three 5/16 inch diameter brass-pin hinges, Three-point locking system with 3/8 inch latch rod on the right door that engages both the top and bottom of the cabinet.
 - c. 3/16 inch latch plate secures left door when the handle position is in closed position.
 - d. Aluminum handle includes a 3/8 inch thick hasp for adding padlock.
- B. Finish:
1. Powder coat paint finish.
- C. Shelves:
1. Four adjustable 36 inches wide x 21 inches deep steel shelves.
 2. Each shelf to have a payload capacity of 1,450 lbs.

3. Shelves adjustable on 3 inch centers.
4. 4 inch high forklift base.

2.03 JANITOR CLOSET SHELVING

- A. Wall Mounted Shelving:
 1. Closed Shelving:
 - a. 36 inches wide x 12 inches deep x 36 inches high.
 - b. Two adjustable shelves.
 2. Construction No. 16 U.S. standard gage cold-rolled and leveled sheet steel reinforced or stiffened to prevent distortion.

2.04 RESTROOM SHELVING

- A. Supplies Storage:
 1. Closed Shelving:
 - a. 36 inches wide x 12 inches deep x 36 inches high.
 2. Two adjustable shelves.
 3. Construction No. 16 U.S. standard gage cold-rolled and leveled sheet steel reinforced or stiffened to prevent distortion.
 4. Finish:
 - a. White Powder Coat.

2.05 CORRIDOR RAIN COAT AND BOOT STORAGE

- A. Wall-Mounted Metal Wire-Frame Shelving:
 1. 54 inch long unit consisting of 3 sections each at 18 inches long X 20 inches deep x 78 inches high.
 2. Include end panels of high-pressure laminate all sides of $\frac{3}{4}$ inch plywood 20 inches deep x 78 inches high. Bolted to ends of 54 inches units. One end panel is acceptable when two 54 inch long units abut.
 3. Acceptable manufacturer:
 - a. Groves Incorporated Ready Rack.
 - b. Approved Equal.

2.06 TOOL LOCKERS

- A. Doors:
 1. General: Doors and door frames shall be No. 14 U.S. standard gage cold-rolled and leveled sheet steel reinforced or stiffened to prevent distortion.
 2. Locking Devices:
 - a. Positive, automatic, pre-locking type which permit the lockers to be locked while the doors are open, then closed without unlocking.
 - b. The locking bars shall be enclosed, tamper-proof and equipped with 3 locking points.
 - c. Use rubber silencers to prevent metal-to-metal contact in the locking devices or otherwise to minimize noise generated by opening and closing the doors.
 - d. Handles: Die cast nonferrous metal with provisions for padlocks and having a padlock strike.
 3. Hinges: Each door shall have at least three 2-inch-wide tight pin style hinges.
 4. Number Plates: Mount metal number plates with etched or stamped consecutive numbers at least $\frac{1}{2}$ inch in height on the doors.
- B. Shelves
 1. Capacity of 1450 pounds per shelf.
 2. Shelves bolt securely into welded keyhole slots and can be repositioned on 3 inch centers.

- C. Body:
 - 1. General:
 - a. 36 inches wide x 24 inches deep x 82 inches high.
 - 2. Construction: Body, consisting of upright sheets, backs, tops, bottoms and shelves, to be of not lighter than No. 24-gage mild cold-rolled steel free from imperfections.
 - 3. Bolts and nuts shall be zinc-plated.
 - 4. The top of each locker shall be perforated with 1/4-inch holes on 1-inch centers each way to provide passage to the power ventilation system.
- D. Trim Angles:
 - 1. Provide to cover the gap at the ends and across the top of each locker section at junctions with walls.
 - 2. Dimensions: 3 inches wide and not less than 18-gage steel with returns.
- E. Base: Design lockers for installation as shown.
- F. 4 inch high legs welded to cabinet.
- G. Locker Finish: After fabrication, clean all steel surfaces of all oil and grease, phosphatize to inhibit corrosion, and finish with a prime coat and 2 coats of baked-on enamel in the selected color.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install lockers stainless steel screws.
- B. Fasten sides and back of units directly to framing at the top and the bottom.
- C. Provide one set of fasteners for every other locker.

END OF SECTION

SECTION 11 30 13

APPLIANCES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies appliances.

1.02 QUALITY ASSURANCE (NOT USED)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data: Submit complete product data for each appliance.
- C. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data: Submit installation, maintenance, and warranty documents with Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufactures
 - 1. General Electric
 - 2. LG.
 - 3. Approved Equal.
- B. Refrigerator:
 - 1. GIE22JSNRSS; 21.9 cu ft.; ADA-compliant, Energy Star, stainless steel. 32.75 inches wide, 34.5 inches deep, 66.375 inches high.
 - 2. Approved Equal.
- C. Range:
 - 1. GE JB48STSS, 30 inch, free-standing, Electric.ADA-compliant, Stainless steel, ceramic glass cooktop or Approved Equal.
- D. Range Hood:
 - 1. GE JVX3300SJSS; 30 inch, install as unvented recirculating unit, stainless steel, Energy Star. (5.5 inches high x 29 7/8 inches wide x 20 inches deep).
 - 2. Approved Equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence. Notify the Project Representative in writing of conditions detrimental to the proper and timely completion of the Work.

- B. Do not begin installation until unsatisfactory conditions are resolved. Beginning work constitutes acceptance of site conditions and responsibility for defective installation caused by prior observable conditions.

3.02 INSTALLATION

- A. Install appliances in accordance with the manufacturer's recommendations in the locations indicated.

END OF SECTION

SECTION 12 35 54
PLASTIC LAMINATE CASEWORK

PART 1 GENERAL

1.01 SUMMARY

- A. Section specifies plastic laminate casework, countertops, vanity tops and hardware.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NEMA LD 3	High-Pressure Decorative Laminates
AWI	Architectural Woodwork Institute

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Finished color samples of each finish, 3 sets.
- C. Manufacturer's literature for specialty items not manufactured by the casework manufacturer.
- D. Shop Drawings: Include large scale plans, elevations, joint details, connections to adjacent items, rough-in and anchor placement dimensions and tolerances, and clearances required.

1.04 QUALITY ASSURANCE

- A. Construct casework in accordance with AWI Quality Standards. Items not identified with a specific quality grade shall be AWI Custom Grade.
- B. Manufacturer shall have demonstrable record of successfully completing comparable work.

1.05 DESCRIPTION

- A. Plywood core covered with laminated plastic sheets.
- B. Manufacturer's standard sized modular units complying as closely as possible to the dimensions indicated.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver until the building has been free of excessive moisture for at least 10 days and has been conditioned and prepared to store casework without damage or discoloration.
- B. Protect casework: Store in dry, well ventilated area not subject to extreme changes of temperature or humidity.

1.07 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on the shop drawings.

PART 2 PRODUCTS

2.01 COMPONENTS

- A. Plywood:
 - 1. PS 1.
 - 2. Minimum 3/4-inch thick.
 - 3. No surface knots or voids.
 - 4. Waterproof glue.
- B. General Purpose Plastic Laminate:
 - 1. NEMA LD 3.
 - 2. Grade GP 50 high pressure laminate.
 - 3. Minimum 1/16-inch thick.
- C. Cabinet Liner (The following may be used for unexposed cabinet interiors instead of general purpose laminate specified):
 - 1. Pre-veneered panels.
 - 2. 1/32-inch vertical grade plastic laminate surface.
- D. Particle board not allowed.

2.02 HARDWARE

- A. Hinges:
 - 1. Full overlay concealed.
 - 2. Stainless steel finish.
 - 3. No edge fastening allowed.
- B. Pulls: 4-inch center to center wire type with brushed chrome finish.
- C. Shelf Brackets: Standards and supports of metal flush mount design with zinc-plated finish.
- D. Drawer Slides:
 - 1. Plastic or metal providing a smooth sliding action.
 - 2. Capable of supporting on the extended drawer:
 - a. 75 pounds in drawers 6 inches and less in depth.
 - b. 100 pounds in other drawers.
- E. Catches: Magnetic.

2.03 COUNTERTOPS

- A. Plastic laminate over 3/4-inch plywood with matching backsplash.
- B. Particle board not allowed.

2.04 FABRICATION

- A. Shop assemble casework for delivery to site in units that are:
 - 1. Easy to handle.
 - 2. Capable of passage through building openings.
- B. Corners and joints:
 - 1. Fabricate without gaps or inaccessible spaces.

- 2. Fabricate without areas where dirt or moisture could accumulate.
- C. Structural integrity:
 - 1. Fabricate each unit rigid, not dependent on building structure or adjacent units for rigidity.
 - 2. Do not construct to rely on mechanical fastening of core edges for strength.
 - 3. Utilize face screwed fasteners or a combination of face screwed fasteners and gluing for strength.
- D. Surfaces: (Including fronts, backs, sides, tops, bottoms, shelves, doors, drawer fronts, bases and fillers):
 - 1. Plastic laminate on both sides.
 - 2. Bonded by polyester resin at high pressure and temperature.
- E. Exposed edges: Plastic laminate.
- F. Form edges smooth.
- G. Form material for counter tops from continuous sheets.

2.05 COLOR

- A. As selected by Project Representative.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Secure in place, level, plumb and square with cleats that have been secured to building structure with toggle bolts.
- B. Join together at top and bottom of front and back of adjoining cabinets with bolts placed inconspicuously inside cabinets.
- C. Close exposed-to-view openings larger than joints with filler of same material and finish as adjacent casework. Secure filler to casework with concealed screws. Minimize width and number of fillers and in no case exceed 4 inches in width for a filler.
- D. Install countertops level to within 1/16-inch in 10 feet.
- E. Unless otherwise indicated, provide toe space at front of cabinets by setting front face of cabinets 3 inches in front of face of base.

3.02 ADJUSTING AND CLEANING

- A. Adjust hardware, doors, drawers and other moving or operating parts to function smoothly.
- B. Clean casework, counters and hardware.
- C. Restore stained or discolored finish or replace unit.

END OF SECTION

SECTION 21 13 00

AUTOMATIC SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. The Fire Protection System to be provided for the Raw Sewage Pump Station is a delegated design and this is a performance-based specification. Contractor shall provide a code compliant sprinkler system serving the existing West Point Treatment Plant Raw Sewage Pump Station that meets the requirements of all applicable local and national codes.
- B. This Section specifies automatic sprinkler systems for fire protection purposes including requirements for design, obtaining permits, provision of materials and installation in accordance with or exceeding fire protection engineering standards.
- C. Fire protection systems:
1. Water based:
 - a. A wet-pipe sprinkler system shall serve the Raw Sewage Pump Station (including the Screening Areas), except for those areas served by single interlock auxiliary single interlock / pre-action systems.
 - b. A single interlocked auxiliary single interlock / pre-action system shall serve each of the following areas:
 - 1) Electrical room.
 - 2) North battery room.
 - 3) South battery room.
 - c. Fire protection piping.
 2. Where system requirements described in the Contract Documents exceed those of the AHJ, FM and NFPA, meet the most stringent of the requirements.
- D. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Fire Pre-Action Systems Isolation Valve	704-BTV270420 RSP
Fire Pre-Action Isolation Valve Electrical Room 411	704-BTV270421 RSP
Fire Pre-Action Isolation Valve North Battery Room 409	704-BTV270422 RSP
Fire Pre-Action Isolation Valve South Battery Room 408	704-BTV270423 RSP
Fire Pre-Action Valve Electrical Room 411	704-270421 RSP
Fire Pre-Action North Battery Room 409	704-270422 RSP
Fire Pre-Action South Battery Room 408	704-270423 RSP

1.02 DEFINITIONS

- A. Wet Pipe System: A sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to water supply system so that water discharges immediately from sprinklers opened by heat from a fire.

- B. Single Interlocked Auxiliary Pre-Action System: A sprinkler system employing automatic sprinklers attached to a piping system containing compressed nitrogen, with a supplemental fire detection system installed in the same areas as the sprinklers. Actuation of the detection system opens a combination of pre-action sprinkler valves that permit water to flow into the Fire Protection piping system and to be discharged from any sprinklers which may be open.

1.03 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME	American Society of Mechanical Engineers, B31.1, Power Piping
FM	Factory Mutual Research Corporation Standards
FM 2-0	Installation Guidelines for Automatic Sprinklers
FM 2-1	Corrosion in Automatic Sprinkler Systems
FM 2-8	Earthquake Protection for Water-Based Fire Protection Systems
FM 3-26	Fire Protection for Nonstorage Occupancies
FM 5-33	Electrical Energy Storage Systems
FM 7-11	Conveyors
NICET	National Institute for Certification in Engineering Technologies
NEMA	National Electrical Manufacturers Association, 250, Enclosures for Electrical Equipment (1,000 Volts Maximum)
NFPA 13	Standard for the Installation of Sprinkler Systems. 2016 Edition
NFPA 291	Recommended Practice for Water Flow Testing and Marking of Hydrants
NFPA 820	Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2020 Edition
NFPA 855	Standard for the Installation of Stationary Energy Storage Systems, 2020 Edition
UL 199	Automatic Sprinklers for Fire Protection Service
UL 262	Fire Service Water Control Valves
SBC	2018 Seattle Building Code (International Building Code with local amendments)
SFC	2018 Seattle Fire Code (International Fire Code with local amendments)

1.04 DESIGN AND PERFORMANCE REQUIREMENTS:

- A. Design of automatic fire sprinkler systems:
1. The existing wet pipe fire sprinkler riser located in the pipe gallery and the fire sprinkler system located in the unoccupied storage rooms on the pump level shall be replaced and the sprinkler system shall be expanded to serve the Raw Sewage Pump Station.
 2. Complete a design analysis to determine the best method for installing a Wet Pipe System and Single Interlocked Auxiliary Pre-Action Systems for specified locations.
 - a. Perform thorough site investigation to examine the Raw Sewage Pump Station to determine the existing conditions therein:
 - 1) Examine each area and document existing ceiling heights, obstructions, construction variations, and architectural configurations.
 - 2) Evaluate the equipment hung from existing ceilings and coordinate sprinkler system piping placement accordingly.
 - b. Coordinate new sprinkler pipe routing with all trades and existing conditions.
 - c. Be responsible to incorporate all needed accommodations into fire sprinkler system design to make the system work in the existing environment.

- d. The Contractor shall follow NFPA 13, FM 2-0, FM 2-1, FM 2-8, FM 7-11, and the local AHJ requirements for fire protection system drainage, attachment of sprinkler system piping hangers and sway bracing, sway brace calculations, protection underneath and around conveyor openings or obstructions.
- e. All materials of the fire protection system shall be coated and painted per Sections 09 06 90 and 09 90 00, FM, and NFPA 13 for corrosion requirements or other chemical incompatibilities and be listed for fire protection use.
- f. Paint sprinkler systems with the exception of the piping installed above suspended ceilings. Clean, prime, and paint new sprinkler system piping, valves, hangers, accessories, and miscellaneous metal work as describe herein. Clean surfaces prior to painting. Immediately after cleaning, prime metal surfaces with SSPC Paint 25 or SSPC Paint 25 metal primer applied to a minimum dry film thickness of 1.5 mils. Paint piping with CID A-A-2962, OSHA Red enamel applied to a minimum dry film thickness of 1.6 mils. Exercise care to avoid painting sprinkler heads and operating devices. Upon completion of painting, remove materials which were used to protect sprinkler heads and operating devices which have been inadvertently painted and provide new clean sprinkler heads and operating devices of the proper type.
- g. All penetrations through a fire rated assembly shall be provided with firestopping per Section 07 84 00.
- h. All penetrations through atmospherically separated areas shall be provided with sealants per section 07 92 00 to ensure that there is no atmospheric communication between these spaces.
3. The fire protection piping, fittings, hangers, seismic bracing, seismic separation assemblies and attachments shall follow this Section, NFPA 13 and FM data sheets for material specifications and requirements.
4. Water supply fire flow test:
 - a. Conduct a water supply fire flow test in accordance with the latest edit of NFPA 291 prior to design of the fire sprinkler system.
 - b. Design fire sprinkler system using static pressure and residual pressure/flows as determined during the testing.
 - c. Design systems using hydrant flow test water supply curve:
 - 1) Adjust the flow test water supply curve to correspond with the low hydraulic grade line as provided by the water supplier.
 - d. Existing test results from February 7, 2023:
 - 1) Existing hydrants nearby the planned building site.
 - a) Residual = Fire Hydrant # H-8; Flow = Fire Hydrant # H-12
 - 2) 140 psi static pressure and 119 psi residual pressure with 1,590 GPM flowing.
 - 3) Verify the available pressure & flow of the water supply.
5. Provide and arrange the wet fire sprinkler systems for flushing per FM 2-0.
6. The Single Interlocked Auxiliary Pre-Action System shall use a nitrogen medium that is FM Approved for maintaining the internal pressure within the system. Activation water delivery times shall follow FM 2-0.
7. Hydraulically designed sprinkler systems shall be designed to include a minimum safety factor of 10% of the supply pressure or 5 psi below the supply curve.
8. The sprinkler system shall be hydraulically designed to work without addition of a fire pump. Minimize the pressure loss of the sprinkler system by increasing pipe sizes, reducing head spacing, adjusting sprinkler head k-factors, and incorporating other design details as necessary to make the system work with the available water supply and avoid the need for a fire pump.
- B. Provide a fire protection system complete and operable in accordance with the following:
 1. Governing authority fire department standards.
 2. FM Data sheets, 2-0, 2-1, 2-8, 3-0, 3-36, 5-33 and 7-11.
 3. NFPA 13, 820 and 855.
 4. SBC and SFC.
- C. Occupancy classifications for this specification shall be for sprinkler systems design criteria and installations and their water supplies only, in accordance with NFPA 13 and FM 3-26. They shall not be construed to specify a general classification of occupancy hazards. Provide sprinkler systems to comply with the following:

Building or Area	Occupancy Type	Minimum Sprinkler System Hydraulic Density (gpm/ft ²)	Sprinkler System Type
Break Room	HC-1	0.10	Wet
Crane Hall, Control Room, Motor Room, Pump Room, Screen Room	HC-2	0.20	Wet
Electrical Room	HC-2	0.20	Pre-action
North and South Battery Room	HC-3 ¹	0.30 ¹	Pre-action

(1) Per FM 5-33

1.05 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. General:
 - 1. Automatic sprinkler system design including product information, detailed design and piping layout, and water supply fire flow test results shall be submitted for reviews, permits and approvals to:
 - a. Project Representative.
 - b. Authority Having Jurisdiction (AHJ).
 - 2. Upon receipt of comments from AHJ, make resubmissions, if required, with clarifications or revisions to obtain approval.
 - 3. Fire Protection submittals and shop drawings shall be made as a complete package which includes product data, drawings, and calculations. Incomplete/partial submittals will be returned without being reviewed.
 - 4. Submit Working Plans after design has been approved by AHJ.
- C. Project Information:
 - 1. Catalog and technical data sheets and specifications for all manufactured components supplied as part of the fire protection system components, including fittings, couplings, pipe, fire valves, check valves, fire department connection, sprinkler heads, flow alarm, hangers, sway bracing, nitrogen generation system with air compressor, and other components and appurtenances requires for a complete system.
- D. Detailed design and piping layout of fire protection systems:
 - 1. Include calculations prepared in accordance with the requirements for Hydraulic Calculations described in applicable NFPA standards and FM data sheets.
 - 2. Hydraulic design including sizing and design calculations for all portions of the sprinkler system.
 - 3. Complete hydraulic calculations of the system pipe sizing procedure and seismic bracing calculations.
 - 4. Complete layout drawings of sprinkler systems, alarms, and signal devices.
 - 5. Indication of hazard classification of all sprinkled spaces.
 - 6. Submit seismic bracing design calculations for all portions of the sprinkler system. Indicate the seismic zone of influence for all seismic sway bracing calculations on the drawings.
 - 7. All piping crossing seismic joints shall be installed with a seismic separation assembly.
 - 8. Drawings shall be signed by a professional fire protection engineer currently registered in the State of Washington.
- E. Copy of the most recent water supply fire flow test. Flow test used for hydraulic calculations shall not be less than a year old from the time shop drawings are submitted.
- F. Bill of Materials, including Form 01 78 45-A.

- G. Final shop drawings:
 - 1. Working plans that have been stamped approved by the AHJ Fire Marshal's Department.
 - 2. AutoCAD Files, 2013 version or newer.
 - 3. Submit complete hydraulic, sizing and design calculations for all portions of the sprinkler system.
 - 4. Submit catalog data and specifications for all manufactured components supplied as part of the fire protection system.
 - 5. Submit seismic bracing design calculations for all portions of the sprinkler system. Indicate the seismic zone of influence for all seismic sway bracing calculations on the drawings.
- H. Qualifications:
 - 1. Provide documentation of the Qualifications required by this Section for the sprinkler system designers and installers.
- I. Acceptance test records and test certificates signed and approved by the AHJ.
 - 1. Fire Marshal's Department approvals:
 - a. Certification that all plans and calculations, including fire sprinkler hydraulic and seismic bracing calculations have been approved by all agencies with jurisdiction.
 - b. Certification that all required post installation tests and inspections have been completed and approved by all agencies with jurisdiction.
 - 2. The test reports shall include Contractor's material and test certificate for above ground piping and main piping as described in NFPA 13 and FM.
- J. O&M manual: 01 78 23.
- K. Contract Closeout Information:
 - 1. Operating and maintenance data
 - 2. Owner instruction report.
 - 3. Test reports:
 - a. Certification that tests as specified in this Section have been successfully completed and approved by authorities having jurisdiction.
 - 4. As-built drawings:
 - a. As-built shop drawings, at no later than 14 days after completion of the Final Tests. The Sprinkler System Drawings shall be updated to reflect as-built conditions after all related work is completed. Provide electronic drawings in 'dwg' and 'pdf' format.
- L. Welding data and weld inspection reports, as specified in Section 05 05 20.

1.06 JOB CONDITIONS

- A. Arrange and pay for permits, fees and inspections required.
- B. Maintain the existing fire protection facilities, equipment, and piping during the construction period. NFPA and FM regulations regarding notification of sprinkler system shutdowns and modifications shall be followed.
- C. When a fire protection system outage exceeding eight hours in a 24 hour period an impairment plan or fire watch shall be provided. These outages shall be provided by the Contractor with no additional cost to the Owner.

1.07 QUALITY ASSURANCE

- A. Single Contractor Responsibility:
 - 1. The complete fire protection piping and sprinkler systems shall be the responsibility of one Contractor. The Contractor shall be responsible for the design, selection, installation, operation, and field testing of all materials, equipment, and components of each automatic sprinkler system provided as specified in this Section.

- B. Qualifications:
1. Use subcontractors with prior, demonstrable experience with fire protection systems.
 2. Sprinkler System designer:
 - a. Fire protection system to be designed by a NICET Certified Level IV Designer with additional oversight provided by a Professional Engineer, licensed in the State of Washington as a Fire Protection PE.
 - b. Drawings and hydraulic and sway brace calculations shall include certification for the NICET Certified Level IV Designer, signature and registration number of the Professional Fire Protection Engineer if require by state regulations.
 3. Installers:
 - a. Fire protection systems shall be installed under the direct supervision of the NICET Level IV designer indicated above.
 - b. Fire Protection Installer shall be licensed and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.
 - c. Use workmen skilled in this trade.
 - d. Welders and welding operators shall meet the qualification requirements of NFPA 13.
 4. Nitrogen Generation System Commissioning Technician:
 - a. Shall have one of the following qualifications. Qualifications shall be provided prior to preliminary inspection and tests:
 - 1) Employed by and certified by the nitrogen generation system manufacturer.
 - 2) In lieu of manufacturer's commissioning technician, the fire sprinkler contractor shall provide the following proof for the proposed commissioning technician:
 - a) Manufacturer's certified training for the equipment being installed.
 - b) Proof of at least five previous installations of manufacturer's equipment where the contractor's commissioning technician has successfully conducted commissioning under the direct supervision of the manufacturer's commissioning representative.
 - c) Proof the five supervised commissioning occurred after contractor's commissioning agent has obtained the certified training. Commissioning carried out prior to factory training, or without supervision of manufacturer's technician or commissioning of other manufacturer's equipment does not qualify as applicable experience.
 - 3) Conducting preliminary inspections and testing does not qualify as applicable installation experience.
 - b. Design and install the nitrogen generation system in accordance with the requirements of NFPA 13 and FM standards.
- C. Requirements of Regulatory Agencies: The automatic sprinkler system shall conform to the requirements of:
1. Authority Having Jurisdiction (AHJ):
 - a. Where there is conflict between local authority requirements or other standards agency requirements and these Drawings and Specifications, requirements of standards that are the most stringent shall be followed.
 2. Design and install entire system in accordance with indicated codes, standards, and regulations.
 3. The AHJ for the fire protection systems is the Seattle Fire Department.

1.08 WORKING PLANS

- A. Working drawings shall be easily duplicated and readable after duplication.
- B. When drawings are prepared using computer-aided drafting (CAD), drawings shall be provided in electronic format (DVD, CD-R or flash drive) and on both half and full size prints (one paper copy each). Electronic format shall be AutoCAD 2010 or newer.
- C. Working plans shall be drawn to an indicated scale, on 22-inch by 34-inch sheets, and shall show the following data:
1. Name of owner and occupant.
 2. Location, including street address.
 3. Point of compass.

4. Ceiling construction.
5. Location of fire walls.
6. Location of partitions.
7. Full height cross section.
8. Occupancy of each area or room.
9. Location and size of concealed spaces and closets.
10. Any enclosures in which no sprinklers are to be installed.
11. Size of water main, pressure and distance to nearest circulating main, and main test results.
12. Sources of water supply, with pressure and elevation.
13. Make, type and nominal orifice size of sprinklers.
14. Temperature rating and location of high temperature sprinklers.
15. Total area protected by each system on each floor.
16. Number of sprinklers on each riser per floor.
17. Location of alarm bells.
18. Pipe type and schedule of wall thickness.
19. Nominal pipe size and cutting lengths of pipe (or center to center dimensions).
20. Location and size of riser nipples.
21. Type of fittings and joints and location of all welds and bends.
22. Type and locations of hangers, sleeves and sway bracing.
23. All control valves, check valves, drain pipes and test pipes.
24. Water main pipe size, length, location, weight, material, point of connection to main and the type of valves, and the pipe anchor system.
25. Provision for flushing and complete drainage of the system.
26. For hydraulically designed systems, the material to be included on the hydraulic data nameplate.
27. Name and address of Contractor.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Fire Department Connection (FDC):
 1. Elkhart Brass Mfg. Co., Inc.
 2. Fire End & Croker Corporation.
 3. Potter Roemer Fire Products.
 4. Smith Cooper International.
 5. Approved Equal.
- B. Pipe Hangers and Seismic Bracing:
 1. Allied Rubber & Gasket Co.
 2. Anvil International, LLC.
 3. Cooper B-Line / Tolco.
 4. ERICO International Corp.
 5. Hiliti, Inc.
 6. Approved Equal.
- C. Pre-action valves:
 1. Globe Fire Protection.
 2. Reliable Automatic Sprinkler Co., Inc.
 3. Tyco Fire Products, LP.
 4. Victaulic Co.
 5. The Viking Corporation.
 6. Approved Equal.
- D. Automatic Air Vent:
 1. Engineered Corrosion Solutions.
 2. Potter Electric Signal Co.
 3. Reliable Automatic Sprinkler Co., Inc.

4. Tyco Fire Products, LP.
 5. Victaulic Co.
 6. Approved Equal.
- E. Sprinklers, Alarm Valves, and Alarm and Supervisory Devices:
1. Globe Fire Protection.
 2. Reliable Automatic Sprinkler Co., Inc.
 3. Tyco Fire Products, LP.
 4. Victaulic Co.
 5. The Viking Corporation.
 6. Approved Equal.
- F. Nitrogen Generators:
1. Engineered Corrosion Solutions, LLC.
 2. Potter Electric Signal Co.
 3. General Air Products.
 4. Tyco Fire Products, LP.
 5. Victaulic Co.
 6. Approved Equal.
- G. Gauges:
1. Pressure gauges shall be FM approved and labeled for fire protection sprinkler service, minimum 3½-inch dial, phosphor bronze tube, brass socket, moisture proof and weather resistant, 0-300 psi scale, 5 psi increments. Reliable.
 2. Each gauge shall be fitted with a three-way valve and a ¼-inch threaded test connection:
 - a. Ametek P1590
 - b. Approved Equal
- H. Valves, Check Valves, and Indicating Devices:
1. American Fire Products Company.
 2. Clow Valve Co.
 3. Kennedy Valve.
 4. Mueller Company.
 5. Reliable Automatic Sprinkler Co., Inc.
 6. Victaulic Co.
 7. Watts Regulator Company.
 8. Approved Equal.

2.02 MATERIALS AND EQUIPMENT FEATURES

- A. General:
1. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
 2. Provide corrosion resistant components in accordance with NFPA 13 and FM.
 3. Use only new, unused material, designed, and guaranteed to perform service required and approved by NFPA and FM.
 4. See Section 40 05 01 for additional piping and valve requirements, including but not limited to identification, installation requirements, testing and hydrostatic testing, cleaning, and flushing.
- B. Pipe, Hangers, Bracing and Fittings:
1. FM approved for fire protection systems.
 2. Optional pipe materials and joining methods approved by NFPA 13 and FM are allowed if in accordance with applicable agency approval and insurance requirements.
 3. Seismic Separation Assembly:
 - a. All sprinkler pipe passing through or crossing building seismic joints, shall contain a flexible expansion loop, designed for seismic movement. Seismic separation assemblies shall impart no thrust loads to building structure. These shall be located at, or near, the building seismic

- joint. Seismic bracing shall not pass-through building seismic joint and shall not connect or tie together different sides or parts of building structure. All flexible expansion loop connections to sprinkler piping shall be installed, inspected, and tested in accordance with NFPA 13 and FM requirements.
- b. The seismic separation assembly can be installed no more than 24" away from the seismic joint.
 - c. The entire seismic separation assembly will need clearance around it equal to the desired deflection. See the structural drawings for these seismic joint locations.
4. Wet-pipe and pre-action for fire protection systems:
- a. Fire Protection piping less than 2.5-inch: Black steel, Schedule-40:
 - 1) Threaded joints.
 - 2) Welded joints.
 - 3) Mechanical joints:
 - a) Cut or rolled groove type.
 - b) Mechanical locking (push-on) type.
 - b. Fire Protection piping 2.5-inch and greater: Black steel, Schedule-40:
 - 1) Welded joints.
 - 2) Mechanical coupling joints:
 - a) Rolled groove type (cut grooving not allowed).
 - b) Mechanical locking (push-on) type, (Plain end not allowed).
- C. Fire Sprinkler Heads:
- 1. FM approved.
 - 2. Type required for service indicated.
 - 3. Standard 165 degrees F rating except when application requires higher rating.
 - 4. In no case use heads rated less than 50 degrees F higher than anticipated ambient temperature. Intermediate or higher temperature classification sprinkler heads shall be provided for locations with higher-than-normal ambient temperatures in accordance with NFPA 13 and FM global requirements, such as in mechanical rooms, electrical rooms, pump/motor/equipment rooms, spaces with skylights, etc.
 - 5. All sprinkler heads shall be provided with guards in mechanical rooms, electrical rooms, pump/motor/equipment rooms, under grating, and similar spaces, where the sprinkler head are subject to damage.
 - 6. Flexible Sprinkler Hose Fittings:
 - a. For use in connecting sprinkler heads in suspended ceilings.
 - b. Bracket attaches to the suspended ceiling for support of the flexible hose.
 - c. Braided stainless steel, hose fittings and accessories shall be FM 1637 approved.
 - 7. Sprinkler Guards:
 - a. Provided in the electrical and battery rooms and where subject to mechanical and physical damage.
 - b. Listed for the fire sprinkler that they are installed on.
 - c. Heavy duty welded wire.
 - d. Red baked enamel finish.
 - 8. Dry type sprinkler head (Pendant and Sidewall):
 - a. For coverage of exterior area from interior wet-pipe system.
 - b. For systems with piping that is subject to freezing.
 - c. Finish: Electroless Nickel PTFE (ENT)
 - 9. Upright sprinkler heads:
 - a. Quick response with cast brass frame.
 - b. Spray type head with glass bulb and brass deflector.
 - c. Finish: rough brass, polished brass, or chrome plated.
 - 10. Pendant:
 - a. Quick response with cast brass frame.
 - b. Spray type with glass bulb and brass deflector.
 - c. Finish: rough brass, polished brass, or chrome plated.
 - d. Unless otherwise indicated, pendant heads installed exposed, below a finished ceiling, shall have a white polyester finish.

- e. Pendant heads used for semi-recessed sprinkler locations shall be chrome-plated finish. Escutcheon plates shall be provided for all pendant sprinkler heads at finished ceilings.

D. Alarm Check Valve:

1. 175 pound, FM approved water flow alarm check valve which lifts from its seat when water flows.
2. Complete with clapper, external bypass valve, alarm test bypass, pressure gage, main drain connections, mounting supports for the retarding chamber, neoprene O-ring seal, tapped bosses for and with water pressure gages, alarm test valve, and a drip funnel.
3. Retarding chamber for varying water pressure as conditions require.
4. Include angle valves, globe valves, alarm line strainer, orifice restriction, pipe nipples and fittings.

E. Pre-Action Valve:

1. Quick opening, differential diaphragm flood valve with one moving part.
2. Used with single interlocked pre-action sprinkler system.
3. The valve shall be made of ductile iron, cast bronze clapper, clamp ring, valve seat ,175 LB rated, FM and Fire Marshal approved.
4. Valve seat Teflon coated.
5. Neoprene diaphragm and seat rubber.
6. Stainless steel seat rubber retaining ring.
7. Include drip check, drain cup, check valve, drain valve, priming valve, priming check valve, priming strainer, restricted orifice, flow test valve, emergency release, pressure operated relief valve, strainer in relief line, magnetic release control and main control valve.
8. The valve shall be fitted with all accessories required for single interlocked pre-action sprinkler system controlled by nitrogen generation system with compressed air and fire alarm heat detection system, approved by Fire Marshal.
9. Provide pre-action system control panel:
 - a. Multiple zone panel or single zone panels for each pre-action valve.
 - b. Battery and charger system.
 - 1) Maintain supervision with batteries for 24 hours.
 - 2) Energize alarm and solenoid valve(s) with batteries for 10 minutes during fire condition.
 - c. Include pressure alarm switch.
10. Include low air pressure supervision switch.
11. Mount panel(s) locally.
12. Provide complete supervision of all vital components.
13. Include auxiliary trouble and alarm contacts for connection to fire alarm system.
14. Pre-action solenoid shall be compatible with the fire alarm releasing control panel, UL Listed and FM Approved, 12 or 24 VDC.
15. Single-interlocked auxiliary pre-action fire protection sprinkler system:
 - a. Description: Automatic system shall employ closed sprinklers attached to a piping system filled with pressurized nitrogen and connected to an accelerated pre-action valve that is opened only by the actuation of either sprinkler pipe pressure loss or supplemental fire detection system installed in same areas as sprinklers.
 - b. Normal operation:
 - 1) Actuation of detection system sends signal to Fire Alarm Releasing Panel 704-FAPNL2711 and opens pre-action valve allowing water to enter piping system.
 - 2) Subsequent actuation of sprinkler relieves pressure in piping allowing water to flow through actuated sprinkler.
 - 3) Water flow through pre-action valve sends signal to Fire Alarm Releasing Panel 704-FAPNL2711 and sounds local alarm.
 - c. Failure operation:
 - 1) Failure of detection system sends signal to Fire Alarm Releasing Panel 704-FAPNL2711 and opens pre-action valve allowing water to enter piping system.
 - 2) Failure of sprinkler relieves supervised air pressure in piping sending signal to Fire Alarm Releasing Panel 704-FAPNL2711. Pre-action valve does not open.
 - d. Air source:
 - 1) Provide dedicated nitrogen generation system with an air maintenance device.
 - e. Provide manual-actuation station adjacent to area served.

- 1) Station shall be within 200 feet of area served.
 - f. Supplemental fire detection (valve release) system:
 - 1) Electrically actuated system.
- F. Alarm and Signal Devices:
1. Alarm pressure switch:
 - a. Shall signal the Fire Alarm Releasing Panel 704-FAPNL2711 upon sensing change of pressure in fire system valve.
 - 1) Switch shall automatically reset when pressure returns to normal.
 - b. Service: Normal
 2. Pressure supervising switch:
 - a. Shall signal Fire Alarm Releasing Panel 704-FAPNL2711 upon drop in air pressure.
 - 1) Adjustable low-pressure setting.
 3. Valve tamper switch:
 - a. 115 VAC/30 VDC.
 - b. Switches for butterfly and OS&Y valves to be FM approved.
 - c. Shall signal the the Fire Alarm Releasing Panel 704-FAPNL2711 upon valve movement.
 - d. Provide lock and chain in addition to a valve tamper switch.
- G. Inspector's Test Station:
1. Valve and drain system to test operation of alarm devices.
 2. 1-inch pipe with ½-inch orifice size nozzle.
 3. A sight glass shall be provided so that a visual confirmation of active water flow through the system can be visually seen.
- H. Nitrogen Generation System with Compressed Air Maintenance:
1. Supply air for the nitrogen systems serving the pre-action sprinkler systems shall be taken from dedicated air systems.
 2. Installed with a compressor sized appropriately for the application and capable of achieving system pressure within 30 minutes in accordance with the requirements of NFPA 13.
 3. In accordance with NFPA 13. The connection pipe from the nitrogen generator shall not be less than 1/2-inch in diameter and shall enter the system above the priming water level of the pre-action valve. Install a check valve in the system supply nitrogen piping from the generator. A shutoff valve of the renewable disc type shall be installed upstream of this check valve. The nitrogen supply system shall be sized to pressurize the sprinkler system to 40 psi within 30 minutes.
 4. Designed to achieve a nitrogen concentration of 98% or greater and maintain that concentration within the fire sprinkler system continuously.
 5. Gas stream analyzer to confirm output nitrogen quality.
 6. For multiple pre-action sprinkler risers, provide automatic vent and air maintenance devices for each sprinkler system riser.
 7. Nitrogen generation system requires a dedicated, hardwired 120V AC power supply.
 - a. The nitrogen generation system shall comply with the NFPA 13 and FM requirements to have the compressor capacity capable of storing normal gas pressure in the largest zone of the pre-action systems within 30 minutes.
 - b. Black steel pipe or approved tubing shall be used to connect the self-contained unit to the pre-action valve on the pre-action systems.
 - c. All manufacturer installation guidelines shall be followed.
 - d. The nitrogen generation system shall be a self-contained, factory-assembled nitrogen generator unit.
 8. Design of Nitrogen Generation System:
 - a. All equipment shall be installed within the confines of the riser room with the exception of a connection for a manual or automatic gas analyzer.
 - b. System shall be capable of delivering a minimum of 98 percent nitrogen composition throughout all of the system piping within 14 days from the commencement of the inerting process.
 - c. Provide membrane type nitrogen generators that provide "instant on-instant off" nitrogen gas production without the need for nitrogen storage tanks.

9. Nitrogen generator accessories:
 - a. Oil less compressor.
 - b. Refrigerated dryer.
 - c. Leak detection system.
 - d. Purge vent assembly.
 - e. Particle and coalescing filters.
 - f. Nitrogen membrane separator.
 - g. Nitrogen receiver.
 - h. Manual bypass valves.
 - i. Digital compressor runtime monitor.
 - j. Visual indicators for normal and bypass modes.
 - k. Single-point connection for 120VAC single-phase power.
 - l. Leveling feet.
 - m. Single drain connection point for all required drains.
 - n. A low pressure alarm shall be provided on the gas storage containers to notify the need for refilling.
10. Nitrogen Air Compressor to be used in conjunction with the nitrogen generator shall be capable of the following:
 - a. Capable of producing a continuous stream of compressed air at 100+ psig.
 - b. Capable of automatic cut in and cut out.
 - c. Equipped with an on-board after-cooler.
 - d. Equipped with an on-board automatic water blow down system.
 - e. Equipped with vibration dampening system.
 - f. Equipped with an air storage tank to provide continuous delivery of compressed air to the nitrogen generator.
 - g. Rated for continuous duty service.
 - h. Compressors less than 3.0 hp shall be an oil-less design.
 - i. Oil-less compressors shall be such that the manufacturer has designed the oil-less compressor to provide 5,000 hours of continuous duty service before requiring a gasket and seal rebuild.
11. Nitrogen Venting Device shall be functional component of the nitrogen venting device for use in the "fill and purge" breathing process shall:
 - a. Be FM approved for use on sprinkler systems.
 - b. Not require plumbing to drain.
12. Nitrogen generation system with compressor shall be designed to maintain pressure in fire protection systems. Restrict flow of supply air so that it does not interfere with actuation of system and provide field adjustable out pressure of 5 to 75 psig. It shall meet the following requirements:
 - a. FM approved. Dedicated for fire protection service
 - b. Mounting hardware for wall mounted or pipe mounted with couplings and guard.
 - c. Pressure switches with High and Low operation. Field adjustable cut-in and cut-out pressure switch. Air pressure switch shall monitor the air pressure of the dry sprinkler system. The pressure switch shall be monitored by the Fire Alarm Panel.
 - d. Inlet silencer and filter
 - e. Include discharge air and water separator, with relief valve, gauge glass and ball float valve.
 - f. Include integral discharge check valve, isolation valve, pressure regulator valve, restricted orifice, strainer, ball valves, by-pass valve, and pressure gauge.
- I. Fire Department Connection:
 1. An approved fire department connection, of the same size as the system riser, shall be provided on the system side of the alarm check valve.
 2. A chrome, three-way, 4" x 2-1/2" x 2-1/2" x 2-1/2", fire department hose connection shall be provided at an approved yard location, as shown on the drawings.
 3. The hose connections shall be chrome 2½-inch pipe size, with internal threaded outlet having threads compatible with those of the Seattle Fire Department.
 4. The hose connection shall be provided complete with chrome clapper, chrome threaded plug and chain.

5. The fire department hose connection shall be provided with a chrome escutcheon that clearly indicates which fire protection system it serves, labeled "Fire Sprinkler System for Raw Sewage Pump Building (704)".
6. The fire department connection shall be provided with an approved check valve and an automatic drip type drain valve in the piping between the hose connection and the system riser connection.
7. Free standing connections: Chrome sleeve, escutcheon plate with lettering, caps and chain.
8. Fire department connection shall be located not less than 36 in. or more than 48 in. above the level of the adjoining ground, sidewalk, or grade surface.

J. Valves:

1. FM approved.
2. Valves in water supplies and supply pipes shall be provided with approved indicating means.
3. Valves shall not close in less than 5 seconds when operated at maximum possible speed from the fully open position.
4. Valves shall be iron body, bronze trim, gate valves, 175 psi working water pressure rated, Underwriters Laboratory labeled for the application in which they are used.
5. Above ground valves shall be OS&Y type unless otherwise specified.
6. Automatic Ball Drip Valves:
 - a. Straight or angle cast-brass ball drip valve, ½ inch, shall close against pressure and open when pressure drop.
 - b. Mount on the fire department connection on the siamese side of check valve.

K. Hangers, Seismic Bracing, and Supports for Piping:

1. Pipe hangers, seismic bracing, hanger rods, insets and clamps shall be made of ferrous materials, unless otherwise approved, and shall be constructed as approved by NFPA and FM standards.
2. Portions of the building structure used to support the system shall be designed to support the weight of water-filled pipe plus 250 pounds.
3. Hanger type and minimum sizes shall be as specified by NFPA 13. Maximum support spacing shall be as specified in NFPA 13 and FM 2-0.
4. Seismic bracing shall be provided on Fire Protection piping per NFPA and FM.
5. Pipe hangers and supports located outside of the building shall be galvanized.

L. Fire Alarm Releasing Panel 704-FAPNL2711 and Heat Detection:

1. Heat detectors and fire alarm control panel for the pre-action sprinkler system shall be as specified in Section 28 46 00.

M. Automatic air vents:

1. Equip with an isolation valve.
2. Piped to an acceptable drain location.

2.03 ACCESSORIES

- A. NFPA approved identification signs shall be provided for valves and the sprinkler alarm. Each valve identification sign shall indicate the portion of the system controlled by the particular valve.
- B. The sprinkler alarm shall have a sign stating, "SPRINKLER FIRE ALARM", "When bell rings call 911, fire department, or police."

2.04 FINISHES

A. Coating and painting of fire protection system components:

1. Per Section 09 90 00, FM and NFPA 13 for corrosion or other chemical incompatibilities and be listed for fire protection use.
2. Paint sprinkler systems with the exception of the piping installed above suspended ceilings.
3. Clean, prime, and paint new sprinkler system piping, valves, hangers, accessories, and miscellaneous metal work.

4. Clean surfaces prior to painting. Immediately after cleaning, prime metal surfaces with SSPC Paint 25 or SSPC Paint 25 metal primer applied to a minimum dry film thickness of 1.5 mils.
5. Paint piping with CID A-A-2962, OSHA Red enamel applied to a minimum dry film thickness of 1.6 mils.
6. Exercise care to avoid painting sprinkler heads and operating devices.
7. Upon completion of painting, remove materials which were used to protect sprinkler heads and operating devices which have been inadvertently painted and provide new clean sprinkler heads and operating devices of the proper type.

PART 3 EXECUTION

3.01 GENERAL

- A. Contractor shall be responsible to request any record drawings available for the existing fire protection system from Project Representative. Contractor shall perform field verification of existing conditions prior to bid submittal.
- B. Protect existing conditions such as: structures, ceilings, walls, equipment, utilities, etc.
- C. Be responsible for patching and repairing floors, ceilings, and walls to match existing conditions in areas impacted by the demolition of the existing fire protection system and installation of the new fire protection systems.
- D. Remove and replace the existing fire protection system serving, including the hangers and bracing, within the unoccupied area on the pump level and the fire sprinkler riser that serves the existing RSP fire protection system (located adjacent to the fire sprinkler riser, in the pipe gallery).
- E. The designer shall be responsible for understanding the construction of the building which includes building construction type, ceiling heights, beam depths, obstructions, other disciplines layouts (e.g., mechanical, electrical, etc.), and other features of the building that are required in order to provide a fire protection system that is fully code compliant.
- F. Field quality control:
 1. Manufacturer's field services: Provide service by a factory-authorized and certified service representative to supervise field assembly and connection of components and pre-testing, testing, and adjustment of system.
 2. Pre-testing: Determine, through pre-testing, conformance of system to requirements of Contract Documents. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
 3. Inspection:
 - a. Inspect equipment installation, interconnection with system devices, hanging and bracing methods.
 - b. Verify that pipes are properly installed, connected, labeled, and are identified.
 4. Welded connections visual inspection and nondestructive weld testing:
 - a. As specified in Section 05 05 20.
- G. Design Requirements:
 1. Use only new, unused material, designed and guaranteed to perform service required and approved by NFPA. Material and equipment shall be UL Fire Protection Directory listed and FM Approval Guide approved for fire protection service.
 2. Provide fully code complaint operational systems.
 3. Installation of the following items/systems shall be done by authorized representatives of respective manufacturers:
 - a. Fire system valves.
 - b. Nitrogen Generation System.
 4. Provide seismic protection for the sprinkler system. Design and install seismic protection in accordance with the requirements of NFPA 13 and FM 2-8.

3.02 WORKING PLANS CERTIFICATION

- A. Obtain permit from AHJ Fire Marshal before any equipment is installed.
- B. The submitted drawings shall comply with working drawing requirements as specified in NFPA 13 and this Section.

3.03 PRE-INSTALLATION CONFERENCE

- A. Prior to the installation of fire protection piping, set up and conduct a pre-installation conference attended by the Contractor and other subcontractors involved in the project. At this time, identify and make any necessary adjustments to the fire protection piping layouts to avoid conflicts with other trades.
- B. Provide an impairment plan in accordance with NFPA 25 and local authority having jurisdiction requirements, where a fire protection system is out of service for more than 8 HRS in a 24-hour period. Coordinate schedule with owner and receive approval for the fire protection system impairment plan with the local authority having jurisdiction prior to proceeding with work. Contractor will provide fire watch while fire protection system(s) are out of service.

3.04 PREPARATION

- A. Review plans, Specifications and Shop Drawings of other trades to coordinate work.
- B. Do not begin installation until all Agency approvals are submitted to Project Representative.

3.05 INSTALLATION

- A. General:
 - 1. Install in strict accord with approved Shop Drawings.
 - 2. Install all piping, valves, and connections from mains to building fire protection systems.
- B. Test Stations:
 - 1. Provide test stations to each alarm device and individually test each item required by NFPA 13.
- C. Valves:
 - 1. Install valves and accessories in accordance with manufacturer's instructions.
 - 2. Locate valves to individually isolate building systems and to maintain proper flow and functions of the systems.
 - 3. Provide shutoff valve operation security as required by the Fire Marshal.
 - 4. Provide OS&Y valve within sprinkler system at each of following locations:
 - a. Each zone takeoff within Fire Protection piping system.
 - b. Base of all sprinkler risers.
 - 5. Install monitor switch on each OS&Y or butterfly valve within fire protection piping system, sprinkler control, base of sprinkler zone, and/or isolation valves and post indicator valve.
 - 6. Provide auto ball drip valves at outside fire department connections between hose connection and check and/or shutoff valve. Additional auto ball drip valves shall be provided to insure that this piping, from the fire department check valve to the fire department connection, does not have any water trapped inside it.
 - 7. Install pressure gages at each sprinkler risers and elsewhere as required by local authority.
- D. Sprinklers:
 - 1. Install sprinklers throughout all areas specified and shown in the Drawings.
 - 2. Maximum protection area per sprinkler shall be in accordance with occupancy required in the building served.

3. Avoid interferences with sprinkler discharge pattern by beams, bracing, girders, trusses, piping, lighting fixtures, ductwork, grates, equipment platforms, stairs, etc. per FM requirements.
4. Adjust location of sprinklers to accommodate ceiling tile grids and beams, centering sprinklers on architectural features in finished areas if code spacing requirements do not dictate otherwise.
5. Install sprinklers to provide and maintain minimum 36 inch clear between bottom of deflector and top of storage, files, shelving, and cabinets per FM requirements.
6. Install in accord with approved Shop Drawings.
 - a. Modifications made to system design or arrangement after approval of drawings by local authority may only be made after receiving written approval of authority and Project Representative.
 - b. Such modifications do not include minor relocations in piping or head placement.
 - c. Make all revisions in accord with NFPA 13 and FM requirements.
7. Do not install sprinkler heads through or with escutcheon plate covering suspended ceiling grids. Install oversized escutcheon plates in all suspended ceilings unless flex sprinkler drops are used.

E. Piping and Hangers:

1. Sprinkler main locations shown in Drawings are approximate. Verify exact location before installing piping.
2. Branch lines shall be provided above cross mains and cross mains shall be above feed mains in order to allow complete drainage of the system.
3. Piping shall be supported independently of ceiling sheathing and substantially supported by building structure.
4. Unless otherwise indicated, provide a minimum of one hanger for each pipe length. Maximum distance between hangers shall be as required by NFPA 13 and FM requirements.
5. Risers shall be supported by attachment directly to the riser or by hangers at horizontal connections close to the riser. Spacing of riser supports shall be as required by NFPA 13 and FM requirements.
6. Provide seismic and sway bracing on all sprinkler systems in accordance with NFPA 13 and FM requirements.
7. Design wet sprinkler system piping with provisions to vent trapped air at all high points (within the work area).
8. Install approved drip legs and drain valves at low points of all piping to permit complete drainage of system without disconnection of any piping:
 - a. Drain valves at base of risers to have 1-1/2 inch hose adapters matching threads of hose systems in the building.
9. Extend 2 inch main drain(s) and 1 inch inspector's test connections on ends of sprinkler branches to nearest floor drain or janitor's sink.
10. Flush outside fire water mains prior to connecting to inside system.
11. Pitch all branch lines, cross mains, feed mains and risers to drainage points.
12. Provide angle drain valves at all low points.
 - a. Plugs permitted at offsets when approved by local authority.

F. Sleeves and Escutcheons:

1. Provide sleeves for all pipes passing through slabs, walls and partitions.
2. Extend sleeves 3 inches above floor and flush with the walls.
3. Set sleeves in forms prior to concrete pour for new concrete walls.
4. Secure escutcheons so they make contact with floor, wall, or ceiling.

3.06 TESTING

- A. The AHJ shall witness all final testing and inspection in order to obtain final approval for system.
- B. Pre-Action Valve Trip Test:
 1. Trip-test each pre-action valve by reducing normal system nitrogen pressure through operation of the inspector's test connection.
 2. Systems equipped with quick-opening devices shall first be tested without the operation of the quick-opening device and then with it in operation.
 3. Test results shall be witnessed and recorded.

4. Test results shall include the number of seconds elapsed between the time the test valve is opened and tripping of the dry valve; trip-point nitrogen pressure of the pre-action valve; water pressure prior to valve tripping; and number of seconds elapsed between time the inspector's test valve is opened and water reaches the orifice.
 5. The delivery of water from the pre-action valve to the system test connection shall not exceed 60 seconds, regardless of system size.
 6. Water delivery times shall be measured starting at the normal nitrogen pressure on the system.
- C. Supervisory Nitrogen System Test:
1. System supervisory nitrogen pressure shall be reduced from the normal system pressure to the point at which a low-pressure alarm is sounded.
 2. Nitrogen pressure shall be restored to verify trouble signal restoration.
 3. Automatic start/stop features of nitrogen generator shall be tested.
- D. Flow Test:
1. Conduct a hydrant flow test in accordance with NFPA 291 on the water main supplying the sprinkler system to determine static and residual pressures available.
 2. Use the results of the flow test as the basis for sprinkler system sizing in hydraulically designed systems and submit these results to the AHJ for approval with the calculations.
 3. Conduct the flow test under maximum domestic consumption conditions.
 4. The test hydrant used for static and residual pressure readings shall be located as close as possible to the fire protection system tap location.
- E. Test complete alarm system including control and signal circuits.
- F. Give advance notice and arrange for field tests and inspections by local authority, including paying for inspection fees and securing permits.
- G. Each hydraulically calculated system should be identified by a permanent placard attached to the base of the riser indicating the design characteristics of the system:
1. Information on the placard should include the design density, area, and the flow and pressure required at the base of the riser.
- H. Hydrostatic Test:
1. Hydrostatically test the entire sprinkler system following installation.
 2. Hydrostatically test the system at not less than 200 psi or 50 psi above maximum static pressure of the system, whichever is greater, for a minimum of 2 hours.
 3. No visible leakage from the system shall be permitted.
 4. Following completion of the test, fill out test certificates and obtain approval of the AHJ.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies drains, piping, appurtenances and general requirements for plumbing systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
UPC	Uniform Plumbing Code
ASTM D1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog data and installation details for all plumbing equipment.

1.04 QUALITY ASSURANCE

- A. Work shall be in accordance with the Seattle Plumbing Code as adopted and/or modified by the Local Authority Having Jurisdiction.

PART 2 PRODUCTS

2.01 CLEANOUTS

- A. General:
1. Unless otherwise indicated, cleanouts shall be the same size as the pipe connected.
 2. Provide cleanouts with clamping collars where waterproofing membranes are located in the floor.
 3. Provide cleanouts located inside buildings with nickel-bronze covers.
 4. Provide bronze plug with tapered thread for cleanouts on pressurized systems.
 5. Cleanouts on chemical waste or drain lines shall be of the same material and type of joint as the pipe.
- B. Acceptable Manufacturers:
1. Type I Cleanout:
 - a. Josam series 56010.
 - b. J. R. Smith series 4020.
 - c. Approved Equal.
 2. Type II Cleanout:
 - a. Josam series 56010(-12).
 - b. J. R. Smith series 4140.
 - c. Approved Equal.
 3. Type III Cleanout:
 - a. Josam series 58500 (-20).

- b. J. R. Smith series 4420.
 - c. Approved Equal, with cast iron frame and cover as specified on the drawing details.
- 4. Type IV Cleanout:
 - a. Josam series 58500(-20).
 - b. J. R. Smith series 4420.
 - c. Approved Equal.
- 5. Type V Cleanout:
 - a. Josam series 58890.
 - b. J. R. Smith series 4472.
 - c. Approved Equal.

C. Chemical cleanouts: Cleanouts on chemical waste or drain lines shall be Duriron or material equal to that used for the pipelines and piping fittings.

2.02 DRAINS

- A. Floor Drains:
 - 1. General: Provide floor drains with clamping collars where waterproofing membranes are located in the floor.
 - 2. Acceptable Manufacturer:
 - a. Type I Floor Drain (FD-1):
 - 1) Josam series 32130.
 - 2) J. R. Smith series 2225.
 - 3) Approved Equal.
 - b. Type II (FD-2), III (FD-3), and IV (FD-4) Floor Drains:
 - 1) Josam series 32100-81.
 - 2) J. R. Smith series 2220.
 - 3) Approved Equal.
- B. Condensate Drains:
 - 1. Unless otherwise specified, condensate drains shall be as specified for piping system 24 in Section 40 05 01.
- C. Equipment drains:
 - 1. As shown on the mechanical general detail sheet.
- D. Parapet drains:
 - 1. Unless otherwise indicated, parapet drains shall be Josam series 24700.

2.03 VALVE ACCESSORIES

- A. Access Covers:
 - 1. Access covers for concealed valves within structure interiors shall be 12 inches by 12 inches minimum, stainless steel.
 - 2. Acceptable Manufacturers:
 - a. J. R. Smith series 4762 or 4767.
 - b. Karp 214-M or 214-P.
 - c. Approved Equal.
- B. Provide 2 keys or wrenches for each type of key-operated valve.

2.04 COUPLINGS, NIPPLES AND UNIONS

- A. Couplings and nipples shall be of the same material as the pipe on which they are used.

B. Unions: See Section 40 05 40.

2.05 WATER HAMMER ARRESTERS

A. Welded bellows type, all stainless steel construction. Zurn Shoktrol, Jay R. Smith Hydrotrol or equal.

P.D.I. Size	Zurn Shocktrol	Jay R. Smith Hydrotrol
A	Z-1700-100	5005
B	Z-1700-200	5010
C	Z-1700-300	5020
D	Z-1700-400	5030
E	Z-1700-500	5040
F	Z-1700-600	5050

2.06 SLEEVES

A. Sleeves shall be 22-gage sheet metal.

2.07 ESCUTCHEONS

A. Escutcheons shall be chrome-plated cold rolled steel or stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Work shall be in accordance with the Seattle Plumbing Code.
2. Provide plumbing to avoid obstructions, allow 7.5 feet minimum headroom, and keep openings and passageways clear.
3. Make no holes in structural members.
4. Repair torn and pierced waterproofing.
5. Wrap fixtures, fittings, valves, and copper and brass items with burlap or building paper. Remove wrapping at completion of the work.

B. Valves and Accessories:

1. Provide valves upstream of branches, apparatus and fixtures.
2. Provide valves on branch lines and at distribution points with a 2-inch heavy brass disc, stamped and stencil with 1/4-inch high letters, stating portion of system controlled by valve.
3. Valve locations shall be shown on record drawings. The Contractor shall provide a chart of location and use of main valves.
4. Provide adjustable shaft valve boxes for underground valves.

C. Dielectric Unions:

1. Provide dielectric unions at connections between different materials.

D. Escutcheons:

1. Provide escutcheons where pipes penetrate finished walls, ceilings or floors.
2. Securely mount escutcheons allowing clearance for expansion.

E. Piping:

1. Carry piping in chases or recesses where provided in walls, through floors and partitions, and over ceilings. Unless otherwise indicated, do not run piping in floor slabs.
2. Do not support pipes by plumbing fixtures or equipment. Make changes in pipe size with reducing fittings. The use of bushings is not acceptable.
3. Where galvanized steel pipe is caulked into a cast iron hub, provide a soil pipe adapter on the caulked end of the steel pipe.
4. Unless otherwise indicated, underground piping outside buildings shall have a minimum cover of 24 inches. Piping under buildings shall have a minimum clearance from structure of 12 inches.
5. Separate hot and cold water piping by at least 6 inches.

3.02 CLEANING AND FLUSHING

- A. Clean and flush piping and equipment in accordance with Section 40 05 01.

END OF SECTION

SECTION 22 13 33

PACKAGED SUBMERSIBLE SEWERAGE PUMP UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies submersible sump pumps complete with motor and discharge connection.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Pump Room Sump Pump 1	704-P03SP031
Pump Room Sump Pump 2	704-P03SP032

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A48	Specification for Gray Iron Castings
ASTM A276	Specification for Stainless Steel Bars and Shapes
NEMA MG1	Motors and Generators
NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's data including materials of construction, installation instructions, and equipment weight.
 2. Predicted performance curves plotting head/capacity/efficiency with horsepower and selected impeller diameter for the performance requirements specified.
 3. Sphere size for solids passing capacity, suction size, discharge size, flange or compression gland connection.
 4. Motor data Form 40 05 93-A with motor data showing rated hp, service factor, voltage, full load amperage and enclosure rating. Power cable rating and listing (UL approved, or ETL, CSA) for this service.
 5. Shop drawings including dimensions and section views showing installation dimensions and minimum sump dimensions.
 6. Bearing service life calculations.
 7. Operating and maintenance information per Section 01 78 23.
 8. Installation certification on Form 43 05 01-A.
 9. Bill of Materials, including Form 01 78 45-A.

1.04 PERFORMANCE REQUIREMENTS

A. General:

1. Each pump shall be a heavy duty, submersible, vertical shaft, centrifugal, with self-clearing impeller, suitable for pumping fluids containing sewage solids.
2. Motor and pump: attached or close coupled suitable for continuous duty in submerged or dry application.
3. Design for continuous operation under submerged, partially submersed, or totally dry condition without damage to the pump or motor.

B. Operating Requirements:

Equipment No.	Rated Capacity (gpm)	Rated Head (ft)	Solids Size (in)	Discharge Size (in)	Max. Speed (rpm)	Voltage / Phase / Frequency (V / - / Hz)
704-P03SP031	300	25	2	3	1800	480 / 3 / 60
704-P03SP032	300	25	2	3	1800	480 / 3 / 60

C. System Operation: As shown on Drawings.

D. Motor nameplate power shall be sufficient to avoid motor overload for any point on the pump curve.

1.05 LABELING

- A. Electrical materials, devices, appliances, and equipment labeled by the established standards of the Underwriters Laboratories Inc. or other electrical product testing laboratory which is accredited by the State of Washington Department of Labor and Industries. A valid label affixed to the item.
- B. Panels, which consist of multiple components: labeled as a unit in addition to any other regulatory requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 1. Ebara
 2. Flygt
 3. Fairbanks Morris
 4. Approved Equal.

2.02 MATERIALS

A. Materials employed for the fabrication of the pumps shall be as follows:

Component	Material
Pump volute, impeller, discharge elbow	Cast Iron, ASTM A48, Class 30.
Motor casing	Cast Iron, ASTM A48, Class 30.
Motor and pump shaft	Stainless steel, ASTM A276, Series 400.
Wear rings / wear plate	Stainless steel, ASTM A276, Series 400 heat treated.
External bolts and nuts	Stainless steel, ASTM A276, Type 304.

Guide bar brackets, guide rails, and lifting chain	Stainless steel, ASTM A276, Type 304
Mechanical Seal	Double, carbon/tungsten-carbide faces with multiple spring system.

2.03 EQUIPMENT FEATURES

- A. General:
 - 1. Pump volute: fit with a flange or compression gland connection for the discharge piping.
- B. Impellers and wear rings/wear plates:
 - 1. Dynamically balanced, self-clearing, blockage resistant shown design capable of handling solids, fibrous materials, heavy sludge, and other matter found in normal sewage applications.
 - 2. A replaceable wear ring or wear plate system designed for abrasion resistance shall provide efficient sealing between the volute and impeller.
- C. Pump Shaft:
 - 1. Pump/motor shaft: one-piece, stainless steel of sufficient size, machined, and ground to industry standards for bearing clearance with radius shoulders as needed to eliminate stresses.
 - 2. Shaft shall not extend or overhang more than 2½ times its diameter beyond the bottom support bearing.
- D. Bearings: heavy duty, rolling element, grease lubricated, permanently lubricated and sealed with a five year service life.
- E. Mechanical seal: tandem double mechanical seal running in an oil reservoir, with leak sensor. Carbon/ceramic seal faces and a single coil spring system are not acceptable.
- F. Cable Seal:
 - 1. Cable entry: comprised of a single cylinder elastomer grommet to seal against the outside of the cable.
 - 2. Cable strain relief: separate from the cable sealing function.
- G. Motor:
 - 1. Per Section 40 05 93
 - 2. Squirrel-cage induction, shell type design, housed in an air filled or oil filled water tight chamber.
 - 3. Insulation: Class F with Class B temperature rise, or better.
 - 4. Motor windings: provide high temperature trip or resistance temperature detectors.
 - 5. NEMA MG-1: for applicability, fabrication, labeling, and installation.
- H. Discharge:
 - 1. Discharge pipe: one piece up through the surface plate with grooved end.
 - 2. Discharge elbow: 125 lb. flat face ANSI flange.
- I. Lifting System
 - 1. Two 304 stainless steel Schedule 40 guide rails mounted directly to the quick discharge connector at the floor of the sump and to a guide rail bracket at the top of the sump below the hatch opening.
 - 2. Type 304 stainless steel lifting chain, with closed 304 stainless steel lifting rings, every 5 feet, connected to the top of the motor with a hook at the top of the sump under the cover with sufficient chain to reach above the cover for connection to a lifting hoist.

2.04 CONTROLS

- A. General:
 - 1. Control panels:
 - a. NEMA 4X enclosures.

- b. Assembled package UL approved and listed.
 - c. Each panel shall contain standard relays as needed for bubbler level control panels.
 - 2. Circuit breakers, contactors, overload relays, HAND/OFF/AUTO selector switches, manual alternator switch, operation status indicator lights, manual alternator switch, high level alarm dry contact and panel lights for leak sensor, motor over temperature, and high level alarm.
 - 3. Three level switch indicators for bubbler level control.
 - 4. Internal space heater with thermostat.
 - 5. Terminal strip for connection of external devices.
 - 6. Panel face labels: phenolic, white letters on black background, pinned to the panel face. Adhesive is not acceptable. Letters shall be minimum 1/4 inch.
 - 7. Panel identification label, pump identification over H/O/A switches, high level alarm, motor over temperature, and leak sensor light.
- B. Bubbler Level Control:
- 1. Installations using a bubbler level control system shall contain at a minimum in addition to items noted in this Section.
 - 2. Diaphragm activated pressure switches, one common OFF, one for each pump ON.
 - 3. Bubbler piping shall contain a pressure regulator with filter, rotameter, purge valve, etc. as shown on the Drawings.
- C. Other items:
- 1. Suitable cable holder to support pump power and liquid level sensor cables or bubbler tube.
 - 2. Cable holder: plastic coated or painted and designed to permit easy individual adjustment of level sensor cables.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings
- B. Field Testing: Section 01 75 20.
- 1. After completion of installation, field test for functional operation and demonstrate compliance with the performance requirements.

END OF SECTION

SECTION 22 33 33

DOMESTIC HOT WATER HEATER

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies small tank-type electric water heaters for potable water.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Breakroom Water Heater	704-WH25BS011
Sample Room Water Heater	704-WH25BT011

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASHRAE Standard 90A	Energy Conservation in New Building Design
ASME BPVC	ASME Boiler and Pressure Vessel Code Section IV Heating Boilers

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer and manufacturer's type designation.
 2. Manufacturer's catalog and/or other data confirming conformance to specified design, material, and equipment requirements.
 3. Electrical and control diagrams.
 4. Installation requirements, showing clearance required for maintenance purposes.
 5. O&M manual: Section 01 78 23.

1.04 QUALITY ASSURANCE

- A. UL listed meeting the requirements of ASHRAE Standard 90A.
- B. Construct to Section IV of ASME Code and test for 150 psig working pressure.

1.05 SPECIAL WARRANTY

- A. Five-year warranty on all water heaters and materials. Submit per Section 01 78 36.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturer
1. A.O. Smith.
 2. Bosch

3. PVI
4. National.
5. Rheem.
6. Ruud.
7. Approved Equal.

2.02 EQUIPMENT

- A. General:
 1. Water heater as a complete unit with elements, insulated storage tank, corrosion protection, operating, and safety controls.
 2. High temperature safety cut-off and an ASME code pressure-temperature relief valve on each water heater which shall comply with Section 40 05 72.
- B. Tank:
 1. Glass lined storage tank type unit, complete with drain valve.
 2. Insulated for heat retention.
 3. Equip with factory installed supporting legs. Mini-tank heater to be capable of wall mounting.
- C. Corrosion Protection: magnesium anodes inside the tank for corrosion protection.
- D. Heating Elements:
 1. Suitable for use in hard water, designed to resist lime build-up.
- E. Performance: As scheduled in the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions, the local plumbing code, and as indicated on the Drawings.
- B. Use dielectric unions for all piping connections.
- C. Provide isolation valves on the hot and cold water piping.
- D. Wiring shall be with flexible connection.
- E. Pipe relief valve to drain point.

END OF SECTION

SECTION 22 42 00

COMMERCIAL PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies plumbing fixtures, trim, and fittings.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ADA ANSI/ICC A117.1	Accessible and Usable Buildings and Facilities
ANSI Standard A112.19.2	Ceramic Plumbing Fixtures
ASME A112.18.1	Plumbing Supply Fittings
ASME A112.19.3	Stainless Steel Plumbing Fixtures
NSF/ANSI 61 Section 9	Mechanical Plumbing Devices

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. All operations and maintenance information specified in Section 01 78 23.
 2. Manufacturer's catalog data.

PART 2 PRODUCTS

2.01 LAVATORY (LAV-1)

- A. Lavatory:
1. Wall hung and accessible.
 2. White vitreous china, over 20 inches wide, with front overflow and 4-inch faucet openings.
 3. Dimensions shall conform to ANSI Standard A112.19.2.
 4. Supply wall hangers.
 5. Provided chrome-plated strainer, tailpiece and tubular brass P-trap with flange.
 6. Acceptable manufacturers:
 - a. American Standard, Lucerne Model 0355.012.
 - b. Kohler.
 - c. Sloan.
 - d. Approved Equal.
- B. Faucet:
1. Provide ADA handicapped lavatory faucets with chrome-plated wrist blade handles.
 2. Provide faucet with 0.5 gpm aerator and with renewable seats.
 3. Acceptable manufacturers:
 - a. Chicago Faucets, Model 802-VE2805-317ABCP.
 - b. T and S Brass.
 - c. Elkay.

- d. Approved Equal.

2.02 WATER CLOSET (WC-1)

- A. Toilet:
 - 1. ADA Height wall mounted.
 - 2. Elongated bowl.
 - 3. Vitreous china.
 - 4. High efficiency, low consumption.
 - 5. 1-1/2-inch top spud.
 - 6. Concealed trapway design.
 - 7. Maximum Performance (MaP) score of 1000 grams at 1.1 gpf – 1.6 gpf.
 - 8. Direct fed siphon jet action.
 - 9. Acceptable manufacturers:
 - a. American Standard 2257.101.
 - b. Kohler.
 - c. Approved Equal.
- B. Seats:
 - 1. Open front.
 - 2. Extra heavy duty.
 - 3. White.
 - 4. Acceptable manufacturers:
 - a. American Standard 5901.100.
 - b. Bemis.
 - c. Olsen.
 - d. Kohler.
 - e. Approved Equal.
- C. Flush valves:
 - 1. Dual flush action.
 - 2. 1.1 gpf and 1.6 gpf.
 - 3. Acceptable manufacturers:
 - a. Sloan Royal WES 111.
 - b. Delany.
 - c. American Standard.
 - d. Kohler.
 - e. Approved Equal.

2.03 SERVICE SINKS AND MOP SINKS

- A. Service sinks (SSK-1)
 - 1. Acid resisting enameled cast iron, white with rim guard, 22 inches x 18 inches, and shall be wall hanger type.
 - 2. Sinks shall be provided with chrome plated strainer, wall mountings, and fittings.
 - 3. Service sinks shall be provided with adjustable 3" trap.
 - 4. Sinks shall be Kohler K-6718 with rim guard or Approved Equal.
 - 5. Trim shall be Kohler K-8907 or Approved Equal.
- B. Mop sinks (MS-1):
 - 1. Floor type, nominal 28 inches x 28 inches.
 - 2. Acid-resisting enameled cast iron.
 - 3. Corner type with vinyl coated rims.
 - 4. Chrome plated strainer, rubber hose, and hose holder.
 - 5. Mop sink shall be American Standard 7740.020 or Approved Equal.
 - 6. Hose and hose holder shall be American Standard 8344.111 or Approved Equal.

- C. Faucet:
1. Sink shall be provided with faucet with bucket hook.
 2. Faucet, Chrome plated, Wall mounted, 8: body, lever handles, ¼ turn ceramic cartridges
 - a. Vacuum breaker spout with pail hook and wall brace. ¾ inch male hose thread outlet
 - b. Integral stop valves for servicing faucet.
 - c. ADA ANSI/ICC A117.1.
 - d. ASME A112.18.1.
 - e. Acceptable manufacturers:
 - 1) Chicago Faucets, model 897-CP.
 - 2) T and S Brass.
 - 3) Approved Equal.

2.04 SINK (S-1)

- A. Sink:
1. Top counter mounted double basin, 18 gauge stainless steel.
 2. For use in 36 inch minimum cabinet width.
 3. 33 inches x 22 inches x 9.25 inch deep.
 4. Double equal bowls.
 5. Drain holes: 3-5/8 inch, Sink drains shall the ability to accept stopper.
 6. ASME A112.19.3 compliant.
 7. Acceptable manufacturers:
 - a. Kohler, Model K-3847-4.
 - b. Elkay.
 - c. Just.
 - d. Approved Equal.
- B. Faucet
1. L-type swing spout.
 2. 1.5 gpm.
 3. Write blade handles.
 4. With side spray wand included.
 5. ADA ANSI A117.1 compliant.
 6. ASME A112.18 and NSF/ANSI 61 Section 9 compliant.
 7. Certified to WaterSense by ICC-ES.
 8. Acceptable manufacturers:
 - a. Chicago Faucets, Model 1102-E35-317 ABCP.
 - b. T and S Brass.
 - c. Elkay.
 - d. Approved Equal.

2.05 GENERAL ITEMS

- A. Strainers chrome plated brass by Kohler, McQuire, T&S Brass or Approved Equal.
- B. Stop valves, quarter turn by Dahl, T&S Brass or Approved Equal.
- C. Hangers and carriers by manufacturer, Zurn, JR smith, Wade, or Approved Equal.
- D. ADA protection: PlumberEx, Handy Shield, Trubro, Lav Guard or Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Fixtures shall be provided plumb and level. Seal joints between wall and fixtures with silicone sealer, top and sides.
- B. Fixtures shall remain in manufacturer's packaging until installation.
- C. Fixtures shall be provided with required holes for fittings and mounting hardware. Unoccupied fixture faucet holes are not acceptable. Exposed fixture setting bolts shall be fitted with china caps.
- D. Supporting of fixtures:
 - 1. In accordance with manufacturer's recommendations.
 - 2. Wall-mounted fixtures shall be provided with brackets and anchorage.
 - 3. Drop-eared fittings shall be provided at fixture outlets and securely fastened to backing.
- E. Openings into pipes shall be capped during construction.
- F. Vitreous finished surfaces shall have heavy paper pasted thereon during construction.
- G. Provide vent pipe for water closet, breakroom sink, and lavatory, as shown on Drawings and required by the Seattle Plumbing code.

END OF SECTION

SECTION 22 45 33
EMERGENCY FIXTURE UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies emergency eyewash units for indoor use.
- B. Equipment List: Not used.

EQUIPMENT	EQUIPMENT NO.
704-ME01001	RSP MOTOR LEVEL EYE/FACE WASH 1
704-ME01002	RSP MOTOR LEVEL EYE/FACE WASH 2
704-FSH01001	RSP MOTOR LEVEL EYE/FACE WASH 1 FLOW SWITCH
704-FSH01002	RSP MOTOR LEVEL EYE/FACE WASH 2 FLOW SWITCH

- C.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/ISEA Z358.1	American National Standard for Emergency Eyewash and Shower Equipment
ASSE 1071	Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's catalog data.

PART 2 PRODUCTS

2.01 GENERAL

- A. Eyewash shall have tepid water supplied.

2.02 EYEWASH UNITS

- A. Indoor Eye/Face Wash Unit (704-ME01001)
 - 1. Indoor unit shall be wall-mounted emergency eye/face station.
 - 2. Barrier Free design.
 - 3. Eyewash bowls: Stainless steel.
 - 4. Eyewash valve: Hand activated stay-open ball valve.
 - 5. Eyewash unit accessories: Automatic pressure and volume control and supply line strainer.
 - 6. Integral/local mixing valve with positive hot water shut off if cold water fails.
 - 7. ANSI/ISEA Z358.1 compliant.

8. ASSE 1071 approved
 9. Provide with flow switch which shall open a contact when flow occurs and is rated for 120V service.
 10. Acceptable manufacturer:
 - a. Stingray Systems, T2535.
 - b. Bradley.
 - c. Haws
 - d. Approved Equal.
- B. Indoor Eye/Face Wash Unit, Swing Down configuration (704-ME01002):
1. Indoor unit shall be wall-mounted.
 2. Eyewash valve: Hand activated Pull Down stay-open ball valve.
 3. Nickle Plated Stainless Steel finish.
 4. Eyewash unit accessories: Automatic pressure and volume control and supply line strainer.
 5. Local mixing valve with positive hot water shut off if cold water fails.
 6. ANSI/ISEA Z358.1 compliant.
 7. ASSE 1071 approved
 8. Provide with flow switch which shall open a contact when flow occurs and is rated for 120V service.
 9. Acceptable manufacturer:
 - a. Stingray Systems, S2550.
 - b. Bradley.
 - c. Haws
 - d. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Coordinate installation location to provide user access. Verify installation with the Project Representative.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the labor and services necessary to test, adjust, and balance under actual operating conditions air and hydronic systems design flow rates.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AABC	Associated Air Balance Council, National Standards for Total System Balance
ASHRAE 70	Standards--Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets
NEBB	National Environmental Balancing Bureau, Procedural Standards for Testing Adjusting and Balancing of Environmental Systems

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Balancing report as specified.
 2. A description of each air and hydronic system including list equipment to be balanced.
 3. Certificate of Completion as specified.

1.04 QUALITY ASSURANCE

- A. Codes and Standards:
1. Comply with applicable procedures and standards of the certification sponsoring association:
 - a. National Standards for Field Measurements and Instrumentation, Total Systems Balance, Air Distribution and Hydronic Systems, AABC.
 - b. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, NEBB.
 - c. Method of Testing for Rating the Air Flow Performance of Outlets and Inlets, ASHRAE.
 2. Calibration and maintenance of instruments and accuracy of measurements shall comply with the requirements of the standards.
- B. Testing Agency: Procure the services of an independent air and hydronic balancing and testing agency, belonging to the AABC or the NEBB, to perform balancing, testing and adjustment of systems. One organization shall perform the testing and balancing services.

1.05 SPECIAL REQUIREMENTS

- A. Tests and adjustments shall include the complete testing and balancing of all new or modified hydronic systems and heating, ventilating, and air conditioning systems and necessary adjustments to the heating, air conditioning, and ventilating equipment to accomplish the specified design flow rates.
- B. Should any apparatus, material or work fail to meet the specified requirements in these tests, make the necessary corrections and retest the apparatus, material, or work at no additional cost to King County.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. The balancing agency shall conduct the field tests in the presence of the Project Representative as specified in following paragraphs.
- B. Following completion of testing and balancing, leave the system in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.02 PERFORMANCE OF WORK

- A. Perform testing, adjusting, and balancing after the system installation is complete but prior to acceptance of the project.
- B. Air Systems Measurements:
 - 1. Measure and adjust air supply and exhaust units to deliver at least 100 percent of the design air volume at 100 percent cooling.
 - 2. Measure static air pressure conditions on fans, including filter and coil pressure drops, and total pressure across the fan.
 - 3. Adjust fan speeds and motor drives within drive limitations, for required air volume. Set a speed to provide air volume farthest distance from the fan without excess static pressure. Check draw amps of fans on initial start-up. If running amps exceed nameplate, shut off motor immediately, notify Project Representative, and make necessary drive changes as directed.
 - 4. Measure airflow rates with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between design values specified for clean and dirty filters with auxiliary systems in operation.
 - 5. Airflow rates supplied, exhausted, or returned shall be within plus or minus 5 percent of the design values specified.
 - 6. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.
- C. Hydronic Systems Measurements:
 - 1. Measure and adjust pumps to deliver at least 100 percent of the design water flow. Check draw amps of running pumps. If in excess of nameplate, shut off immediately and notify the Project Representative. Proceed as directed by the Project Representative.
 - 2. Measure and adjust water flow at coils for design conditions, plus or minus 10 percent. Check conditions at coils for required performance at design conditions.
 - 3. Measure and adjust total water flow rates at each control valve.
- D. Systems to be balanced: Balance all heating, ventilating, and air conditioning and foul air systems and equipment.

3.03 BALANCING

- A. Characteristics to be tested and adjusted to conform to the values specified include the following:
 - 1. Total airflow rates delivered by fans and air-handling units.
 - 2. Flow rates at all grilles, registers, diffusers, supply and exhaust and return ducts.
 - 3. Capacity and temperature rise or drop across each heating and cooling coil.
 - 4. Total water flow rates at each heating and cooling coil, control valve, and pump.
 - 5. Operation and modulation of each control valve.
- B. Air Flow Rate Measurements:

1. Airflow rates shall be obtained by adjustment of the fan speeds, dampers, or registers. All flow rates shall be measured with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between the design values specified for clean and dirty filters, with auxiliary systems in operation and with all doors and windows closed.
2. Flow rates at grilles, registers, branch ductwork and air distribution patterns shall be tested in strict accordance with ASHRAE Standard 70.

C. Water Flow Rate Measurements:

1. Total water flow rates shall be measured at each heating coil, cooling coil, unit heater, valves, and fittings.
2. All flow rates shall be measured with control valves 100 percent open.
3. Pump capacities shall be determined by differential pressure measurement.
4. Temperature shall be measured across the heat transfer elements in the system.

3.04 BALANCING REPORT

A. The final certified balancing report shall include the following actual field-verified data:

1. Equipment data:
 - a. Manufacturer and model, size, arrangement, class, location, and equipment number.
 - b. Motor horsepower, voltage, phase, and full load amperage.
 - c. Fan cfm, static pressure, rpm, and operating motor BHP.
 - d. Pump gpm, discharge pressure, suction pressure, pressure change across pump, total discharge head, gpm at major equipment and operating motor BHP.
2. Duct size, supply or exhaust recorded cfm, velocity, pressure measurements, and location of all measurements.
3. Pipe size, recorded gpm, velocity, pressure measurements, balancing valve size and model, location of all measurements.
4. Terminal Units:
 - a. Manufacturer and model, supply or exhaust, location, and identification number.
 - b. Recorded and design cfm.
 - c. Recorded and design noise levels and velocities, where specified.

B. Report Requirements:

1. Each individual final reporting form shall bear the signature of the person who recorded the data and that of the supervisor of the reporting organization.
2. All instruments which were used shall be listed and identified including the last date each was calibrated.

C. Final report shall be submitted prior to Contractor's request for final inspection. In addition to providing all specified data and information on applicable reporting forms, report shall include the following:

1. A schedule for testing and balancing parts of the systems which shall be delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor. Delayed work shall be completed as early as the proper conditions will allow, after consultation with the Project Representative.
2. Due to delayed testing, reports shall be submitted after execution of those services.
3. A total balance report shall include the following components:
 - a. General Information and Summary.
 - b. Instrument Calibration.
 - c. Air Systems.
 - d. Hydronic Systems.
 - e. Sound and Vibration Systems.
 - f. Temperature Control Systems.
 - g. Record drawings with specified and measured flow rates.

3.05 FINAL INSPECTION

- A. Following completion of testing and balancing, but prior to submitting the balancing report, the Contractor shall recheck, in the presence of the Project Representative, random selections of data water and air quantities, air motion, and sound levels recorded in the report. Points and areas for recheck shall be as selected by the Project Representative. Measurement and test procedure shall be as approved for work forming basis of the report.
- B. Selection for recheck will not exceed 25 percent of the total tabulated in the report.
- C. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new reports submitted, and new inspection test made.
- D. Following acceptance of the reports by the Project Representative, permanently mark all damper positions so that they can be restored to their correct position if disturbed at any time. If a balancing device is provided with a memory stop, set it and lock it. Do not mark devices until after final inspection.

3.06 CERTIFICATE OF COMPLETION

- A. At completion of testing and balancing, Contractor shall submit a Certificate of Compliance stating that each apparatus, device, outlet, and system has been tested, adjusted, and balanced so that it is operating in conformance with manufacturer's recommendations and with the specified and shown conditions.

END OF SECTION

SECTION 23 07 13

DUCTWORK THERMAL INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies thermal insulation for HVAC systems metal air ductwork system. Ductwork insulation shall be suitable for continuous service of ductwork.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C1338	Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
NFPA 255 / ASTM E84	Test Method for Surface Burning Characteristics of Building Materials
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Duct Liner Application Standard
Seattle Energy Code	Table C403.10.1.1 – Outdoor Air Ductwork Insulation Table C403.10.1.2 – Supply, Return, Exhaust, and Relief Air Ductwork Insulation

1.03 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Ductwork insulation shall comply with Tables C403.10.1.1 and C403.10.1.2 of the Seattle Energy Code and below whichever is greater.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Manufacturer's descriptive literature, including insulation and heat transfer coefficient, and methods of installation.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers:
1. Knauf.
 2. Johns Manville.
 3. Owens Corning Fiberglass.
 4. Approved Equal.

2.02 DUCTWORK LOCATION AND INSULATION TYPE:

Ductwork Location	Insulation Type
Outdoor air ducts, inside the building	UL Labeled, 1.5-pound density, duct wrap insulation with FSK vapor barrier R-16 between exterior and fan or isolation damper. R-8 downstream of fan or isolation damper.
Supply or exhaust air in the screen room	Not insulated
Supply air or exhaust air plenums and ducts that are located in a building envelope assembly	UL Labeled, 3 pound density, fiberglass board internal insulation with approved weather proof barrier, or in accordance with Seattle Energy Code whichever is greater R-16
Supply air and exhaust air upstream of a heat recovery device, outside the building	UL Labeled, 3 pound density, duct wrap internal insulation with approved weatherproof barrier R-8
Supply air and exhaust air upstream of a heat recovery device, inside the building, and concealed in walls or above a ceiling	UL Labeled, 1.5-pound density, duct wrap insulation with FSK vapor barrier R-3.3
Supply air and exhaust air ducts upstream of a heat recovery device, inside the building, and exposed to the space and not in the screen room.	UL Labeled, 3-pound density, duct wrap insulation with 8 ounce treated canvas vapor barrier and fire retardant covering R-3.3

2.03 THERMAL INSULATION MATERIALS

- A. Flexible blanket type.
- B. Made of long, extremely fine, flame attenuated glass fibers, bonded with a thermosetting resin.
- C. Facing: Constructed out of reinforced foil-scrim-kraft.
- D. Fire hazard classification: Flame spread not exceeding 25 and smoke developed not exceeding 50 per NFPA 255 / ASTM E84.
- E. Fungi and bacteria resistance: Does not breed or promote growth per ASTM C1138.

2.04 ADHESIVE

- A. Adhesive used to secure insulation to the ductwork shall meet the requirements of the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) Duct Liner Application Standard.
- B. Adhesive used will meet the low emitting materials requirements for adhesives as referenced in Section 01 33 29.

PART 3 EXECUTION

3.01 GENERAL

- A. Insulate all heating and air conditioning supply ducts, return ducts, and outside air intake unless otherwise indicated.
- B. Unless otherwise indicated, do not insulate exhaust air, untempered air, and foul air ducts.

3.02 INSTALLATION

- A. Apply external insulation in sections with edges tightly butted. Seal all edges with 4-inch wide tape, with the ends overlapping at least 6 inches.
- B. Secure external insulation to the ductwork by applying vapor barrier adhesive in 6-inch wide strips on 12-inch center. Where the underside of horizontal ducts exceeds 24 inches in width, additionally secure insulation by mechanical fasteners or speed clips and nail type stick clips fastened with adhesive.
- C. Use one mechanical fastener for every 2 square feet of duct surface.
- D. Seal all duct penetrations with a piece of the same facing material as the duct and install with the same vapor barrier adhesive.
- E. Extend external insulation and vapor barrier through all duct sleeves.

END OF SECTION

SECTION 23 09 03

VARIABLE FREQUENCY DRIVES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies variable frequency drive (VFD) controllers. The controllers include converters, inverters, control functions, instrumentation, filters, harmonic analysis, protective equipment and accessories necessary to provide the specified functions and features.
- B. The requirements listed in this section applies to all mechanical equipment specified in Division 22 and Division 23 using VFD controllers that are 40 horsepower or smaller. For VFD's larger than 40 horsepower see requirements listed in Section 26 29 23 – Variable Frequency Drives.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-Control Room Supply Fan VFD	704-VFD25AF011
RSP-Control Room Exhaust Fan VFD	704-VFD25AF012
RSP-Crane Hall Air Handler VFD	704-VFD25AF013
RSP-Crane Hall Exhaust Fan VFD	704-VFD25AF014
RSP-Screen Room Supply Fan VFD	704-VFD25AF015
RSP East Fan Room Gallery Supply Fan VFD	704-VFD25AF016
RSP-Crane Hall Air Handler VFD #2	704-VFD25AF023
RSP-Crane Hall Exhaust Fan VFD #2	704-VFD25AF024
RSP-Screen Room Supply Fan VFD #2	704-VFD25AF025

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

REFERENCE	TITLE
ANSI C37.90	Relays and Relay Systems Associated with Electric Power Apparatus
NEMA ICS6	Enclosures for Industrial Control and Systems
NEMA ST20	Dry Type Transformers for General Applications
IEEE 519	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
UL Standard 508	Industrial Control Equipment
UL 61800-5-1 and -2	Standard for Adjustable Speed Electrical Power Drive Systems
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Submit manufacturer's technical product data and maintenance data for each VFD.
 2. Shop Drawings that include control wiring diagram indicating factory and field installed wiring, schematics and wiring diagrams.

3. Installation instructions outline dimensions and weights including filters and/or isolation, transformers, front view drawing identifying control and monitoring devices, nameplate engravings, and wall mounting requirements for all assemblies.
4. External connection diagram showing function and identification of all terminals requiring field connections.
5. Operations and Maintenance manuals as specified in Section 01 78 23.
6. Plan drawings showing conduit entry locations.
7. Calculations:
 - a. Total harmonic current and total harmonic voltage distortion calculations:
 - b. Point of Common Coupling (PCC) is the service entrance disconnect.
 - c. Include first 36 odd current and voltage harmonics: Voltage calculated on line to line basis
 - d. Provide distortion figures for each harmonic and the total demand distortion.
 - e. Provide plots of voltage and current waves.
 - f. Perform calculations for the following criteria:
 - g. Provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5% at the point of common coupling as described in IEEE-519.
 - h. The manufacturer shall submit calculated line distortion percentages in accordance with IEEE - 519, based upon the total connected horsepower and source kilovolt-amperes of the utility and emergency power distribution system. Use electrical data (transformer KVA and impedance) from the electrical drawings.
 - i. Efficiency and power factor calculations:
 - j. Calculate efficiencies of the VFD controller including the auto-transformer (where applicable), ventilation fans, control power and all VFD losses.
 - k. Calculate displacement and total power factor including filter.
 - l. Perform calculations at 100, 75, and 50 percent speed.
 - m. Include first 36 harmonics.
 - n. Calculations of cooling and ventilation requirements.
8. Certifications:
 - a. Provide letters of certification signed by officers of manufacturer and the motor manufacturer that the specific application has been reviewed and that the motor and drive combination are compatible and will satisfy operating requirements under all conditions of operation without adverse impacts on either the motor or VFD.
 - b. Certified final factory test procedure and results for each drive.
 - c. Certified copies of all material test reports.
 - d. Manufacturer's certification that the controller can withstand fault conditions on the load side based on the assumption that an infinite bus and 5 percent impedance on a 1000kVA delta-to-wye service transformer exists on the supply side of the controller.
9. Location and description of service center and spare parts stock.
10. Bill of Materials, including Form 01 78 45-A.
11. Test procedures as specified in this Section.
12. VFD training instructor qualifications.
13. Training schedule and materials.
14. Provide written verification to the Project Representative that the factory installed wiring, busing, metering, relaying, and related equipment are properly connected, aligned, phased and identified.
15. Test instruments used to perform factory testing, including documentation of calibration.
16. Test documentation from post installation field testing.
17. Mounting base design requirements
18. For all drawings prepared for the submittals, provide updated CAD drawings to reflect as-built conditions in *.dwg format per Section 01 78 39 upon completion of Operational Testing per Section 01 75 20.
 - a. Provide written statement that manufacturer's equipment has been installed and properly adjusted and is ready for operation by Owner's personnel.

1.04 QUALITY ASSURANCE

A. Unit Responsibility:

1. The variable frequency drive system specified in this Section shall be the product of a single vendor. Unit Responsibility for the system shall be as specified in this Section in accordance with the requirements of Section 43 05 01.

2. The system shall consist of the following components:
 - a. Custom air handlers as specified in Section 23 75 00
- B. Qualifications:
 1. The VFD training instructor shall be factory-trained.
- C. Listed and labeled by Underwriter's Laboratories, Inc. (UL), ETL, or Canadian Standards Association.
- D. All upgrades to specified requirements per UL 508 or ETL.
- E. Compatibility: VFD controller's performance shall be compatible with and tolerant of disturbances produced by other VFD controllers and not interfere with each other.
- F. Harmonics:
 1. All line side harmonic suppression devices used to eliminate or deal with harmonics in any way shall be contained within the VFD enclosure and shall be integral with the VFD controller.
 2. Use of input line filters external to the VFD shall not be permitted to meet the specified harmonic levels contained in this specification.
 3. Output filters, used to protect motors from high voltage reflections, may be installed external to the VFD.
- G. VFD controller's performance shall be in compliance with the latest version of IEEE 519.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.06 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Reference Architectural Code Summary sheets and the Electrical Plan sheets.

PART 2 PRODUCTS

2.01 GENERAL

- A. The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Obtain input power voltage from the mechanical equipment schedules.
- B. Capable of starting, stopping, and driving an AC variable output from 0 to 60 Hz while maintaining a constant volts/hertz ratio
- C. Sized as required by motors as indicated on the Drawings. Where motor full load amps are not shown, use NEC Table 430-150 for sizing.

2.02 MANUFACTURERS

- A. Acceptable manufacturers:
 1. Rockwell Automation
 2. Yaskawa
 3. Donfoss
 4. ABB
 5. No substitution for the above manufacturers.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. General:

1. Minimum Continuous Current Ratings: 1.15 nameplate current of driven motor at full voltage, torque and speed.
2. Torque Requirements: Variable torque type.

2.04 FABRICATION REQUIREMENTS

A. General Requirements

1. Pulse Width Modulated (PWM) drive design suitable for use with NEMA design B squirrel-cage induction motors rated for inverter duty at 480 volt, 3 phase, 60 hertz with 1.15 service factor.
2. Converters:
 - a. For 6-pulse drives VFDs: 6-Pulse, multiple full wave, 3 phase, solid state rectifier bridge to convert incoming fixed voltage and frequency to a fixed DC voltage. All components for converters shall be integral to the VFD enclosure
3. Inverter:
 - a. Output voltage: Adjustable and controlled by the value of output frequency to maintain a constant ratio of Volts per Hertz throughout the operating range. The Volts per Hertz shall be internally field adjustable.
 - b. Capable of varying the speed of any standard NEMA B or NEMA E design, squirrel cage, induction motor with a 1.15 service factor.
 - c. A single unit, with no paralleling of smaller inverters.
 - d. Suppresses output dV/dT high voltage spikes and shall be compatible with the pump motors provided under Section 43 25 05.
4. Telephone Interference Requirements: Limit the I-T product at any harmonic as defined in IEEE 519 to 10,000 at the primary of the station supply transformer for 2 pumps running.
5. General Features:
 - a. Inverter output shall be conditioned to prevent high voltage ringing on motor leads. Output filters are acceptable.
 - b. Microprocessor controlled pulse width modulation output voltage control strategy.
 - c. Utilize pulse width modulation control techniques such that the maximum root mean square motor line current at rated voltage, torque and speed is less than 1.05 times that motor nameplate current.
 - d. Power transistor output circuitry shall use insulated gate bipolar transistors (IGBT). An essential 18-pulse design combining three 6-pulse inverters to achieve a 18-pulse output will not be accepted. Input phase shifting transformer shall be specifically designed for equal current sharing in VFD applications.
 - e. Power devices to have peak reverse voltage ratings of 2.5 times line current.
 - f. Input power devices shall have peak reverse voltage ratings of 2.5 times line voltage.
 - g. Insensitive to incoming power phase sequence.
6. Ratings:
 - a. Rated Input Power: 480 Volt, plus 10 percent or minus 10 percent, 3 phase, 48 - 62 Hertz, incoming voltage imbalance of plus or minus 0.5 percent.
 - b. Rated Output Power: 0-480 Volt, plus or minus 1 percent, 3 phase, 1-90 Hertz.
 - c. Frequency Drift: Plus or minus 0.5 percent.
 - d. Voltage Regulation: Plus or minus 1 percent rated value no load to full load.
 - e. Speed Regulation: 3 percent.
 - f. Ambient Temperature Range: 0-40 degrees Celsius.
 - g. Atmosphere: Non-condensing relative humidity to 95 percent.
 - h. VFD Efficiency: A minimum of 95 percent at 100-percent speed and torque at 40 degrees Celsius ambient based upon measurement of input power versus output power with all specified components in system.
 - i. Displacement Power Factor: The minimum displacement power factor the VFD controller shall present to the AC system shall be 95 percent at all speeds. The unit shall be designed to inherently provide this minimum power factor.
 - j. Speed Range: 40:1.
 - k. Input Speed Signal: A 4-20 mA DC from an external source and a remote pot. Circuitry shall be isolated.

- I. Output Contacts: Three electrically isolated, programmable auxiliary status contacts, rated 5 amp at 120 VAC, for Ready, Run, and Fault.
 7. Frequency control and regulation:
 - a. Range: 4 mA DC at minimum equipment speed and 20 mA DC at maximum equipment speed.
 - b. Accuracy: 1.0 percent of span.
 - c. Deadband: 0.5 percent of band.
 - d. Repeatability: 0.5 percent of band.
 - e. Input signal impedance: 100 Ohms minimum, with isolated two-wire signal follower.
 - f. Adjustable minimum and maximum output frequency limits.
 - g. Independent timed linear acceleration and deceleration functions adjustable from 3 to 300 seconds.
 8. Provide program to prevent operation of the VFD at a minimum of two critical speeds.
 9. Disconnects:
 - a. For 6-pulse VFD drives: Provide input fused disconnects or circuit breaker and current limiter combinations.
 - b. Provide disconnects or circuit breakers with through-the-door or flange-mounted handle and include door interlocks with defeater mechanisms.
 - c. Provide these disconnect switch and circuit breakers as integral components of the factory built assemblies
 10. VFD overload capacity: 150 percent of continuous current rating for one minute.
- B. Microprocessor Digital Control:
1. Drive operating parameters programmable.
 2. Sealed keypad with pushbuttons or sealed membrane type keypad with LED or LCD display, mounted on door when VFD is inside a NEMA 1 enclosure.
 3. Operating parameters, fault, and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data for a minimum of the four most recent events, and is accessible via keypad and RS232/RS422 serial port.
 4. Utilize English messages and engineering units.
 5. Menu driven.
 6. Password security.
 7. Computer Interface via RS232/RS422 Serial Communication Port:
 - a. Adjust drive-operating parameter.
 - b. Fault and diagnostic data accessible.
 - c. Isolated from pump station ground so that no connection of a computer powered by the pump station power can cause damage to the computer or the VFD serial communication ports.
 8. Display fault and diagnostic data.
- C. Basic Drive Features and Functions:
1. Automatic Restart Feature:
 - a. Field selectable.
 - b. Faults:
 - 1) Overload.
 - 2) Overvoltage.
 - 3) Undervoltage.
 - 4) Voltage imbalance.
 - c. Final fault, requiring manual reset, if restart is not successful after three attempts at 30-second intervals between restart attempts.
 - d. Provide drive with the ability to start into a motor that is spinning in the forward direction and assume normal operation upon auto restart of the drive.
 2. Upon restoration of AC power after a loss of utility or standby power, the VFD controller shall not attempt to restart until an external start signal is received. The drive shall not require any type of reset command after a power outage.
 3. 30 percent voltage dip ride through capability for one cycle.
 4. Controllers shall be compatible and tolerant of disturbances produced by other VFD controllers and shall not interfere with each other.
- D. Adjustments:
1. Maximum frequency: Adjustable 60-90 Hertz.

2. Minimum frequency: Adjustable 6-40 Hertz.
 3. Speed: Frequency maximum and frequency minimum.
 4. Independent acceleration and deceleration rates: Field adjustable with minimum range of 3-300 seconds.
 5. Voltage parameters: Minimum and maximum voltage and Volts/Hertz.
 6. Current limit: 50 to 150 percent of drive limit for 1 minute.
 7. Inverse time overload: NEMA Class 10.
 8. Speed shedding: Automatic upon low voltage.
 9. Speed profile: Starting ramp, stopping ramp, minimum speed, and maximum speed.
 10. Starting boost: 4%.
- E. Protective Features and Functions:
1. Current limiting fuses, regulators, or other techniques for both internal and external fault protection.
 2. Overvoltage protection on the incoming AC line.
 3. Ground fault protection.
 4. Single-phase fault or 3-phase short-circuit on VFD output terminals without damage to any power component.
 5. Over-speed (over-frequency).
 6. Instantaneous overcurrent and overvoltage trip with inverse time overcurrent protection.
 7. Single phase and undervoltage trip.
 8. Power unit over-temperature.
 9. Electronic motor overload protection.
 10. De-saturation circuit protection for the following conditions:
 - a. VFD fault.
 - b. Motor protection interlock.
 - c. Emergency stop.
 11. DC bus discharge circuit for protection of operator and service personnel with indicator lamp.
 12. Transistor assembly overcurrent protection.
 13. Provides safe drive shutdown on following faults:
 - a. Loss of input power.
 - b. Sustained input undervoltage (minus 15 percent).
 - c. Sustained gradual overload.
 - d. Instantaneous severe overload.
 - e. Power transistor over-temperature.
 - f. Blown fuse.
 - g. Logic power supply failure.
 14. Voltage transients: Provide solid state line transient protection up to 6000 volts peak per IEEE C62.41-1991.
 15. Overcurrent protection:
 - a. The VFD system shall provide adjustable electronic current limit. Current shall be accurate to within 1.0 percent and shall smoothly limit motor speed at whatever value is necessary to limit motor current to that value.
 - b. The VFD shall provide motor running overcurrent protection in compliance with NFPA-70.
 16. Short-circuit protection:
 - a. The VFD shall be fully protected against load faults.
 - b. Bolted, phase to phase, or phase to ground faults shall not damage the unit.
 - c. Fault protection shall be based on a power source short circuit capacity of 65,000 Amps RMS symmetrical at the VFD power input terminals. Any impedance or other current limiting necessary to meet this requirement shall be provided as part of the VFD system, and any losses caused by current limiting devices shall be included in efficiency calculations for the VFD system.
 17. Line voltage: The VFD shall be protected against high and low line voltage on one or more phases.
 18. Internal faults: The VFD shall incorporate an internal fault monitoring system to detect malfunctions. This system shall be designed to protect the VFD from transient and sustained faults and to limit damage that may be caused by these faults.
 19. Motor overtemperature:
 - a. The VFD shall interface to motor temperature switches and shall shut down if the motor becomes overheated.

- b. The VFD shall include all components necessary to sense a contact opening and shutdown the affected motor if the motor winding temperature exceeds maximum rated operating temperature.
 - c. Drive must be manually reset after a motor over-temperature trip.
 - d. Install and integrate motor protective relay for motor over temperature. Coordinate with Section 43 25 05.
- 20. Annunciator:
 - a. The VFD shall be provided with a fault annunciation system that shall indicate the cause of any shutdown.
 - b. Annunciation shall identify the first fault in those cases where multiple faults occur between manual or automatic resets and shall be visible without opening the VFD cabinet.
 - c. The annunciation language shall be English.
 - d. As a minimum, the following faults shall be annunciated:
 - 1) Motor overtemperature.
 - 2) Motor overcurrent.
 - 3) VFD overtemperature.
 - 4) Line over/under voltage.
 - 5) VFD overvoltage
- F. Special Features and Functions:
 - 1. Operator interface devices and Human Interface Module (HIM) on door of VFD enclosure:
 - a. Elapsed time meter (non re-settable) via individual meter.
 - b. Indication of output voltage in volts, via HIM.
 - c. Indication of output currents in amps, via HIM.
 - d. Indication of motor speed in RPM, via HIM.
 - e. Local/Off/Auto selector switch, via individual switch. When in Auto, the speed is controlled from an external 4 to 20 mA DC signal, via individual switch. In Local, the speed is controlled from a keypad module, via HIM.
 - f. Start, Stop pushbuttons (keypad) active in Local mode, via HIM.
 - g. VFD off but ready indication light (green), via individual light.
 - h. VFD running indication light (red), via individual light.
 - i. Power indication light (white), via individual light.
 - j. VFD failure indication light (amber), via individual light.
 - k. System stop mushroom head maintained contact pushbutton, via individual switch.
 - l. Reset pushbutton, via individual switch.
 - m. Indicating lights per Section 26 09 16.
 - n. EtherNet port for extracting drive data to station PLC or Plant SCADA System. Drive shall be setup to provide kWh information through this port
 - 2. Control power transformer:
 - a. 120 VAC secondary; 100 VA minimum.
 - b. Two primary fuses and one secondary fuse with non-fused secondary leg grounded.
 - c. Door mounted "Control Power On" pilot light.
 - d. Independent transformer utilized for internal VFD electronic controls.
 - 3. Remote local control interface requirements:
 - a. Remote run signal from PLC contact closure, two-wire control.
 - b. Remote: Isolated 4-20 mA DC speed reference input signal; preset speed input is active.
 - c. Local: 4-20 mA DC inactive; preset speed inactive; reference from interface module. May be keypad operated.
 - d. Drive running: 1 form C isolated contacts, 120V, 5 amps (typical).
 - e. Drive off and ready to run: 1 form C isolated contacts.
 - f. Drive fault: 1 form C isolated contacts.
 - g. Drive in remote mode: 1 form C isolated contacts.
 - 4. Preset speed: The drives shall ramp to a pre-programmed speed upon a contact closure, ignoring the 4 to 20 mA DC normal speed reference signal
- G. Noise Data: Free field noise generated by the VFD shall not exceed 85 dBA at 3 feet from any point of the VFD cabinet under any normal operating condition

H. Enclosures:

1. Wall-mounted.
 2. NEMA 1 with fan and ventilation provisions that are necessary for equipment cooling and coordinated with the cooling ductwork provided by others in the pump station building.
 3. Painted parts:
 - a. To undergo phosphatizing, prepaint treatment for rust resistance and paint bond.
 - b. Paint and process color: Manufacturer's color.
 - c. Paint: Applied by electrostatic process and baked to a durable hard finish.
 4. Nameplates:
 - a. Provide laminate phenolic nameplates showing the controller designations as specified.
 - b. Design: Black, with minimum 3/16-inch high white letters. Nominal size shall be 1 inch high by 3 inches long.
 - c. Abbreviations: If required because of space limitations, abbreviations shall be submitted to the Project Representative for approval.
 5. Seismic bracing: The entire assembly, including electronics and controls, shall be braced for the site seismic criteria listed in Section 01 73 00.
 6. Audible noise requirements: See Section 44 21 00 and this Section.
 7. All components shall be accessible and removable from the front only.
 8. Doors:
 - a. Open at least 90 degrees and shall be provided with 4 point hinges.
 - b. Door handles: Capable of accepting a padlock with a 3/8-inch shackle to lock the VFD enclosure closed and the input breaker open.
 9. Drive enclosures:
 - a. Provided with external framework for housing the air filters.
 - b. Access to the filter media for purposes of replacement or cleaning shall be possible from the exterior of the drive without the need to open doors on the drive enclosure or otherwise gain interior access to the drive.
 10. Ventilation: When required provide intake and exhaust ventilation in the door of the enclosure.
- I. Maintainability: VFD controller's parts shall be interchangeable and modular for all controllers.

2.05 MAINTENANCE BYPASS SWITCH

- A. General: Three-contactor electro-mechanical bypass system with capability to automatically disconnect drive from power source for maintenance while in bypass mode. Drive-Off-Bypass-Service switch shall be used for manual selection of operating mode. VFD shall be programmable to automatically switch to across-the-line operation under certain circumstances. Two-contactor schemes are not acceptable.
- B. Operation: Manually switched, full voltage contactors to isolate VFD and power load directly from line. Include Drive-Off-Bypass-Service selector switch. Include contact closure to indicate "DRIVE ON BYPASS" to DDC system.
- C. Mode selection via a four-position DRIVE/OFF/BYPASS/SERVICE switch.
 1. DRIVE Mode: VFD input and output contactors are closed and the motor is operated via VFD power
 2. OFF mode: VFD input, output and bypass contactors are all open.
 3. BYPASS mode: Bypass contactor is closed and motor is operating from line power. Both the drive input and drive output contactors are open for servicing of the VFD without power.
 4. SERVICE mode: Bypass contactor is closed and the motor is operated from line power. The VFD input contactor is closed but the drive output contactor is open. This allows for the testing and programming of the VFD while the motor is operated via line power.
- D. Overload Protection: Bypass contactors with suitable overload protection in each leg.

2.06 SOURCE QUALITY CONTROL

- A. Perform stand-alone Factory Test
 1. The Project Representative will observe factory tests on the VFD controller at the Project Representative's option and expense.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. General: Verify installation conditions as satisfactory to receive work of this section. Do not install until any unsatisfactory conditions are corrected. Do not install VFDs until building environment can be maintained within conditions required by manufacturer. Beginning work constitutes acceptance of conditions as satisfactory.
- B. Install in accordance with manufacturer's recommendations.
- C. Install equipment level and plumb and anchor on wall in accordance with the equipment manufacturer's instructions and as indicated herein.
- D. Before and during installation, protect VFD from site contaminants.
- E. Coordinate required electrical and control installation work with other Divisions as required.
- F. Power Wiring: Comply with requirements in Division 26.
- G. Control Wiring: Comply with requirements in Section 230900.
- H. Wall mount the VFD enclosures with a minimum of 1/4" separation between the VFD and mounting surface.
- I. Demonstrate satisfactory operation including line reactor [and bypass switch] during test run.
- J. Program VFD to automatically reapply power and drive motor to control set point upon resumption of power following power failure.
- K. Perform field assistance and additional technical support and devices to solve problems evidenced on site related to drive operation.
- L. Include start-up reports in the Operation and Maintenance Manual
- M. Provide seismic anchorage, supports and bracing for equipment per Section 01 73 00.

3.03 HARMONIC ANALYSIS CALCULATION

- A. Calculate total harmonic distortion at the common node Motor Control Center bus for the controller units based on the specified impedances and system configuration. Unless otherwise indicated, determine distortion in accordance with IEEE 519.

3.04 TRAINING

- A. Provide coordinated training course, approved by the Project Representative, to instruct ten County personnel on variable frequency drives. The training will be conducted at the West Point Treatment Plant, coordinate with the Project Representative for room location. The training shall include, but not be limited to, the following:
 - 1. Conduct two hours of training to cover general variable frequency drive theory and operation.
 - 2. Conduct six hours of training on operation and maintenance of the variable frequency drives specific to the supplied VFDs.
 - 3. Training may be split into two identical course covering the above material as directed by the Project Representative

- B. Training to include at a minimum the following:
 - 1. Demonstrate operation of operator keypads for viewing data and setting parameters.
 - 2. Demonstrate operation in manual mode, including setting of specific speeds.
 - 3. Explain the drive parameters that might require operator adjustment.
 - 4. Demonstrate operation of bypass switch and door-mounted disconnect switches, if included in this project. Explain emergency operation.
 - 5. Describe troubleshooting techniques and warranty procedure.

3.05 FACTORY TEST

- A. Perform standard factory tests on each drive provided.
- B. Notify the Project Representative at least 4 weeks in advance of any test. Provide certified copies of the test reports.

3.06 TESTING AND STARTUP

- A. Test Procedure:
 - 1. Prepare test procedure and conduct tests in accordance with the procedure to demonstrate to the Project Representative the accuracy of the wiring, control, and proper functioning of the equipment.
 - 2. Submit proposed test procedure for approval at least two weeks prior to the demonstration.
 - 3. All equipment and systems shall be demonstrated as operating properly prior to acceptance of the work. All protective devices shall be operative during the demonstration.
 - 4. If the demonstration indicates unsatisfactory operation as determined by the Project Representative or inspecting authorities, correct defects and repeat the demonstration.
- B. Phase Relationship Tests:
 - 1. Check connection to all equipment for proper phase relationship.
 - 2. During such check, disconnect all devices that could be damaged by the application of voltage of reversed phase sequence.
- C. Insulation Resistance Tests:
 - 1. Perform insulation resistance tests on conductors, cables, and equipment, signal circuits exempt.
 - 2. Make tests using 1,000-volt Biddle hand cranked megger insulation resistance tester.
 - 3. Disconnect all equipment that may be damaged by such tests before the tests are made.
 - 4. Tests shall measure insulation resistance from line to ground.
 - 5. Test conductors and cables after placement and the completion of the terminations, but before connection to equipment.
 - 6. Test 600-volt class circuits and equipment. Minimum acceptable values of insulation resistance of circuits and equipment shall be 100 megohms.
 - 7. Provide test reports listing test equipment used, person or persons performing the tests, the date tested, the circuits or equipment tested, and the results of all tests.
 - 8. These tests shall be witnessed by the Project Representative.
 - 9. The Contractor shall notify the Project Representative one week in advance of testing.
- D. High Voltage Ringing on Motor Leads:
 - 1. The contract requires VFDs, or VFDs with output filters, which control the phenomenon of high voltage reflected voltage waves on motor cable, produced by the high speed switching of PWM drives.
 - 2. Use an oscilloscope with a 5,000-volt test probe at the motors with the longest length able to record the amplitude of the voltage at the motor.
 - 3. Voltage spikes plus base 480 volts: Not exceed 1488 Volts peak, per NEMA.
- E. Test Equipment: All test instrumentation equipment used during testing shall be NIST traceable and certified

END OF SECTION

SECTION 23 09 13.13

TWO-WAY AND THREE-WAY CONTROL VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies three-way mixing and two-way control valves with equal percentage flow characteristics for water service. See Drawings for boiler two-way and three-way control valve schedules. HVAC control valves shall be provided by the Direct-Digital Controls (DDC) systems specialized firm (DDC system provider) per Section 23 09 13.
- B. Two-way and Three-way Control Valve Equipment List:

EQUIPMENT SERVED	EQUIPMENT NO.
Boiler 1, pair 2-way valves, linked, single pneumatic actuator (single tag)	705-TCV19JJ011
Boiler 2, pneumatic 3-way valve	705-TCV19JJ021
Boiler 3, pair 2-way valves, linked, single pneumatic actuator (single tag)	705-TCV19JJ031
Boiler 4, pneumatic 3-way valve	705-TCV19JJ041
RSP-Control Room Heating Control Valve	704-TWV25CR011
RSP-Screen Room Heating Control Valve	704-TWV25SR011
RSP-Crane Hall Heating Control Valve	704-TWV25PR011
RSP-East Fan Room Gallery Heating Control Valve	704-TWV25AG011
Boiler Room Unit Heater Control Valve	705-TSV25AM011

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI B16.5 Class 150	Pipe Flanges and Flanged Fittings
ISA S51.1	Process Measurement and Control Technology

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. All operation and maintenance information specified in Section 01 78 23, except Items 4, 8, 9 and 10.
- C. A complete description of the valves and accessories.

1.04 DESIGN REQUIREMENTS

- A. Three-way valves at Boilers 2, and 4, and pair linked two-way valves, with single actuator each, at Boilers 1 and 3, control boiler water temperature allowing it to be hotter than the main loop temperature. See schedule on Drawings.

- B. HVAC hot water control valves, rising temperature shall decrease the hot water flow to the heating coils.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Fisher.
- B. Honeywell.
- C. Johnson Control.
- D. MCC Powers.
- E. Bray.
- F. Approved Equal.

2.02 MATERIALS

- A. Body: Bronze, cast iron or semi-steel.
- B. Trim, throttling plug: Bronze or Type 304 stainless steel.
- C. Spring, stem assembly and bonnet: Cadmium-plated steel or stainless steel.
- D. Stem head retainer: Brass or steel.
- E. Packing: Teflon.

2.03 FABRICATION

- A. Hot water control valves: Three-way throttling (modulating) type for mixing service. Two-way globe type (modulating) where two-way valves are indicated on the HVAC control diagrams.
- B. Boiler hot water, near boiler circulation loop: Pair linked two-way at Boiler 1 and 3, and three-way throttling (modulating) type at Boiler 2 and 4, for mixing service, manual handwheel for operating valve if valve motor is disengaged:
 - 1. Carbon steel body with stainless steel disc or ball. Ductile iron TEE.
 - 2. Close-Off Pressure Rating: ANSI 150 flanged.
- C. Valves shall have single seated valve plugs, cage guided trim, and equal percentage flow characteristics.
- D. Connections:
 - 1. Valves 2-1/2 inches and larger: 125-pound ANSI flanges.
 - 2. Valves 2 inches and smaller: Threaded connections.

2.04 OPERATORS

- A. Size operators to meet the operating conditions of rooms and fluids as specified in Section 43 23 32.
- B. Near boiler circulation loop valves shall have a manual motor override system in addition to the pneumatic actuator:

1. Minimum travel range 90 degrees with over travel at 3% with adjustable travel stops in each direction.
2. Mechanical visual position indicator.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings.

3.02 REMANUFACTURE

- A. Where indicated on Drawings, boiler temperature control valves must be remanufactured by the original valve manufacturer or certified third-party shop.
- B. Remanufactured valves are required to function like new and must be seat leak and shell tested.
- C. Reused components must conform to the same specification as new manufactured components.
- D. All work must be done to meet ASME and ASTM standards.

3.03 FIELD TESTS

- A. Each valve, after installation and connection to the piping system, shall be cycled three times manually or utilizing the manual override to demonstrate proper operation.
- B. Each valve, upon completion of installation of the piping system, shall be cycled to fully demonstrate proper operation and confirm that operating times, under both normal operating, and emergency closure conditions, are as specified.
- C. Be responsible for all adjustments necessary to bring the equipment into conformance with the specifications.

END OF SECTION

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes specifications for the following types of instrumentation and control devices for Heating, Ventilation, and Air Conditioning (HVAC) systems:
1. Temperature transmitters.
 2. Pressure differential switches.
 3. Motorized dampers.
 4. HVAC control valves.
 5. Miscellaneous control devices.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NFPA 70	National Electric Code (NEC)
SEC	2018 Seattle Energy Code

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
1. The instrumentation and control devices shall be supplied and installed completely under the Direct-Digital Controls (DDC) systems specialized firm (DDC system provider).
 2. Furnish all labor, materials, equipment, services and incidentals required to provide complete, integrated, and operating control system.
- B. Performance Requirements:
1. Room air temperature transmitters:
 - a. Power requirements: 120-VAC.
 - b. Output signal: 4 to 20-mA.
 - c. Measurement range: -58 to 175-degrees F.
 - d. Accuracy: +/-0.9 degrees F.
 - e. Output Signal: 24-VDC.
 2. Pressure differential transmitter:
 - a. Power requirements: 10 to 35-VDC.
 - b. Output signal: 4 to 20-mA.
 3. Motorized dampers shall be Class 1, low leakage, with sizes, capacities, performance, and electrical requirements as specified in the Equipment Schedules shown on Drawings.
 4. Control valves shall meet the requirements for 2-way or 3-way control valves as indicated in Section 23 09 13.13.
- C. System Operation: Section 23 09 93.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00

- B. Provide the following submittals:
 - 1. Manufacturer's literature for each type of instrumentation and control device for HVAC systems as shown on the HVAC Control Diagrams and other Drawings and included in the Specifications.
 - 2. O&M manual: Section 01 78 23
 - 3. Manufacturer's Installation Certification: Form 43 05 01-A
 - 4. Training Procedure Documentation: Form 01 79 00 -B.
 - 5. Bill of Materials, including Bill of Materials Input Form: Form 01 78 45-A.

1.05 QUALITY ASSURANCE

- A. Unit Responsibility:
 - 1. The instrumentation and control devices specified in this Section shall be the product of a single vendor. Unit Responsibility for the system shall be as specified in this Section in accordance with the requirements of Section 43 05 01.
 - 2. The system shall consist of the following components:
 - a. Direct-Digital Control System for HVAC in Section 23 09 23.
 - b. Sequence of Operations for HVAC in Section 23 09 93.
- B. Qualifications:
 - 1. The DDC systems provider shall have a minimum of three years' experience in the design and installation of DDC systems similar in scope and performance to that specified herein.
 - 2. The DDC systems provider shall have a local office within a 90-mile radius of the job site, staffed with factory trained engineers fully capable of providing instruction, routing maintenance and emergency maintenance service on all system components.
 - 3. All electrical work performed in the installation of the DDC control system and corresponding control devices and sensors shall be in accordance with the National Electrical Code (NEC), applicable state and local codes, and with Division 26.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Reference the Architectural code summary sheets and the Electrical Plan sheets. Reference the Electrical Plan sheets for NEMA enclosure requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Control devices:
 - a. Room temperature transmitters: Minco AS2PW000S; or Approved Equal.
 - b. Pressure Differential Transmitters: Dwyer MS Series; or Approved Equal.
 - c. Override timer:
 - 1) Timer: Airotronics Series MC363; or Approved Equal.
 - 2) Enclosure: Hoffman; or Approved Equal.
 - 3) One shot button: Schneider Electric; or Approved Equal.
 - d. Motorized dampers:
 - 1) Dampers: Refer to section 23 33 13.13.
 - 2) Actuators: Belimo; Honeywell; or Approved Equal.
 - e. Control Valves: Refer to section 23 09 13.13.
 - f. Actuators: Belimo; Honeywell; or Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Room temperature transmitters	
Sensing element	Stainless steel
Enclosure	White polyvinyl
Override timer	
Enclosure	Steel, 16 gauge.

1. Panels shall meet the requirements of Section 40 67 00.

2.03 EQUIPMENT FEATURES AND COMPONENTS

- A. Room temperature transmitters:
1. Non-heat conductive, solar reflecting noncorrosive shield.
 2. Enclosure shall be completely sealed against moisture.
 3. Slotted shield allows air to flow freely to the probe to provide accurate measurement.
- B. Low limit thermostat:
1. Manual reset, low temperature safety switch with a minimum element length of 1 foot per square foot of coverage which shall respond to the coldest 18 inch segment with an accuracy of plus/minus 3.6 degF.
 2. The switch shall have a field adjustable setpoint with a range of at least 30 to 50 degF.
 3. The switch shall have two sets of contacts, one to shut down fan and one for alarm, and each contact shall have a rating greater than its connected load.
 4. Contacts shall open or close upon drop of temperature below setpoint as shown and shall remain in this state until reset.
- C. Damper actuators:
1. External mount type.
 2. Sized to provide operation of damper through full range of motion in a maximum of 45-seconds.
 3. Minimum torque shall be at least 9 inch-pounds per square foot of damper area for parallel blade dampers and 6 inch-pounds per square foot for opposed blade dampers
 4. Spring return type for two position control and fail safe operation.
 - a. Where dampers operate from a common signal, the actuators shall provide an output signal identical to its input signal to the additional devices.
 - b. Electric modulating dampers shall be positive positioning, responding to a 2-10 VDC or 4-20 mA signal (with the addition of a 500 ohm resistor). Floating control dampers are permitted on terminal units only, except where indicated on contract documents.
 - c. All electric actuators shall be UL listed.
 - d. Dampers shall be provided with NEMA enclosure based on installation location and as indicated in the Electrical Drawings. Provide heaters as required.
 - e. There shall be a visual damper position indicator and an actuator generated 2-10 VDC valve position output signal for electronic feedback to the control panel.
 - f. Damper actuators shall have integral limit switches with position feedback or provide damper limit switch per the following:
 - 1) Momentary type, adjustable limit switch for monitoring motion of damper at a prescribed arc of rotation. Switch shall have oil tight contacts that operate by way of a trip lever. Switch shall have a DPDT contact arrangement that exceeds load requirements for voltage and current. Submit installation detail on how trip lever mechanism will be actuated for approval prior to installation. The use of ball bearings or mercury is unacceptable.

- g. Damper actuators shall be fail safe spring return and shall open the damper to the open position during electric power failure or the position indicated in the sequence of operations.
- D. Electric Relays:
 - 1. Minimum 2 sets of Form C contacts rated for application in accordance with NEMA ICS 1.
 - 2. Dust proof enclosure.
 - 3. Equipped to limit transients to 150 percent of rated coil voltage.
 - 4. Minimum contact rating: 20 A inductive at 120 VAC.
- E. Selector Switches:
 - 1. Provide with indicating nameplates.
 - 2. Manual operation, 2 position type with SPDT contacts rated for application.
 - 3. Acceptable manufacturers:
 - a. Allen-Bradley.
 - b. Square D.
 - c. Cutler-Hammer.
 - d. Approved Equal.
- F. Pilot Lights:
 - 1. Miniature pilot lights shall operate on 24 VDC power, 12 mm diameter, and lens color as shown or specified.
 - 2. Acceptable manufacturer:
 - a. IDEC.
 - b. Approved Equal.
- G. HOA Switches:
 - 1. Provide with indicating nameplates.
 - 2. Manual operation, 3 position type with SPDT contacts or DPDT as required for the application and rated for application.
- H. Multi-Channel Signal Isolator / Repeater:
 - 1. Accommodate either 0-10V or 4-20ma loop powered inputs and have 2- to 4-output channels.
 - 2. One 4-20ma source shall not be wired in series to more than two isolator/repeaters.
 - 3. Field calibratable with zero and span adjustments.
 - 4. Accuracy of plus/minus 0.1 percent of span.
 - 5. Operate in an ambient temperature range of minus 20 to 180 deg F.
 - 6. DIN rail mounted.
 - 7. Acceptable manufacturer:
 - a. Moore Industries Model ECT.
 - b. Approved Equal.
- I. Differential Liquid Pressure Switch:
 - 1. Snap action SPDT switches shall operate from a neoprene slack diaphragm adjustable through total pressure range.
 - 2. Switches shall withstand at least twice system working pressure.
 - 3. Install switch with three valve bypass manifold piped in copper to pressure taps in liquid lines.
- J. Electric Immersion Thermostat:
 - 1. Two position, remote bulb type, adjustable set point, range of minus 10 to plus 70 deg F.
- K. Standard Pushbutton Switches:
 - 1. Momentary push or maintained push/pull switch as required by the application/sequence.
 - 2. Switch shall fit into a single gang electrical box complete with cover plate suitable for flush mounting.
 - 3. Provide a plastic tag attached to cover plate identifying intended use of switch.
 - 4. Switch contacts shall be rated for application.

- L. Differential Pressure Gauges:
 - 1. Gauges for low differential pressure measurements.
 - 2. Minimum of 3.5 inches (nominal) size with two sets of pressure taps, and a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment.
 - 3. Bidirectional with zero in the center of the dial.
 - 4. Gauge range suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit.
 - 5. Accuracy shall be plus or minus two percent of scale range.
 - 6. Select gauges with set point in midspan of range.
 - 7. Acceptable manufacturer:
 - a. Dwyer Magnehelic.
 - b. Approved Equal.
- M. Control Transformers:
 - 1. UL-listed, Class II with 120 VAC primary and 24 VAC secondary.
 - 2. Integral manual reset circuit breaker.
- N. Pressure Gauges:
 - 1. Suitable for field or panel mounting as required.
 - 2. Black legend on white background.
 - 3. Pointer traveling through a 270 degrees arc.
 - 4. Gauge range suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit.
 - 5. Accuracy shall be plus/minus 3 percent of scale range.
 - 6. Meet requirements of ASME B40.100.
- O. Commercial Current Sensing Relay:
 - 1. Provide for all pumps and small exhaust fans.
 - 2. Provide a solid-state, adjustable, split core, current operated relay. Provide a relay that changes state in response to a change in the load on the associated equipment.
 - 3. Adjust the relay switch point so that the relay responds to motor operation under load as an "ON" state and so that the relay responds to an unloaded running motor as an "OFF" state. A motor with a broken belt is considered an unloaded motor.
- P. Floor Mounted Leak Detector:
 - 1. Electrodes mounted at slab level with a minimum built-in-vertical adjustment of 3 mm 0.125 inches.
 - 2. Detector shall have a binary output.
 - 3. The indicator shall be automatic reset type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup and commissioning.
- B. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases, shall field installed conduit be smaller than 3/4" trade size be allowed, as specified in Division 26.
- C. All control devices and sensors shall be installed where indicated on Drawings and in accordance with manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

- A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this Contract and supply services incidental to the proper performance of the DDC system specified herein.
- B. Upon completion of calibration, start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation. Generate software and enter database necessary to perform the sequence of control and specified software routines. An acceptance test in the presence of the Project Representative shall be performed.
- C. Provide as-built documentation and all associated support documentation on approved media that accurately represents the final system.
- D. Commissioning and testing shall conform to Section 01 75 20 and 2018 Seattle Energy Code Section C408.
- E. Field inspection and testing: Section 01 75 20.

END OF SECTION

SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the specifications for the labor, materials and equipment required for the construction of the Direct-Digital Controls (DDC) systems for HVAC. The DDC systems shall include all local control panels and hardware and software, electronic and control equipment, transformers, sensors, and wiring required for complete operating systems.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-HVAC Master Control Panel	704-LCP2504
RSP-Screen Room Air Handler Controller	704-TC25AD011
RSP-Control Room Air Handler Controller	704-TC25AD021
RSP-Crane Hall Air Handler Controller	704-TC25AD022
RSP-Gallery Air Handler Controller	704-TC25BM013

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/ASHRAE 135	BACnet Data Communication Protocol for Building Automation and Control Networks
NFPA 70	National Electric Code (NEC)
SEC	2018 Seattle Energy Code

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
- The DDC system specialized firm (DDC system provider) shall be responsible for the complete DDC system. The DDC system provider shall:
 - Provide engineering, installation, calibration, software, programming and checkout necessary for complete and fully operational DDC systems as specified in this Section.
 - Furnish all labor, materials, equipment, services and incidentals required to provide complete, integrated, and operating control system.
 - Provide and install conduit and wiring between electrically operated equipment and between equipment and field-installed control devices of the DDC system.
 - Provide DDC control conduit and wiring specified as factory installed.
 - Provide control conduit and wiring between field-installed controls, indicating devices, and equipment control panels.
 - Integrate all controls with all manufacturer-supplied equipment
 - DDC system:
 - BACnet compatible and meet the requirements of ANSI/ASHRAE Standard 135.
 - Compatible with the West Point Administration building DDC control system.
 - Shall monitor and electronically control equipment including fans, damper actuators, HVAC control valves, and unit heaters with digital, analog, and discrete control.

3. Extent of controls systems work required by this Section is indicated on Drawings, Schedules, and by requirements of this Section.
4. All DDC system devices and components must appropriately satisfy the intent of the specified sequence of operation in 23 09 93 and the requirements of the Drawings.
5. Contractor shall be responsible for:
 - a. Power supply wiring from power source to power connection on controls and/or equipment control panels. Include providing starters, disconnects, and required electrical devices, except where specified as furnished in schedules or specifications, or factory-installed by manufacturer.
 - b. Control wiring and conduit (110-VAC or above) between controls panel and Division 26 motor starters.

B. Performance Requirements:

1. Local control panels shall meet the following requirements:

Power requirements	115 VAC + 10%, 60 Hz, 150 Watts maximum
Operating environment	40 to 150 degrees Fahrenheit
Contact ratings	4 amps maximum at 120 VAC
Memory	32 Kbyte RAM 24 Kbyte EPROM 32 Kbyte EEPROM
Input/output points	24-total analog and digital points minimum
Enclosure rating	Reference the electrical plans for NEMA and space classification requirements.

C. System Operation: Section 23 09 93

1.04 SUBMITTALS

A. Procedure: Section 01 33 00

B. Provide the following submittals:

1. DDC systems provider qualifications.
2. Block diagrams showing all major components and panels, printer and other processing devices and required cabling between each. Include environmental and space requirements for panels and other major devices.
3. Manufacturer's literature for each type of panel controller or device shown on the Riser Diagram.
4. Riser Diagram showing, schematically, the entire building system with all major components identified.
5. A written description of all control sequences of equipment operation as described in Section 23 09 93.
6. System points list.
7. Elementary or schematic diagram/drawing as defined in Section 26 05 00 with further modification to include as a minimum the detail shown on the control diagrams for HVAC equipment shall be provided. Unique schematic diagrams for all motorized and electronic based equipment shall be provided and shall reflect the wiring requirements to meet the controls specified in this Section. The control diagrams/drawings shall meet the County standards and format specified in Division 26. The schematic diagrams shall be organized by loop number and the loop number shall appear in the drawing title block. Key fans and AHUs have loop numbers assigned, and the unique schematic diagrams submitted shall, where applicable, use the loop numbers assigned. Contractor shall coordinate with County if additional equipment and loop numbers are required to generate the unique control diagrams for all motorized and electronic based equipment provided. The HVAC panels and field equipment interconnection terminal numbers shall be included on the control diagrams to show point-to-point wiring requirements with Division 26 provided equipment.
8. HVAC Control Panel wiring diagrams and panel layout drawings with a Bill of Materials keyed to devices shown on the panel layout drawings.
9. Control system configuration files. Electronic format or hard copies are acceptable.

10. O&M manual: Section 01 78 23
11. Manufacturer's Installation Certification: Form 43 05 01-A
12. Training Procedure Documentation: Form 01 79 00-B
13. Bill of Materials, including Bill of Materials Input Form: Form 01 78 45-A

1.05 QUALITY ASSURANCE

- A. Unit Responsibility:
 1. The DDC system specified in this Section shall be the product of a single vendor. Unit Responsibility for the system shall be as specified in this Section in accordance with the requirements of Section 43 05 01.
 2. The system shall consist of the following components:
 - a. Instrumentation and Control Devices for HVAC in Section 23 09 13.
 - b. Sequence of Operations for HVAC in Section 23 09 93.
 3. The DDC system shall be compatible with the existing West Point Treatment Plant DDC system located in the administration building.
 4. The DDC system contractor shall be responsible for integration of the DDC system software and programming of the system.
- B. Qualifications:
 1. The DDC systems provider shall have a minimum of three years' experience in the design and installation of DDC systems similar in scope and performance to that specified herein.
 2. The DDC systems provider shall have a local office within a 90-mile radius of the job site, staffed with factory trained engineers fully capable of providing instruction, routing maintenance and emergency maintenance service on all system components.
 3. All electrical work performed in the installation of the DDC control system and corresponding control devices and sensors shall be in accordance with the National Electrical Code (NEC), applicable state and local codes, and with Division 26.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 1. Automated Logic
 2. Honeywell, Inc.
 3. Johnson Controls, Inc.
 4. Siemens Industries, Inc.
 5. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:
 1. Reference section 40 67 00 for control panel construction.

2.03 EQUIPMENT FEATURES AND COMPONENTS

A. Local control panels:

1. Local control panels consist of an enclosure, power supply assembly, electronic control assembly, and wiring termination board. Data and software shall be stored in non-volatile EEPROM or there shall be a battery back-up of at least 100 hours. There shall be real-time operating system with a battery back-up of not less than six hours.
2. Local control panels shall use DDC to perform temperature control and energy management with other local control panels to form a network with or without a central processing unit. Local control panels shall allow the user to alter set-points, change control modes, control motors and display point status on any equipment on the network. Local control panels shall diagnose system malfunctions or equipment failures. They shall execute software programs.
3. Local control panels shall also meet requirements specified in Section 40 67 00.
4. Selector switches shall be provided as specified under Section 26 09 16.
5. Provide equipment monitoring lights as specified in the Sequence of Operations.
6. The panels shall contain an RS232C or a standard telephone jack for connection to various devices including a portable terminal. With connection to the portable terminal, the user shall be able to perform the following:
 - a. View and set day and time.
 - b. Modify time-of-day scheduling.
 - c. View-points and alarms.
 - d. Command and modify set-points.
 - e. View totalized point values.
 - f. View and set trends.

B. Software:

1. Time-of-Day Scheduling: Provide scheduling program to allow for 24-7 operation with the capability to schedule Occupied and Unoccupied times and to modify setpoints/setback as needed.
2. Duty Cycling: The duty cycling program shall be capable of suspending cycle control if sensed temperature and/or humidity is outside the user-defined comfort range.
3. Programming must be completed to account for occupied/unoccupied settings in HVAC equipment and lighting.
4. Data Logging: Provide data logging for all data points, tracking a minimum of 1 point per minute for 1 week.

C. Portable Terminal:

1. Provide one portable terminal and necessary software that shall be the user interface with the local control panels. The portable terminal shall allow the user to display point commands and report, to perform database entries, to execute software, and to develop custom programs. The portable terminal shall allow battery operation; have a minimum 10-inch display; have a typewriter style keyboard, a connection port compatible with the local control panels, a liquid crystal display; shall have a minimum of 32 Kbyte ROM and 24 Kbyte RAM of memory; and shall be portable. In lieu of the portable terminal, the Contractor may provide software that can be loaded into a Window based laptop PC to perform the same functions of the portable terminal. All software shall be licensed to the County.

D. Local Touchscreen Display:

1. Touch screen display shall be flush mounted to the master HVAC control panel. If not included by manufacturer, Contractor shall provide all hardware necessary to securely flush mount device per manufacturer's requirements. Device shall meet all of the following requirements:
 - a. Processor: Intel Atom Processor (or other equivalent) with a minimum processing speed of 1.6 GHz.
 - b. Random Access Memory (RAM): Minimum 8 GB RAM.
 - c. Cooling System: Fanless.
 - d. Touch Panel: Resistive.
 - e. Storage: Minimum 1 TB Hard Drive.
 - f. Display: Minimum 10 inches touch screen.
 - g. Dimension requirements: No greater than 2.5 inches thick.
 - h. Communication Ports: Minimum of (2) USB 2.0, (1) RS-232 serial and (1) RJ-45 ports.

- i. Operating Conditions: Product shall be rated for operation at ambient temperatures within the range of 32-104 deg F and humidity within the range of 10-90 percent RH, non-condensing.
- E. Uninterruptible Power Source (UPS):
1. Provide a UPS for each controller and workstation which are fed from normal power.
 2. UPS shall be online-double conversion type. Line-interactive type systems are not acceptable, unless it can be demonstrated that all installed BMS equipment is unaffected by switching delays when switching to battery power.
 3. Provide protection and immunity from power surges, spikes, blackouts and brownouts, electrical sags, transients and noise.
 4. Provide immunity from electrical sags, surges, transients, noise, and outages.
 5. Performance:
 - a. Output Voltage Regulation: ± 5 percent.
 - b. Output Frequency Regulation: ± 1 percent.
 - c. Output Harmonic Distortion: 5 percent total, 3 percent single harmonic.
 - d. Output Overload Capability: 125 percent for 1 seconds causes shutdown without hardware damage.
 - e. Transient Suppression: Tested to IEEE 587.
 - f. Battery Reserve: 15 minute typical at full load of controller served; 10-15 minutes with a typical PC load for workstations.
 - g. EMI/RFI: Complies with FCC Part 15J, Class A.
 6. Electrical:
 - a. Input Voltage: Single Phase, two-wire plus ground.
 - b. Input Frequency: Plus/minus 1 percent.
 - c. For Supervisory Stations, provide UPS with quantity of outlets for CPU, monitor, and printers.
 7. Environmental:
 - a. Operating Temperature: 0 to 35 deg C.
 - b. Relative Humidity: 0 to 90 percent non-condensing.
 8. Battery: Internal, sealed, captive electrolyte, non-corrosive, no flammable gases.
 9. Provide "UPS trouble alarm" signal to DDC.
 10. Provide a manual bypass switch permitting scheduled maintenance or UPS replacement without power disruption.
- F. Data Control (D/C) and Graphics:
1. Provide all programming required to accomplish the sequence of operations, including all data and control points not listed on input/output point summary shown on plans.
 2. In addition to graphics of building systems with dynamic data points as noted in following data and control and graphic summary, and graphics required under digital system management sections, following additional graphics shall be provided:
 - a. Building layouts (floor plans).
 - b. Any other graphics necessary for logical penetration.
 - c. Sequence of operation (window split screen view).
 - d. Flow charts for critical DDC loops and existing building.
 - e. Supervisor graphics.
 - f. System configuration.
 - g. Display air handling unit locations and configuration (Functional Control Diagram and control sequence).
 - h. Display all DDC sensors and thermostats on floor plan corresponding to air handler or other controlled device locations.
 - i. Display all DDC panels, indexed to correspond with system configuration.
 3. Each analog point to have unique remote, panel-resident dual high and dual low limit alarm threshold engineering units. Where specified, provide floating (band above and below setpoint) alarm limits.
 4. Each digital output to have software-associated monitored input. Anytime monitored input does not track its associated command output within programmable time interval, "command failed" alarm shall be reported.

5. Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups. Respective unconditioned raw data (such as logarithmic differential pressure) points to also be grouped in special group for display and observation independent of logical groups.
6. Where data or control points are required to accomplish digital control or energy management sequences specified, but not listed on Functional Control Diagrams[or in I/O summary], installer shall provide the points necessary to accomplish the specified sequence.
7. Primary analog input and analog output of each DDC loop to be resident in single remote panel containing DDC algorithm, and shall function independent of any peer or multiplexing (MUX) communication links. Secondary (reset type) analog inputs may be received from the peer network, but approved default values and/or procedures shall be substituted in DDC algorithm for this secondary input in network communications fail or if secondary input becomes erroneous or invalid.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup and commissioning.
- B. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases, shall field installed conduit be smaller than 3/4" trade size be allowed, as specified in Division 26.
- C. DDC panels and field equipment shall be mounted in easily accessible locations, unless otherwise approved by the Project Representative.
- D. All control devices and sensors shall be installed where indicated on Drawings and in accordance with manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

- A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this contract and supply services incidental to the proper performance of the DDC system specified herein.
- B. Upon completion of calibration, start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation. Generate software and enter database necessary to perform the sequence of control and specified software routines. An acceptance test in the presence of the Project Representative shall be performed.
- C. Provide as-built documentation and all associated support documentation on approved media that accurately represents the final system.
- D. Commissioning and testing shall conform to Section 01 75 20 and 2018 Seattle Energy Code Section C408.
- E. Field inspection and testing: Section 01 75 20.

3.04 MANUFACTURER SERVICES

- A. Provide a factory-trained representative at the site for the specified quantity and duration of the following activities. Durations do not include travel time to or from the project site.
 1. One Installation Inspection:

- a. Assist, supervise, and inspect the Contractor's activities during installation.
 - b. Provide a minimum of 8 hours of installation inspection during installation of the DDC system.
 - c. Complete Form 43 05 01-A, Section 01 33 10.
- 2. Test Phase Assistance:
 - a. Assist, supervise, and inspect the Contractor's activities during testing.
 - b. Provide a minimum of 8 hours.
 - c. Complete Form 01 80 00-A, Section 01 33 10.
- 3. Training:
 - a. Procedures: Section 01 79 00.
 - b. Provide a minimum of 4 hours per training.

END OF SECTION

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the sequence of operations for HVAC systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NFPA 70	National Electric Code (NEC)
SEC	2018 Seattle Energy Code

1.03 SYSTEM DESCRIPTION

- A. General Requirements:
1. All timing devices, alarm setpoints and control setpoints shall be adjustable. Setpoints listed herein for duct/zone static pressure control, differential pressure control for discharge/intake isolation dampers, outside airflow control, return fan airflow tracking volume, and static pressure safeties are initial starting values.
 2. All actuator devices on major mechanical systems (AHU, EF, hydronic systems, etc.) shall be electrically operated, including all control valves and dampers. Refer to control drawings and to Section 23 09 13 for actuator requirements.
 3. Provide software alarm points as follows:
 - a. Digital points: Alarm upon change of state from normal condition.
 - b. Analog points: Alarm upon a high or low value Based on a deviation from setpoint as follows, unless otherwise noted:
 - 1) Temperature: ± 2 DEGF.
 - 2) Duct Pressure: ± 0.75 inches WC.
 - 3) Room Pressure: ± 0.04 inches WC, after a 15 seconds time delay.
 - c. All software alarms shall have a sliding deviation window which is directly linked to the setpoint, such that changing the setpoint shall automatically change the high and low alarm setpoints with the original deviation limits without operator intervention, unless the deviation band is required to be adjusted.
 - d. All alarm points shall have a time delay adjustment from [0-300] SEC.
 4. There shall be a software point displayed at the operator workstation for each air handler and exhaust fan to indicate if the specific system is enabled or disabled. The operator shall be able to manually override the "system enable" from the operator workstation to shutdown the systems for maintenance. Only operators with the proper authorization shall be allowed to shutdown systems.
 5. There shall be a software point displayed at the operator workstation for each hydronic system to indicate if the specific system is enabled or disabled. The operator shall be able to manually override the "system enable" from the operator workstation to shutdown either system. Only operators with the proper authorization shall be allowed to shutdown systems.
 6. The DDC shall monitor a general fan status for all fans. For instances of a fan wall array, provide fan status that indicates if any fan is not operating. In the event that any fan status does not coincide with the commanded state of the fan after a [30] SEC delay, an alarm shall be annunciated on the DDC.
 7. The DDC shall monitor the run status of each VFD though a current switch. The enable/disable and speed signals shall be directly wired to the DDC controller associated with the fan or pump. The following conditions shall annunciate an alarm on the DDC:

- a. The fan or pump status does not coincide with the commanded state of the VFD after a 30 SEC delay.
- b. The drive indicates a VFD drive fault alarm.
8. Hand-Off-Auto selector switch shall be provided at each VFD. The BMS shall monitor the switch and shall provide an operator alarm when the fan or pump is out of the "Auto" position.
9. For systems where multiple fans are operating in unison with belt drives, an alarm shall be annunciated on the DDC in the event the run amps of any one operating fan is 20% greater or less than any other operating fan. The alarm shall be enabled 15 minutes after the fans have proven "ON". Note: This alarm shall indicate belt slippage.
10. No control loops shall be controlled over the communication network.
11. At a minimum, the DDC shall monitor and control all I/O points shown on the contract drawings AND required to accomplish the sequence of operations specified herein.
12. Provide all coordination with Division 28 necessary to ensure that interaction with the Fire Alarm or Hazardous Alarm systems are fully functional and operate in accordance with the sequence of operations specified herein and in Section 28 46 00.
13. DDC contractor shall provide all required field installed devices as shown on contract drawings and required to meet sequences of operation described herein, unless otherwise indicated.

B. Common Features:

1. System Start-up:
 - a. Upon start-up of the air handler system, the DDC shall start all supply and exhaust fans. The VFD speeds shall be commanded to minimum. The minimum speed setting in the VFD shall be set to the lowest safe operating value (as dictated by the manufacturer). Once at minimum speed, the supply fan speed shall ramp to the control setpoint over a 5-minute time period.
 - 1) If the air handler serves a positive or neutral pressure area, as indicated on the airflow diagrams, the supply fan(s) shall start prior to the exhaust fan(s) starting.
 - 2) If the air handler serves a negative pressure area, as indicated on the airflow diagrams, the exhaust fan(s) shall start prior to starting the supply fan(s).
 - b. When the supply and exhaust fans are enabled through the HOA switch provided with the VFD or through the DDC when the VFD is in the "Auto" position, the following sequence shall occur:
 - 1) The AHU isolation damper shall be hardwire-interlocked with the supply fan VFD. When the unit is commanded "on" the isolation damper shall open, once the damper proves open with the associated limit switch the fan shall start. At any point during operation, in the event the limit switch indicates the damper is closing, the associated supply fan shall be shutdown.
 - 2) The fan VFD shall slowly ramp to its control setpoint.
 - c. Once supply fans are at control setpoint, the temperature control loop shall be enabled.
2. System shutdown / system off:
 - a. In the event the AHU is disabled through the DDC or through a hardwire-interlock safety the following shall occur:
 - 1) The DDC shall decelerate supply fans speed to minimum over a 5 minute time period.
 - a) In the event AHU is shutdown via hardwire-interlock safety, the VFD shall allow the fan to freewheel to a stop.
 - 2) The supply fans shall be de-energized.
 - 3) The outside air dampers and/or supply discharge isolation dampers shall close. All dampers shall gradually close to prevent a high static pressure condition in the unit or duct.
 - 4) Cooling systems shall be disabled.
 - a) In the event outside air temperature is below 45 degrees F, the heating coil control shall be modulated to maintain minimum supply air temperature. Otherwise the heating coil control valve shall be closed. If the supply fan is off, modulate the heating coil control valve to minimum open position.
3. Damper operation:
 - a. When a supply or exhaust fan fails or is stopped, the associated dampers will close after a 90 second (adjustable) delay.
 - b. Dampers shall take between 10 and 30 seconds to open or close.
4. System Safeties:
 - a. All safeties shall be hardwire interlocked with the supply fan VFD. Alarms shall be specific to the AHU served.

- b. A high or low static pressure condition at the supply fan shall cause the supply fan to be de-energized and an alarm shall be annunciated at the HVAC Master Control Panel. The static pressure set points shall be [1] inches greater than the total static pressure of the fan, as indicated by the unit manufacturer or [0.5] less than the associated ductwork maximum pressure rating, whichever is less. The switch shall be a manual reset type.
- c. Low limit thermostats (freeze stats):
 - 1) The freeze stat shall disable the associated fan and annunciate an alarm at the HVAC Master Control Panel.
 - 2) Upon activation, the associated heating control valve shall open 100% and the circulation pump shall start.
 - 3) Initial setpoint: 38 degF.
- d. A fire alarm relay shall be hardwire-interlocked with the supply and exhaust fan VFD to shutdown the fans in the event of a supply smoke detector connected to the fire alarm system senses products of combustion.
- e. Hardwired safety devices must be active in "Hand" and "Auto" positions. When a safety is activated, the system shall shutdown in a controlled manner.
- 5. System monitoring:
 - a. The DDC shall monitor differential pressure across the filter bank. In the event the pressure drop across the filter exceeds 1.0 in.wc. (adjustable) an alarm shall be annunciated at the DDC.
 - b. The DDC shall monitor the supply airflow via unit mounted airflow switch.
 - c. The DDC shall monitor each supply fan status, via individual current switch. In the event the fan status does not match the commanded state after a 45-second (adjustable) delay, an alarm shall be annunciated at the DDC.
- 6. Maintenance Modes:
 - a. There shall be a software point displayed at the operator workstation for each air handling unit labeled as "Shutdown for Maintenance". The operator shall be able to manually command the "Shutdown for Maintenance" point which enables a shutdown of an individual AHU. Whenever an AHU is shutdown for maintenance, there shall be a smooth transition as not to disrupt the airflow in the supply duct. Only operators with the proper authorization shall be allowed to change over systems.
 - b. Shutdown Sequence:
 - 1) The unit marked for shutdown shall have the supply fans speed control overridden and the fan speed shall be commanded to minimum over a 5 minute time period.
 - 2) When the fan has stopped, the unit isolation dampers shall close.
 - 3) Once the dampers are no longer proven open, the AHU shall be shutdown.
 - c. Start-up Sequence:
 - 1) Upon a restart, the AHU shall be commanded "on" as stated in "System Start-up" above.
- 7. Heating Coil Control:
 - a. DDC shall monitor heating coil discharge temperature.
 - b. Initial heating coil discharge temperature setpoint shall be:
 - 1) Control Room: 72 DEGF.
 - 2) Screen Room, Crane Hall, Gallery: 60 DEGF.
 - c. Heating coil temperature control loop shall be enabled upon supply fan speed reaching control setpoint.
 - d. DDC shall modulate the heating coil control valve to maintain heating coil discharge temperature at setpoint:
 - 1) Provide a +/- 1 DEGF deadband for discharge air setpoint.
 - 2) Upon a drop in heating coil discharge temperature below the deadband, the DDC shall modulate the heating coil control valve open.
 - 3) Upon a rise in heating coil discharge temperature above the deadband, the reverse shall occur.
 - 4) Circulation pumps:
 - a) Circulation pumps shall run in a lead / lag configuration where the lead pump switches on a weekly basis.
 - b) When the outside air temperature is below 40 DEGF one circulation shall run continuously.
 - c) When there is a call for heating at the associated air handler, one circulation pump shall run continuously.

C. Control Room HVAC System:

1. Description: The system consists of one air handler, with plate type energy recovery, hydronic heating, and direct expansion cooling. The supply and exhaust fans provides the minimum 6 air change per hour ventilation rate required by NFPA 820 to reduce the space classification to Unclassified.
 - a. Refer to the Drawings for a diagram of this system.
2. Equipment list:

EQUIPMENT	EQUIPMENT NO.
RSP-HVAC Master Control Panel	704-LCP2504
RSP-Control Room Air Handler Controller	704-TC25AD021
RSP-Control Room Air Handler	704-AHU25AD011
RSP-Control Room Circulating Pump 1	704-P25AG011
RSP-Control Room Circulating Pump 2	704-P25AG021
RSP-Control Room Heating Control Valve	704-TWV25CR011
RSP-Control Room Supply Fan VFD	704-VFD25AF011
RSP-Control Room Exhaust Fan VFD	704-VFD25AF012

3. Operation:
 - a. The system shall operate 24 hours per day, 7 days per week.
 - b. The air handler shall provide temperature and ventilation control to the control room area.
4. Monitors:
 - a. A flow switch at the discharge of the air handler shall monitor the running status and an alarm shall be sent to the RSP-HVAC master control Panel, 704-LCP2504, and the ventilation alarm system as indicated on the control diagram.
 - b. A freeze stat at the heating coil shall alarm if any section of the freeze stat reads 35 DEGF or lower and an alarm shall be sent to the RSP-HVAC Master Control Panel, 704-LCP2504.

D. Crane Hall HVAC System:

1. Description: The crane hall system consists of two air handlers, one for supply air and one for exhaust air, that include hydronic heating, and a heat pipe heat recovery system. The air handlers provide the minimum 6 air changes per hour of ventilation required by NFPA 820 to reduce the space classification to Unclassified.
2. Equipment list:

EQUIPMENT	EQUIPMENT NO.
RSP-HVAC Master Control Panel	704-LCP2504
RSP-Crane Hall Air Handler Controller	704-TC25AD022
RSP-Crane Hall Supply Air Handler	704-AHU25AD012
RSP-Crane Hall Exhaust Air Handler	704-AHU25BS011
RSP-Crane Hall Circulating Pump 1	704-P25AG012
RSP-Crane Hall Circulating Pump 2	704-P25AG022
RSP-Crane Hall Heating Control Valve	704-TWV25PR011
RSP-Crane Hall Air Handler VFD	704-VFD25AF013
RSP-Crane Hall Exhaust Fan VFD	704-VFD25AF014
RSP-Crane Hall Air Handler VFD	704-VFD25AF023
RSP-Crane Hall Exhaust Fan VFD	704VFD25AF024

3. Operation:
 - a. The system shall operate 24 hours per day, 7 days per week.
 - b. The air handler shall provide temperature and ventilation control to the crane hall and connected areas.
 - c. The three temperature sensors in the Crane Hall, Motor Room, and Pump Room shall be averaged to determine the supply air temperature.
 - 1) If the highest temperature exceeds 75 DegF and the system is in heating mode, then the discharge temperature shall be reset 5 DegF lower down to a minimum of 50 DegF.
 - d. The energy recovery system shall operate as required to maintain a the discharge temperature setpoint. When both the return air and outside air temperatures are above or

below the discharge temperature setpoint and the return air is closer to the target discharge air temperature than the outside air, the energy recovery system shall be enabled. When the outside air and return air temperatures are on differing sides of the discharge air setpoint, the energy recovery system shall be enabled in conjunction with the bypass dampers to approach the discharge air temperature setpoint.

4. Monitors:

- a. A flow switch at the discharge of the air handler shall monitor the running status and an alarm shall be sent to the RSP-HVAC master control Panel, 704-LCP2504, and the ventilation alarm system as indicated on the control diagram.
- b. A freeze stat at the heating coil shall alarm if any section of the freeze stat reads 35 DEGF or lower and an alarm shall be sent to the RSP-HVAC Master Control Panel, 704-LCP2504.

E. Screen room HVAC system:

1. Description: The screen room system consists of a makeup air handler with hydronic heating that provides makeup air to the screen room which is a Class 1, Division 1, Group D space.
2. Equipment list:

EQUIPMENT	EQUIPMENT NO.
RSP-HVAC Master Control Panel	704-LCP2504
RSP-Screen Room Air Handler Controller	704-TC25AD022
RSP-Screen Room Supply Air Handler	704-AHU25AD013
RSP-Screen Room Circulating Pump 1	704-P25AG013
RSP-Screen Room Circulating Pump 2	704-P25AG023
RSP-Screen Room Heating Control Valve	704-TWV25PR011
RSP-Screen Room Supply Fan VFD	704-VFD25AF015
RSP-Screen Room Supply Fan VFD	704-VFD25AF025

3. Operation:

- a. The system shall operate 24 hours per day, 7 days per week.
- b. The air handler shall provide temperature and ventilation control to the crane hall and connected areas.

4. Monitors:

- a. A flow switch at the discharge of the air handler shall monitor the running status and an alarm shall be sent to the RSP-HVAC master control Panel, 704-LCP2504, and the ventilation alarm system as indicated on the control diagram.
- b. A freeze stat at the heating coil shall alarm if any section of the freeze stat reads 35 DEGF or lower and an alarm shall be sent to the RSP-HVAC Master Control Panel, 704-LCP2504.

F. Sample room and east fan room / gallery HVAC system:

1. Description: The sample system consists of one supply fan and one electric unit heater. The supply fan provides positive pressurization required by NFPA 820. The electric unit heater provides freeze protection. The east fan room system consists of a makeup air handler with hydronic heating that provides makeup air to the east fan room / gallery, which is an Unclassified space.
2. Equipment:

EQUIPMENT	EQUIPMENT NO.
RSP-HVAC Master Control Panel	704-LCP2504
RSP-Gallery Air Handler Controller	704-TC25BM011
RSP-Sampling Enclosure Supply Fan	704-SF25AC011
RSP-Sampling Enclosure Unit Heater	704-UH25AC011
RSP-East Fan Room Air Handler	704-AHU25BM011
RSP-East Fan Room Gallery Supply Fan VFD	704-VFD25AF016
RSP-East Fan Room Gallery Heating Control Valve	704-TWV25AG011
RSP-East Fan Room Gallery Circulating Pump 1	704-P25AG014
RSP-East Fan Room Gallery Circulating Pump 2	704-P25AG024

3. Operation:

- a. Sample room: 704-SF25AC011 is controlled via the DDC and has a AUTO/OFF switch. 704-UH25AC011 is controlled by a FAN/OFF/AUTO switch on the unit and operates in the FAN and AUTO positions:
 - 1) FAN: The unit heater fan shall run continuously. The heater activates as needed to satisfy the unit mounted thermostat.
 - 2) AUTO: The unit heater fan runs as needed in conjunction with the heating coil to satisfy the unit mounted thermostat.
 - 3) Setpoints: 50 degF (adjustable).
 - b. East fan room:
 - 1) Makeup air handler 704-AHU25BM011 is controlled via the DDC.
 - 2) The system shall operate 24 hours a day, 7 days per week.
 - 3) The heating coil and circulation pumps will provide heating to the gallery.
4. Monitors:
- a. An airflow switch at the discharge of the supply fan shall monitor the fan running status.
 - b. An airflow switch at the discharge of the makeup air handler shall monitor the running status.
 - c. An alarm shall be sent to the RSP-HVAC Master Control Panel, 704-LCP2504, in the event of a flow failure.
 - d. A freeze stat at the heating coil shall alarm if any section of the freeze stat reads 35 DEGF or lower and an alarm shall be sent to the RSP-HVAC Master Control Panel, 704-LCP2504.

G. Miscellaneous systems:

1. Screen room emergency exhaust fans:
 - a. Description: The screen room emergency exhaust system is an existing system consisting of 5 roof mounted exhaust fans and has 20 existing duct mounted dampers and 5 existing flow switches located in the screen room. The new fans will retain the existing dampers and flow switches with no changes. An additional 5 flow switches will be provided with the new exhaust fans.
 - b. All equipment associated with the screen room exhaust shall be rated for class 1, division 1, group D atmospheres in accordance with the NEC and NFPA 820.
 - c. Equipment:

EQUIPMENT	EQUIPMENT NO.
RSP-Exhaust Fan 401 -HVAC-	704-EF03GA011
RSP-Exhaust Fan 402 -HVAC-	704-EF03GA021
RSP-Exhaust Fan 403 -HVAC-	704-EF03GA031
RSP-Exhaust Fan 404 -HVAC-	704-EF03GA041
RSP-Exhaust Fan 405 -HVAC-	704-EF03GA051

- d. Monitors:
 - 1) Provide flow sensing devices (pressure differential or airflow switches) to indicate when any screen room emergency exhaust fan is running.
- e. Monitoring:
 - 1) Provide equipment running indication on the OIT panel at the RSP-HVAC Master Control Panel, 704-LCP2504.
 - 2) The Ovation system shall interface with the RPS-HVAC Master Control Panel, 704-LCP2504, through the network and provide running status within ACC1.

END OF SECTION

SECTION 23 13 24

ABOVEGROUND STEEL STORAGE TANKS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies aboveground, horizontal, double wall, welded steel storage tank (AST) for storing petroleum products, complete with appurtenances. The tank shall be manufactured in conformance with Underwriters Laboratories UL 142 specifications and so labeled.
- B. Equipment list:

EQUIPMENT	EQUIPMENT NO.
Used Oil Tank	705-T03HC011

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
SBC	Seattle Building Code
SFC	Seattle Fire Code, Part V, Chapter 57
NFPA 30	Flammable and Combustible Liquids
NFPA 704	Hazard Sing and Labeling
UL 142	Steel Aboveground Tanks for Flammable and Combustible Liquids

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
1. Conform to the applicable requirements of the codes, standards, and regulations specified in this Section.
 2. The design of the tank, appurtenances, insulation, and testing shall conform to the requirements of UL 142, as applicable for aboveground double wall secondary containment tank.
 3. The tank support and appurtenances design shall meet SFC and SBC seismic design requirements.
 4. The tank pipe connection ports shall be through the top only, except drain connections. The tank shall be equipped with the following:
 - a. One overfill prevention valve.
 - b. One 4" drop tube with cap.
 - c. One level gauge on top.
 - d. Two regular vents with mushroom type flame arrester vent caps for inner tank and secondary containment tank.
 - e. One leak detection probe installation port for secondary containment tank.
 - f. One tank inspection access port on the top to access to the inner tank, 24 inch diameter.
 - g. Two drains with stainless steel lockable ball valves for the inner tank and secondary containment tank with camlock male fittings, caps, and locks.
 - h. Coating inside and outside surfaces of the tank as specified.
 - i. Grounding connection terminal and connection cable.
 - j. Provide labeling and sign to identify the hazards per NFPA 704 and as specified in the specification 10 14 00.

- k. Provide protection guard posts, bollards or other approved means to protect the tank and piping.

B. Design Dimensions:

Equipment No.	Width (in)	Length (in)	Overall Height (in)	90% Capacity (gal)
705- T03HC011	46 dia.	144	58	900

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Provide the following submittals:

1. Tank manufacturer's qualifications.
2. Tank manufacture certification of compliance with the specified codes.
3. Confirm that the tank fabrication meets the requirements of UL 142, NFPA 30 and SFC Chapter 57, and requirements of this Section.
4. Fabrication shop drawings, with all piping connections ports, vents, fueling ports, fuel Inventory, access plate, drain connections ports, etc.
5. Tanks support and seismic calculations designed and signed by a professional engineer currently registered in the State of Washington.
6. Color chart.
7. At the time of delivery of the tank, submit the tank manufacturer's name and address, date of fabrication, tank identification number, and written certification of compliance with the specified codes and standards.
8. Testing procedures applied to both the primary tank and the secondary tank.
9. The tank manufacturer's warranty certificate.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. The tank manufacturer shall be a firm, or individual, regularly engaged in the design and fabrication of tanks of similar or greater complexity required under this Contract.
2. The tank manufacturer shall be licensed by Underwriters Laboratories, Inc., for UL 142 tank fabrication requirements.

1.06 SHIPMENT, PROTECTION, AND STORAGE

A. Shipment, protection, and storage: Section 01 67 00

1.07 ENVIRONMENTAL CONDITIONS

A. Environmental conditions: Section 01 17 00

B. Electrical classification: Section 26 05 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers:

1. Stafco.
2. Ace Tank and Equipment Co.
3. Approved Equal.

2.02 MATERIAL

- A. All materials shall be new conforming to the requirements of UL 142.

2.03 FABRICATION

- A. The tank with its appurtenances shall be fabricated in conformance with the requirements of UL 142, NFPA 30, and SFC Chapter 57.
- B. Tank fabrication shall meet the requirements of SFC Chapter 57 and Standard NFPA 30.
- C. The containment tank shall be tested to the same pressure as the primary tank and in conformance with the requirements of UL 142.
- D. The tank structure shall have anchoring adequate to meet the requirements of SFC and SBC seismic regulations.
- E. Tank shall be insulated per UL 142.

2.04 LEVEL, LEAK, AND INVENTORY SYSTEM

- A. Direct Reading Level Gauge:
 - 1. Provide one float-actuated level measuring gauge directly calibrated for indicating tank fill volume.
 - 2. Gauge components shall be plastic construction with stainless steel rods and aluminum bushing.
 - 3. Acceptable manufacturer:
 - a. Krueger Sentry Type D gauge.
 - b. Approved Equal.
- B. Leak Detection Gauge:
 - 1. Provide one float-actuated gauge for indicating leakage within the interstitial space of the double-wall containment system.
 - 2. Gauge components shall be plastic construction with aluminum internal rods and aluminum bushing.
 - 3. Acceptable manufacturer:
 - a. Krueger Sentry Type K gauge.
 - b. Approved Equal.

2.05 NAMEPLATE

- A. Identify tank by a nameplate indicating, in letters and numerals no less than 5/32-inch high, the manufacturer's name, tank identification number, design capacities, design pressures, design specific gravity, fabrication date, and UL 142.
- B. Name plate shall be fabricated of 316 stainless steel, attached to the tank by continuous, seal welding.

2.06 FINISHES

- A. The interior of the tank shall be coated with the A-1 coating system specified in Section 09 90 00.
- B. The exterior of the tank shall be coated with the C-1 coating system specified in Section 09 90 00.
 - 1. The exterior coating paint color shall match that of existing structures at the tank location.
 - 2. Submit color chart for review by the Project Representative.

2.07 SOURCE QUALITY CONTROL

- A. Factory Test: Conduct prior to shipment and provide documentation showing compliance with test requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install as shown on the Drawings and in conformance with the tank manufacturer's instructions and recommendations.

3.02 FIELD QUALITY CONTROL [NOT USED]

END OF SECTION

SECTION 23 21 18

HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section include special items needed by the hot water heating loops.
- B. The general requirements equipment, as specified in Section 43 05 01, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Centrifugal Air Separator – Hot Water Boiler 1	705-ME19AA011

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME	American Society of Mechanical Engineer
ASME B31.1	Power Piping
ASME B31.9	Building Services Piping
ASME BPVC, Section I	Rules for Construction of Power Boilers
MSS SP 25	Standard Marking System for Valves, Fittings, Flanges and Unions
OSHA	Occupational Safety and Health Act

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Shop drawings:
 - a. Seismic anchorage and bracing drawings and data sheets, as required.
 - b. Identify as referenced in Contract Documents.
 - c. Manufacturer's name and model number.
 - d. Descriptive specifications, literature and drawings.
 - e. Dimensions and weights.
 - f. Capacities and ratings.
 - g. Construction materials.
 - h. Power and control wiring diagrams, including terminals and numbers.
 - i. Vibration isolation.
 - j. Factory finish system.
 - k. Color selection charts where applicable.
 - l. Corrosion protection coating product data.
 - 2. Bill of Materials, including Form 01 78 45-A.

3. Support calculations made and signed by a professional engineer currently registered in the State of Washington.
4. O&M manual: Section 01 78 23.
5. Installation certification: Form 43 05 01-A.
6. Training certification: Form 43 05 01-B.
7. Informational Submittals:
 - a. Seismic anchorage and bracing calculations as required.
 - b. Recommended procedures for protection and handling of equipment and materials prior to installation.
 - c. Manufacturer's installation instructions.
 - d. Test reports.
 - e. Operation and Maintenance Data.
 - f. Welding data and weld inspection reports, as specified in Section 05 05 20.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 1. Welding: Welding processes and operators shall be qualified in accordance with Section 05 05 20, Welding.
 2. Mechanical Grooved Pipe Connections: Field grooving shall be performed by qualified operator, having demonstrated manufacturer's recommended grooving procedures.
- B. Vibration and critical speeds: Section 43 05 50.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.
- B. Piping:
 1. Free of rust and scale.
 2. Install plastic end caps/plugs on each end of pipe.
 3. Maintain end caps/plugs through shipping, storage, and handling to prevent pipe end damage, and to eliminate dirt and construction debris from accumulating inside of pipe.
 - a. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
 - b. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
 - c. Linings and Coatings: Prevent excessive drying.
 - d. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
 - e. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.
- C. Storage:
 1. Where possible, store materials inside and protect from weather.
 2. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

1.06 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Section 26 05 00. Boiler rooms are unclassified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:

1. Pressure and Temperature Test Plug:
 - a. Sisco; Model BNO.
 - b. MG Piping Products; Model PT.
 - c. Peterson Equipment Co.; Pete's Plugs.
 - d. Approved Equal.
2. Bimetallic Industrial Thermometer
 - a. H. O. Trerice; B8.
 - b. Ashcroft.
 - c. Weksler Glass Thermometer Company.
 - d. Approved Equal.
3. Pressure Gauge
 - a. H. O. Trerice.
 - b. Ashcroft.
 - c. Weksler.
 - d. Approved Equal.
4. Centrifugal Air Separator:
 - a. ITT/Bell & Gossett; Rolairtrol.
 - b. Taco; Air Separator.
 - c. Wessels; Spa.
 - d. Thrush; Tangential Air Separator.
 - e. Approved Equal.
5. Manual Air Vents:
 - a. ITT/Bell & Gossett; No. 4V.
 - b. Approved Equal.
6. Pressure Relief Valve:
 - a. ITT/Bell & Gossett; Type 790 or 1170.
 - b. Approved Equal.
7. Strainers:
 - a. Armstrong.
 - b. Keckley.
 - c. Spirax Sarco.
 - d. Approved Equal.
8. Suction Diffuser:
 - a. ITT/Bell & Gossett; Suction Diffuser.
 - b. Taco; SD.
 - c. Approved Equal.
9. Piping Flexible Connectors:
 - a. Mason; Safeflex.
 - b. Metraflex; Metrasphere.
 - c. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Piping and Fittings	<ol style="list-style-type: none"> 1. Refer to Pipe Data Sheet(s), Article Supplements. 2. In accordance with ASME B31.9 and ASME B31.1, as applicable. 3. Unless otherwise indicated, fittings and accessories connected to pipe shall be of same material as pipe. 4. Bullhead tees are not permitted.
Supports	Section 01 73 00.
Insulation	Section 40 42 00.

Component	Material
Valves	Gate, globe, check, ball, and butterfly valves as specified in Division 40.

2.03 EQUIPMENT FEATURES AND COMPONENTS

- A. Feature 7: Pressure and Temperature Test Plug:
 - 1. Brass body.
 - 2. 1/4-inch NPT.
 - 3. Suitable to receive standard 1/8-inch temperature or pressure test probes.
 - 4. Removable threaded brass protective cap.
 - 5. Dual Neoprene core rated for 200 degrees F.

- B. Feature 9: Bimetallic Industrial Thermometer:
 - 1. Precision calibrated bimetallic sensing element.
 - 2. Silicone dampened coil.
 - 3. Adjustable angle type with swivel union connection.
 - 4. 5-inch diameter face.
 - 5. Hermetically sealed stainless steel case.
 - 6. Weatherproof case when thermometer is located in exterior location.
 - 7. Double strength glass window.
 - 8. External recalibrator.
 - 9. Stem:
 - a. Stainless steel.
 - b. Length as recommended by manufacturer for pipe or duct size and insulation thickness at installed thermometer location.
 - 10. When installed in piping, install with thermowell furnished by same manufacturer as thermometer.
 - 11. When installed in ductwork, install with mounting flange and adapter hub furnished by same manufacturer as thermometer.
 - 12. Maximum 2 degrees per scale division for Fahrenheit scale, maximum 1 degree per scale division of Celsius scale.
 - 13. Accurate to plus or minus 1 percent of full scale in accordance with ASME B40.200.
 - 14. Fahrenheit only scale.
 - 15. Heating Hot Water System Range: 20 degrees F to 240 degrees F.

- C. Feature 10: Pressure Gauge:
 - 1. Bourdon tube sensing element.
 - 2. Range:
 - a. 0 psig to 100 psig.
 - b. Indelibly mark ranges with black figures on a white background.
 - 3. Connection: 0.25-inch male NPT.
 - 4. Case:
 - a. Painted steel, stainless steel, fiberglass reinforced polypropylene, or aluminum.
 - b. Weatherproof case when gauge is located in exterior location.
 - 5. Wetted Parts: Bronze, brass, stainless steel, or monel.
 - 6. Ring: Stainless steel or fiberglass reinforced polypropylene.
 - 7. Window: Acrylic or glass.
 - 8. Dial Face:
 - a. 4-inch diameter, minimum.
 - b. White with black figures.
 - 9. Accuracy: Plus or minus 1 percent of full scale in accordance with ASME B40.100.
 - 10. Temperature Rating: 250 degrees F, minimum.

- D. Feature 13: Centrifugal Air Separator:
 - 1. Full-line size.
 - 2. Tangential inlet and outlet connection.

3. Minimum Centrifugal Vessel Diameter: Three times the diameter of inlet and outlet pipes.
 4. Minimum Air Removal Efficiency: 43 percent at 100 percent of rated flow.
 5. Carbon steel tank with stainless steel collector tube.
 6. ASME constructed for 125 psig working pressure.
 7. Blowdown connection.
 8. Finish per Section 09 99 00.
- E. Feature 16: Manual Air Vents: Brass body with nonferrous internals:
1. Maximum Operating Pressure: 150 psig.
 2. Maximum Operating Temperature: 225 degrees F.
- F. Feature 17: Pressure Relief Valve:
1. ASME rated.
 2. Bronze body.
 3. EPDM diaphragm.
 4. Maximum Operating Temperature: 250 degrees F.
 5. Maximum Operating Pressure: 125 psig.
 6. Relief Pressure: 30 psig.
- G. Feature 20: Strainers:
1. Y-type.
 2. Body:
 - a. Copper hydronic pipe: Class 150 bronze body.
 - b. Steel hydronic pipe: Class 125 cast iron body.
 - c. Stainless steel gas pipe: ANSI Class 150 316 stainless steel body.
 3. 2 Inches and Smaller: Screwed ends and screwed face cap.
 4. 2-1/2 Inches and Larger: Flanged ends with bolted end cover and blowdown connection.
 5. Screen:
 - a. Type 316 stainless steel.
 - b. Free Area: Minimum of 2-1/2 times inlet area with 3/16-inch perforations.
- H. Feature 21: Suction Diffuser:
1. Body: 175 psig working pressure, cast iron.
 2. Inlet straightening vanes with length no less than 2-1/2 times pump suction diameter.
 3. Stainless steel combination diffuser-strainer-orifice cylinder with total free area equal to or greater than five times the cross-sectional area of pump suction; designed to withstand pressure differential equal to pump shutoff head.
 4. Disposable 16-mesh startup strainer.
 5. Permanent magnet located in flow stream, removable for cleaning.
 6. Adjustable foot support designed to carry weight of suction piping.
 7. Blowdown tapping in bottom, gauge tapping in side.
- I. Feature 22: Piping Flexible Connectors:
1. Spherical connector.
 2. Twin sphere.
 3. Precision molded of multiple layers of Kevlar cord and EPDM cover.
 4. Rated 175 psi at 200 degrees F.
 5. Refer to Section 40 05 01.
- J. Feature 23 Non-Bladder Type Expansion Tank:
1. Body: 250 gallon Welded carbon steel tank.
 2. Rated for 120-psi working pressure and a Maximum Operating Temperature of 375 degrees F.
 3. Tanks shall be constructed and tested as per ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 4. 2 Inches and Smaller: Threaded couplings.
 5. 2-1/2 Inches and Larger: Steel or cast-iron flanges.

6. Manufacturers and Products:
 - a. Seattle Boiler.
 - b. Taco.
 - c. Wessels Company

2.04 MOTOR

- A. Not used.

2.05 VARIABLE FREQUENCY DRIVE

- A. Not used.

2.06 ACCESSORIES

- A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location with 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Section or as indicated on the Drawings.
- B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.07 FINISHES

- A. Unless indicated otherwise, finish shall be per manufacturers' standard.

2.08 SOURCE QUALITY CONTROL

- A. Factory Tests: NON-WITNESSED.
- B. Hydrostatic Test: None.
- C. Performance Test: Subject equipment to performance tests to verify the full range of operating conditions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify size, material, joint types, elevation, horizontal location, and pipe service of pipelines to be connected to new equipment or existing pipe.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.
- C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and that coating is undamaged.

3.02 INSTALLATION

- A. Install equipment in the locations shown and in accordance with ASME B31.9 and ASME B31.1, and the provisions of Section 43 05 62.
- B. Expansion Tank: Existing system-wide centralized.
- C. Pot Feeder: Existing near main hot water loop circulating pumps.
- D. Balancing Devices:
 - 1. Install balancing devices with unrestricted flow and straight pipe for four pipe diameters up and downstream of hydronic unit heaters.
 - 2. Install well tapings and fittings for control sensors furnished under other sections.
 - 3. Provide pressure and temperature test plugs at the following locations, unless pressure gauges and thermometers are provided:
 - a. Inlet and outlet to unit heater hydronic coils.
 - b. Both sides of pumps.
 - c. Both sides of control valves.
- E. Air Vents:
 - 1. Manual Air Vents: Install at high side of coils and at high points of chilled water, condenser water, heating hot water piping system.
- F. Air Separators:
 - 1. Install as indicated on Drawings.
 - 2. Secure to structure.
 - 3. Remove and clean system strainer after 24 hours of operation and after 30 days of operation.
- G. Valves:
 - 1. Locate and orient so handles are readily accessible.
 - 2. Orient stems vertically in horizontal runs of pipe having centerline elevations 4.5 feet or less above finished floor, unless otherwise noted.
 - 3. Orient stems horizontally in horizontal runs of pipe having centerline elevations above 4.5 feet above finished floor, unless otherwise noted.
- H. Strainers:
 - 1. Install on upstream side of automatic valves, pressure-reducing valves, suction side of pumps, and elsewhere as indicated.
 - 2. Where installed in equipment rooms, provide valved blowout connection piped to nearest drain.
 - 3. Where installed at pump mains, provide 16-gauge bronze startup strainer. Remove startup strainer after system flush and prior to balancing.
 - 4. Remove and clean system strainers after 24 hours of operation and after 30 days of operation.
- I. Suction Diffusers: Provide 16-gauge bronze startup strainer. Remove startup strainer after system flush and prior to balancing.
- J. Flexible Connectors: Install at gas connections to boiler skid, pumps, chillers, air-handling units, equipment on vibration isolators, and at building seismic joints.
- K. Dielectric Isolators: Install where incompatible piping materials, except for bronze valves and strainers, come into contact with each other.
- L. Thermometer:
 - 1. Install in strict accordance with manufacturer's recommendations.
 - 2. Install in location that allows easy access for reading thermometer in safe fashion.
 - 3. When located in piping install with a thermowell and heat transfer gel.

- M. Pressure Gauge:
 - 1. Install in strict accordance with manufacturer's recommendations.
 - 2. Install in location that allows easy access for reading gauge in safe fashion.

3.03 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: Process Piping Leakage Testing, cap and fill with water to the working pressure the piping will see when in service.
- B. Required Weld Examinations:
 - 1. Perform examinations in accordance with ASME B31.1 and ASME B31.9, Section 05 05 20.
 - 2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this Section.
 - 3. Examine at least one of each type and position of weld made by each welder or welding operator.
 - 4. Defects:
 - a. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in applicable piping standards, examine two additional welds made by same welder that produced defective weld.
 - b. Such additional examinations are in addition to the minimum required above.
 - c. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.
- C. Welded connections visual inspection and nondestructive weld testing:
 - 1. As specified in Section 05 05 20.

3.04 ACCESS AND CLEARANCE CONSIDERATION

- A. Obstructions: Drawings do not attempt to show exact details of piping. Anticipate and work around obstructions.
- B. Cover piping installed across aisles or other main access walkways with a protective checkered plate steel ramp, pitched a maximum of 2:12 to allow safe wheeled or foot traffic, and paint with a prime coat and two finish coats of Safety Yellow. Support ramp from floor and do not rest ramp directly on pipe.
- C. Install specialties with suitable access clearances for maintenance or removal of replaceable components. Provide necessary couplings or flanges to maintain or remove specialties without removing connecting appurtenances.
- D. Do not install water or steam piping immediately over or within a 3-foot horizontal clearance of any electrical panel, motor starter, or environmental control panel (ECP). Where piping is located within these zones, install piping inside a PVC conduit or shield electrical device to protect it from direct water access.
- E. Provide an alternate safe means of access where equipment requiring periodic maintenance cannot be reached by walkways because of substitution of equipment or interference with ductwork, piping, or other mechanical conflicts resulting from construction. These may include:
 - 1. Overhead platform with stairway or ladder access and safety railings or handholds.
 - 2. Walk-through duct plenums with hinged access doors.
 - 3. Other means as necessary to meet OSHA standards for safe maintenance procedures.

3.05 CLEANING AND ADJUSTING

- A. Startup Piping System Cleaner:
 - 1. Clean with detergent cleaning compound similar to Nalco 2567. Suitable for removal of organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances,

with or without inhibitor. Suitable for system metals without deleterious effects. Cleaner shall not contain phosphate.

B. Cleanup:

1. Thoroughly clean parts of the installation and remove refuse material at completion of the Work.
2. Lubricate motors and bearings in accordance with manufacturer's service manuals prior to equipment startup.

C. Repair Work: Perform repair work of existing facilities affected by mechanical work performed under this Section. Include such items as:

1. Replacement of ceiling tiles or plaster removed or damaged for access to ceiling.
2. Patching walls and ceilings for piping and ductwork penetrations.
3. Repair of concrete or asphalt paving removed for pipe access.
4. Other repairs as a result of extension and remodeling of existing mechanical systems.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies circulation pumps for air handlers and heating coils.
- B. The general requirements applicable to all mechanical equipment, as summarized in Section 43 05 01 are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-Control Room Circulating Pump 1	704-P25AG011
RSP-Control Room Circulating Pump 2	704-P25AG021
RSP-Crane Hall Circulating Pump 1	704-P25AG012
RSP-Crane Hall Circulating Pump 2	704-P25AG022
RSP-Screen Room Circulating Pump 1	704-P25AG013
RSP-Screen Room Circulating Pump 2	704-P25AG023
RSP-East Fan Room Gallery Circulation Pump 1	704-P25AG014
RSP-East Fan Room Gallery Circulation Pump 2	704-P25AG024

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NFPA 70	National Electrical Code
IBC	International Building Code

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Motor data as specified in Section 40 05 93.
- C. Certified copies of test logs and performance curves that satisfy operating requirements specified
- D. Catalog data showing construction and materials.
- E. Operations and maintenance information in accordance with Section 01 78 23.

1.04 OPERATING REQUIREMENTS

- A. Refer to schedule on the Drawings.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Bell & Gossett.
- B. Armstrong.
- C. Taco Comfort Solutions.
- D. Approved equal, modified as necessary to provide the specified features and to meet specified operating requirements.

2.02 MATERIALS

- A. Casing: Cast iron.
- B. Impeller: Stainless steel or bronze.
- C. Shaft: Alloy or stainless steel with copper, bronze or stainless steel shaft sleeve.

2.03 EQUIPMENT FEATURES

- A. Base Mounted Pumps:
 - 1. Type: Horizontal shaft, single stage, direct connected, radial or horizontal split casing, for 125 PSIG maximum working pressure.
 - 2. Casing: Suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
 - 3. Impeller: Fully enclosed, keyed to shaft.
 - 4. Bearings: Grease lubricated roller or ball bearings.
 - 5. Seal: Carbon rotating against stationary ceramic seat, 225 DEGF maximum continuous operating temperature.
 - 6. Drive: Flexible coupling with coupling guard.
 - 7. Baseplate: Cast iron or fabricated steel with integral drain rim.
 - 8. Performance: As scheduled on the Drawings.
 - 9. Electrical Characteristics and Components:
 - a. Electrical Characteristics: In accordance with Section 26 05 00 and as scheduled on the Drawings.
 - b. Motors: 1750 RPM unless specified otherwise.
 - c. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
- B. In-Line Circulators:
 - 1. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 PSIG maximum working pressure.
 - 2. Casing: Flanged pump connections.
 - 3. Impeller: Keyed to shaft.
 - 4. Bearings: Two, oil lubricated bronze sleeves.
 - 5. Seal: Carbon rotating against stationary ceramic seat, 225 DEGF maximum continuous operating temperature.
 - 6. Drive: Flexible coupling.
 - 7. Performance: As scheduled on the Drawings.
 - 8. Electrical Characteristics and Components:
 - a. Electrical Characteristics: In accordance with Section 26 05 00 and as scheduled on the Drawings.
 - b. Motors: 1750 RPM unless indicated otherwise.

- c. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 TESTING

- A. Test pump systems in accordance with Section 23 05 93.

END OF SECTION

SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies specifications and field testing requirements for HVAC water treatment systems.
- B. The general requirements equipment, as specified in Section 43 05 01, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Boiler 2 Magnetic Filter	705-MF19AA021
Boiler 4 Magnetic Filter	705-MF19AA041

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM D859	Standard Test Method for Silica in Water
ASTM D1067	Standard Test Methods for Acidity or Alkalinity of Water
ASTM D1068	Standard Test Methods for Iron in Water
ASTM D1126	Standard Test Method for Hardness in Water
ASTM D3370	Standard Practices for Sampling Water from Closed Conduits
NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum)
NFPA 70	National Electrical Code
UL 486A-486-B	Standard for Safety for Wire Connectors

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Prior to connection of heating water piping to boiler, each boiler must be boiled-out following approved written procedure.
 - 2. Heating water systems:
 - a. Chemical type: Corrosion inhibitor. Antiscale/pH.
 - b. Heating loop volume to be determined by Project Representative for chemical quantity required in gallons from King County. For purposes of bidding, assume total primary and secondary water loop volume is no more than 60,000 gallons. Contractor shall confirm total water heating loop volume required for water treatment.
 - c. Dosing method: Manual, via pot feeder.
- B. Performance Requirements:
 - 1. Maintain system essentially free of scale, corrosion, and fouling.
 - 2. pH control: Include adequate buffer in inhibitor formulation to maintain pH range of 8.0 to 10.5.

3. Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals.
 4. Corrosion rate of following metals not to exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1.
 5. Inhibitor stable at equipment skin surface temperatures and bulk water temperatures of, respectively, not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees F).
 6. Heat exchanger fouling and capacity reduction not to exceed that allowed by fouling factor of 0.0005.
- C. System Operation: Continuous monitoring of boiler water for chemical treatment. Automatic chemical feeding based on the chemical controller set points.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
1. Written plan for boil-out procedure, including at minimum the following:
 - a. Boil-out preparation requirements.
 - b. Heating water loop and boiler isolation procedure.
 - c. Chemical type and dosing procedure.
 - d. Duration of boil-out, in days.
 - e. Low-fire boiler operation procedure during boil-out.
 - f. Cool down procedure.
 - g. Boiler drainage procedures.
 - h. Document the supporting work required by boiler installers. Example: Removal and replacement of equipment and inspection manways on boilers.
 - i. Certification of boil-out completion by water treatment system contractor.
 2. Shop drawings:
 - a. Detailed equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - b. Wiring diagrams: Detailed power and control wiring; differentiate between manufacturer-installed and field installed wiring.
 3. Manufacturer's literature including rated capacities, water-pressure drops, and furnished products listed below:
 - a. Pumps.
 - b. Chemical solution tanks.
 - c. Control equipment and devices.
 - d. Test equipment.
 - e. Chemical feeders.
 - f. Chemical usages, based on addition rate per gallon of treated water.
 4. Copy of water analysis to illustrate water quality available at Site.
 5. O&M manual: Section 01 78 23.
 6. Installation certification: Form 43 05 01-A.
 7. Training certification: Form 43 05 01-B.
 8. Bill of Materials, including Form 01 78 45-A.

1.05 QUALITY ASSURANCE

- A. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Boiler rooms are unclassified.

PART 2 PRODUCTS

2.01 WATER TREATMENT SYSTEM

- A. Acceptable manufacturers:
 - 1. Chem-Aqua, Inc., NCH Corporation.
 - 2. Barclay Chemical Co., Water Management, Inc.
 - 3. Calgon Corp., ECC International.
 - 4. DuBois Chemicals, Inc., DuBois USA Subsidiary.
 - 5. Harmsco Industrial Filters.
 - 6. Nalco Chemical Co.
 - 7. Boland Services, Water Treatment.
 - 8. Watcon, Inc.
 - 9. Approved Equal.
- B. Materials:
 - 1. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
 - 2. Furnish chemical recommended by water treatment system manufacturer that are compatible with piping system components and connected equipment.
 - 3. System cleaning compounds:
 - a. Alkaline phosphate or nonphosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances.
 - b. Suitable for system wetted metals without deleterious effects.
- C. Chemicals:
 - 1. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.
 - 2. pH control: Include adequate buffer in inhibitor formulation to maintain pH range of 8.0 to 10.5.
 - 3. Will not cause or enhance bacteria/corrosion problems or mechanical seal failure because of excessive total dissolved solids.
 - 4. Suitable for makeup water quality and rate.
 - 5. Corrosion inhibitor: Sodium nitrite/borate, molybdate-based corrosion inhibitor or other approved proprietary compound.
 - 6. Antiscale/pH control/corrosion inhibitor/conductivity enhancer:
 - a. Contains sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.
 - b. Sodium nitrite/borate, molybdate-based inhibitor or other approved proprietary compound.
- D. Closed-loop hydronic system treatment: Features and Components
 - 1. Pot feeder: Existing near primary loop pumps.
 - 2. Packaged conductivity controller: Solid-state circuitry, 5 percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control-function light, output to control circuit, and recorder.
 - 3. Solenoid valves: Forged-brass body, 150-pound pressure rating, and general purpose solenoid enclosure with 120-volt, continuous duty coil.
 - 4. Electronic timers: 150-second and 5-minute ranges, with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.

2.02 BOIL-OUT SYSTEM

- A. Acceptable Manufacturers:
 - 1. Same manufacturer shall be used for boil-out system and water treatment system.
- B. Chemicals:
 - 1. Chemicals suitable for boil-out include caustic soda, tri-sodium phosphate, and soda ash, or other compounds approved by water treatment manufacturer.

2.03 ACCESSORIES

- A. Water test kit: Manufacturer recommended equipment and chemicals, in a carrying case, for testing pH, total dissolved solids, dissolved oxygen, biocount, chloride, total alkalinity, and calcium hardness.
- B. Corrosion test coupon assembly:
 - 1. Complete with housing, holding, piping, valves, and mild steel and copper coupons.
 - 2. Coupon holder: Type 316 stainless steel.
 - 3. Locate copper coupon downstream from mild steel coupon in the test coupon assembly.
 - 4. Two-station rack for closed-loop systems.

2.04 SOURCE QUALITY CONTROL

- A. Performance Test: Subject equipment to performance tests to verify the full range of operating conditions.

2.05 MAGNETIC FILTER

- A. Acceptable manufacturers:
 - 1. Eclipse Magnetics, Boiler Mag series.
 - 2. ADEY, MagnaClean.
 - 3. Approved Equal.
- B. Materials:
 - 1. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
 - 2. Full boiler flow units.
 - 3. Flange connections, ANSI 150.
 - 4. Manufacturer isolation valves upstream and downstream of magnetic filters.
 - 5. Rare earth Neodymium Magnetic Material, 9000 Gauss.
 - 6. No automatic air vent, Operating maximum pressure 145 PSI.
 - 7. Housing and tube cartridges stainless steel, conforms to ASME standards.
 - 8. Seal EPDM.

PART 3 EXECUTION

3.01 PREPARATION

- A. Water Analysis: Perform analysis of supply water to determine type and quantities of chemical treatment needed to maintain water quality specified in this Section.
- B. System Cleaning and Flush:
 - 1. Perform system clean and flush in accordance with water treatment system manufacturer's requirements.

3.02 INSTALLATION

- A. Boil-out shall follow written approved procedure.
 - 1. Fully inspect water side of boilers prior to and following boil-out.
 - 2. Chemicals shall not be introduced directly into boilers.
 - 3. Work shall be performed or directly supervised by qualified personnel with minimum of three years of experience in boiler boil-out work.
- B. Install equipment in the locations shown and in accordance with the provisions of Section 43 05 60.
- C. Install treatment equipment level and plumb.
- D. Connections:
 - 1. Piping installation requirements are specified in other Division 23 Sections.
 - 2. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 3. Install piping adjacent to equipment to allow for service and maintenance.
- E. Electrical:
 - 1. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
 - 2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.03 FIELD QUALITY CONTROL

- A. Test chemical feed piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for 4 hours. Leaks and loss in test pressure constitute defects.
 - 5. Repair leaks and defects with new materials and retest piping until satisfactory results are obtained.
 - 6. Provide test reports, including required corrective action.
- B. Sampler boiler water at one-week intervals after boiler startup for a period of 5 weeks, and provide certified test report for each required water performance characteristic. Where applicable, comply with ASTM D3370 and the following standards:
 - 1. Silica: ASTM D859.
 - 2. Steam System: ASTM D1066.
 - 3. Acidity and Alkalinity: ASTM D1067.
 - 4. Iron: ASTM D1068.
 - 5. Water Hardness: ASTM D1126.

3.04 MANUFACTURER SERVICES

- A. Manufacturer's representative: Present at Site or classroom designated by Project Representative, for minimum person-days listed below, travel time excluded:
 - 1. 1 person-days for installation assistance and inspection.
 - 2. 1 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

- B. Training:
1. Procedures: Section 01 79 00.
 2. Provide a minimum of 8 hours per training.
- C. Maintenance Service Contract:
1. Provide chemicals and service program for maintaining optimum conditions in the HVAC hydronic systems water, for inhibiting corrosion, scale, and organic growths.
 2. Provide service for the following systems, piping and equipment:
 - a. Boiler water, hot-water piping.
 3. Contract Duration:
 - a. Provide services and chemicals for a period of 1 year from date of Substantial Completion.
 - b. Not less than 4 service calls and written status reports.
 4. Provide the following services as a minimum:
 - a. Initial water analysis and recommendations.
 - b. Direct flushing, cleaning, pretreatment, training, debugging, startup assistance, and acceptance testing operations.
 - c. Direct and perform chemical limit control, in accordance with these specifications.
 - d. Periodic field service and consultation.
 - e. Customer report charts and log sheets.
 - f. Laboratory technical assistance.
 - g. Analyses and reports of chemical items concerning safety and compliance with government regulations.
 5. Additional Specific Tests:
 - a. Open and Closed Loop Condenser Water Systems:
 - 1) Perform monthly tests of cooling tower water for Legionella pneumophila and submit reports stating Legionella bacteria count per millimeter.
 - 2) Conduct tests in a certified laboratory and not by a technician in the field.
 - b. Automatic Chemical Feed Systems:
 - 1) Perform two separate water analyses to prove automatic chemical feed systems are maintaining water quality within performance requirements specified.
 - 2) Conduct the first water analysis test after successful HVAC Water Treatment System startup and acceptance.
 - 3) Perform analyses at least 60 days apart.
 - 4) Provide written reports of water analysis.

END OF SECTION

SECTION 23 31 13

SHEET METAL DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies HVAC systems plenums, sheet metal housings, ductwork, equipment connections, reinforcing and other devices required to make the air distribution systems complete and operational.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASHRAE	Handbook - Equipment Volume, Duct Construction
ASHRAE	Handbook - Fundamentals Volume, Duct Design
ASTM A525	General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A527	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM B211	Aluminum and Aluminum Alloy Bar, Rod, and Wire
ASTM B308	Aluminum - Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded
AWS D9.1/D9.1M	Sheet Metal Welding Code
IBC	International Building Code
IMC	International Mechanical Code
NADCA ACR	National Air Duct Cleaners Association, The NADCA Standard for Assessment, Cleaning, and Restoration of HVAC Systems
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
SMACNA	HVAC Duct Construction Standards Metal and Flexible
UL 181	Factory-made Air Ducts and Connectors

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. An 8-1/2-inch by 11-inch manual with detail sheets or catalog data of flexible duct connectors, duct sleeves, duct access doors, turning vanes, volume dampers, supports, hangers, etc.

1.04 QUALITY ASSURANCE

- A. Ductwork construction, installation, and air system performance shall comply with UMC, ASHRAE CH-1 and CH-33, and SMACNA Duct Construction Standards.
- B. Welding shall comply with AWS D9.1.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide all ductwork, plenums, and all auxiliary work and products of any kind necessary to make the ventilation systems complete and ready for operation. Ductwork shall comply with the following restrictions and conditions:
1. Snap lock seams shall be fully sealed and fastened with screws every 18 inches.
 2. Where space conditions permit, full radius turns shall be used at offsets.
 3. Turning vanes shall be provided where tees, bends, and elbows are not 1-1/2 times the width at centerline and in all rectangular elbows.
 4. Ductwork elbows, take-offs, and fittings shall be in accordance with the SMACNA and ASHRAE standards for the medium pressure air duct.
 5. Visible duct deflection, loss of shape, or unwarranted noise or vibration resulting from faulty or inadequate support, reinforcing, metal gauge, fabrication, or joint spacing shall be corrected at no expense to King County.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Duct	Aluminum, alloy 3003-H14, conforming to ASTM B209 and ASTM B211, or Stainless steel 316
Duct sleeve	Aluminum, alloy 3003-H14, conforming to ASTM B209 and ASTM B211, or Stainless steel 316, 10 gage to match duct material
Access doors	Aluminum, alloy 3003-H14, conforming to ASTM B209 and ASTM B211, or Stainless steel 316, minimum 10 gage to match duct material
Flexible duct connector	Noncombustible, weather and ozone resistant, abrasion-proof woven fiberglass fabric with coating weighing not less than 24 ounces per square yard. Maximum flame spread rating of 25, smoke rating of 50 for all materials including connecting tape, etc. UL 181 approved.
Turning vanes	Aluminum or stainless steel 316 to match duct material.
Hangers and supports, rivets, and bolts reinforcing	Aluminum alloy 6061-T6 conforming to ASTM B308, or stainless steel to match duct material.
Ductwork Thermal Insulation	Section 23 07 13

- C. Unless otherwise indicated, all HVAC systems supply air, return air and exhaust air ductwork material shall be aluminum.

2.03 DESIGN CRITERIA AND CONSIDERATIONS

- A. General: Unless otherwise indicated, sheet metal gage, reinforcing, hanger and support systems, ductwork joint types and other basic design construction details shall be in accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) HVAC Duct Construction Standards. Ductwork shall be fabricated to meet the configurations and dimensions specified on the Drawings. Dimensions specified indicate net free area; dimensions shall be increased by the thickness of the internal thermal insulation and acoustical lining where is required.
- B. Low Pressure Ductwork: Low pressure ductwork shall convey air with a velocity less than 2000 fpm and to 2 inches of water column positive or negative static pressure. Low-pressure ductwork shall conform to 2-inch w.c. pressure class.

- C. Medium Pressure Ductwork: Medium pressure ductwork, where specified, shall convey air with a velocity greater than 2000 fpm and 6 inches of water column positive or negative static pressure. Medium pressure ductwork shall conform to 6-inch w.c. pressure class.
- D. System Leakage: All joints shall be sealed as required to limit total system leakage to a maximum of 1 percent of the specified equipment air flows.
- E. Change in Duct Size: Change in duct size shall be made by a uniformly tapering section. The change in direction of the tapering section shall not be more than 1 inch in 5 inches of run, unless otherwise specified.
- F. Bends in Duct: With the exception of mitered bends, all bends in ducts shall have inside radii equal to the duct width or diameter. Double wall turning vanes shall be provided at all 90-degree mitered bends.
- G. Duct Sleeves: Whenever ducts extend through concrete or masonry walls, floors or ceilings, they shall be provided with a sleeve as specified and shown on the Drawings.
- H. Duct Openings: Access doors or hand holes shall be provided in ducts at locations to reach modulating dampers, fusible links, controllers and any other moveable devices in the ducts. The opening shall be 1 inch less duct size or of adequate size to reach in and maintain these devices.
- I. Vibration Isolation Flexible Connections: Flexible connections shall be provided at duct connections to motor-driven air handling equipment and other locations specified. Flexible connections shall be UL approved and provided with the necessary angle, straps, bolts, clips, or other fasteners to secure the flexible material to the equipment and ducts. Flexible connections exposed to the weather shall be provided with approved sheet metal weather covers.

2.04 JOINTS AND REINFORCING

- A. Transverse stiffeners and joints shall be appropriately spaced to maintain duct cross-section integrity in accordance with the pressure class specified and at the prevailing operating velocities.
- B. After joints are crimped, they shall be further secured by bottom punching or riveting.
- C. Longitudinal seams shall be Pittsburgh lock and shall be cross-broken outward. Intake, or exhaust, side ducts shall be cross-broken inward. Discharge ducts shall be cross-broken outward. All plenums and casings shall be similarly cross-broken and further reinforced with 1-inch x 1-inch x 1/8-inch angles running diagonally between joints, riveted to the casings.
- D. Low pressure ductwork shall have slip joints.
- E. Medium pressure ductwork shall have flanged or welded joints.
- F. Joints shall not interfere with airflow in the ducts.
- G. Exterior ducts shall be stiffened, braced, and supported in a manner designed to maintain duct integrity and cross-section under wind and snow loads specified in the appropriate codes or standards.
- H. Interior ducts shall be suitably braced and stiffened at floor and roof penetrations as well as over their unsupported length in a manner designed to maintain duct integrity and limit vibration and noise in accordance with recognized standards of the industry.

- I. Ducts over 17 inches in largest dimension shall be cross-broken or beaded on all four sides. In ducts over 72 inches, 3/8-inch stay rods shall be installed at each transverse joint. Spacing between rods or rods on side of duct shall not exceed 48 inches.

2.05 DUCT SLEEVES

- A. Sleeve flanges shall not be less than 4 inches wide and shall be installed tight against each side of the barrier.
- B. Sleeves shall be 2 inches larger than the duct or external duct insulation.
- C. The space between the duct (or insulation) and the sleeve shall be packed with fiberglass or material of original wall.
- D. Duct flanges not less than 4 inches wide shall be installed tight against the wall on each side and fastened to the duct sleeves.

2.06 HANGERS AND SUPPORTS

- A. Duct support spacing shall be in accordance with the SMACNA standards for the pressure class and conditions specified and prevailing in the system.
- B. Supports shall be spaced to prevent visible duct deflection and loss of system integrity.
- C. Aluminum ductwork shall be constructed with strength and dimensional stability comparable to conventional steel duct. In the absence of other criteria, aluminum sheet and reinforcing shall have a moment of inertia three times greater than that recommended for steel ductwork.
- D. Supports shall be designed in accordance with the International Building Code.
- E. Duct located in concealed ceiling spaces shall be supported with metal strap hanger screwed to the sides and bottom of duct. One strap each side with minimum of two screws in sides and one in the bottom of each strap. Sway bracing shall be provided, minimum of one at right angle to each duct run,
- F. Duct located in exposed areas:
 1. Rectangular ductwork shall be supported with shelf angle trapeze hanger or unistrut with rods or angles by welding or bolting. Sway bracing shall be provided, minimum of one at right angle to each duct run.
 2. Round ductwork shall be supported with two half round bands with rods bolted to the bands. Sway bracing shall be provided, minimum of one at right angle to each duct run.

2.07 ACCESS DOORS

- A. Access doors shall be rigid and shall be provided with airtight gaskets and shall not vibrate or cause noise under service.
- B. Doors shall be continuous hinged type with ventlock latch on outside.

2.08 FLEXIBLE CONNECTIONS

- A. Flexible connection joints shall be airtight and have a minimum allowance of 1-inch slack all around.
- B. Flexible connections shall be designed to be removed from the line and be reinstalled without disassembling adjacent ductwork.

- C. Connections shall be installed with a minimum 4-inch clearance between metal parts on fan connections, equipment connections, and for distribution devices.

2.09 TURNING VANES

- A. Turning vanes shall be 2-inch blades for ducts up to 18 inches in either dimension and shall be 4 1/2-inch blades for larger ducts.
- B. Turning vanes material shall match to duct material. Galvanized ducts turning vane assemblies shall be finished with an air-dried phenolic corrosion resistant coating prior to installation.
- C. All turning vanes shall be constructed of double thickness vanes.

2.10 BALANCING DAMPERS

- A. Manually operated, opposed blade or single blade, quadrant-type balancing damper shall be provided in each branch duct take-off after leaving the main duct on low and medium pressure system. Splitter dampers shall be provided only where specified.
- B. Single-blade dampers shall be constructed for ducts 9 1/2 inches by 30 inch and smaller. Opposed blade dampers shall be constructed with a maximum blade size of 12 inches by 72 inches.
- C. Dampers material shall match the ductwork material.

2.11 DUCTWORK COATING

- A. Exposed uninsulated or internally insulated ductwork shall be coated on all external surfaces in accordance with Section 09 90 00 except in unclassified HVAC mechanical rooms or as specified on the drawings.

2.12 DUCTWORK THERMAL INSULATION

- A. Ductwork thermal insulation shall be as specified in Section 23 07 13.

2.13 ROOF-MOUNTED INTAKE HOOD:

- A. Intake hoods shall be as specified in section 23 27 23.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install ductwork in accordance with SMACNA and NFPA. All ductwork indicated on the Drawings is schematic; therefore, changes in duct size, duct configuration, and location may be necessary to conform to field conditions.
- B. Install ductwork and accessories to provide a system free from buckling, warping, breathing, and vibration. Ductwork installation shall permit installation of other required services without piercing, crimping, or reducing duct sizes. Where space conditions permit, use full radius turns at offsets.
- C. Make all ductwork airtight. Seal flanged joints with closed-cell neoprene gaskets compressed between mating flanges. Seal all other joints and seams with liquid or mastic type sealants. Taped joints are not permitted. All joints, both transverse and longitudinal, shall comply with the requirements of SMACNA Seal Class A.
- D. Fabricate all duct fittings with continuously welded seams and joints.

- E. All ductwork shall be fabricated in accordance SMACNA Standards requirements for medium pressure ductwork and shall conform to 6-inch w.c. positive and negative pressure regardless of actual working pressure of the HVAC systems.
- F. Do not operate equipment during construction without filters.
- G. Clean all ductwork per NADCA ACR standards prior to substantial completion.

3.02 TESTS

- A. Perform tests as specified in Section 23 05 93.
- B. Provide duct test holes with patches in ducts where directed or necessary for testing and balancing purposes.

END OF SECTION

SECTION 23 33 13.13

DAMPERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies HVAC systems balancing and control dampers that are installed in ducts or independently mounted.

1.02 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AMCA Standard 500	Test Methods for Louvers, Dampers and Shutters
SMACNA	HVAC Duct Construction

1.03 OPERATING REQUIREMENTS

- A. Pressure drop shall not exceed 0.02-inches w.c. at the design air volume.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
 2. Dampers dimensions and installation shop drawings.
 3. Dampers construction information including frame, blade and linkage material data. Type of blades, and air flow and friction loss performance curve.
 4. Damper motors data, full stroke time, electric power, installation support bracket information.
 5. Electrical and control diagrams.
 6. Installation requirements, showing clearance required for maintenance purposes.
 7. Applicable operating and maintenance data for damper and operators as specified.

1.05 QUALITY ASSURANCE

- A. Certification: dampers shall bear the AMCA Certified Rating Seal for both air leakage and performance.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00
- B. Electrical classification: Sheet 700-E50001.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer
 - 1. Airolite
 - 2. Ruskin.
 - 3. Construction Specialties.
 - 4. Approved Equal.

2.02 SPLITTER DAMPER

- A. Splitter blade damper shall be minimum 16 gage aluminum and sized to fit the specified duct dimension with 1/8-inch clearance all around. Splitter damper construction and minimum dimensions shall comply with SMACNA standards.

2.03 SINGLE BLADE DAMPER

- A. The damper blade shall be minimum 20 gage aluminum. The damper hinge shall consist of a 3/8-inch pin at each side of the damper blade to provide a pivot point for damper positioning.

2.04 MULTIBLADE DAMPER

- A. General:
 - 1. Dampers shall be heavy-duty industrial grade dampers.
 - 2. Dampers shall be constructed of the same material of the surrounding ductwork or as specified. For galvanized and stainless steel damper the frame shall be minimum 14 gage steel channel frame with 8-inch depth and 2-inch flanges. For aluminum damper frame shall be 16 gage extruded aluminum frame with 2x1/2x1/8 inch thick extruded channel.
 - 3. Blades shall be V type heavy duty fabrication. Blades shall be mounted on 3/4-inch type 304 stainless steel axles. Blades shall be provided with vinyl edge seals.
 - 4. Axles shall be mounted in ball bearings; the bearing shall be externally mounted and shall be replaceable. The axles shall be operated by out of the air stream blade-to-blade stainless steel linkage.
 - 5. The dampers shall be suitable for pressures to 8.5-inches water column and velocities to 3000 FPM when tested in accordance with AMCA Standard 500.
- B. Parallel Blade: Parallel blade dampers shall be constructed such that all damper blades rotate in the same direction when the damper is opened or closed. Parallel blade dampers shall be used for two-position, open/closed, dampers.
- C. Opposed Blade: Opposed blade dampers shall be constructed such that each damper blade rotates in the opposite direction of the blades adjacent to it when the damper is opened or closed. Opposed blade dampers shall be used for modulating dampers and dampers where mixing shall be encouraged such as air handler mixing boxes.

2.05 BACKDRAFT AND BAROMETRIC DAMPERS

- A. Damper frame and blades shall be heavy duty constructed with extruded aluminum and shall be provided with neoprene or felt edge seals to ensure tight closure, unless otherwise specified. The damper frame shall be minimum 3" deep and blades shall be provided with extruded vinyl edge seals to ensure tight closure at working temperature of -50 F to +250 F. Backdraft dampers shall be counterbalanced when installed in vertical position. The blade interconnecting linkage shall be located within the damper frame and out of the airstream. Inline backdraft dampers in the ductwork shall be provided with an open/close position indicator arm to monitor the damper position.

2.06 OPERATORS

- A. Electric Damper Motor:
 - 1. Reference Section 23 09 13.
- B. Manual Positioner:
 - 1. A 3/8-inch locking quadrant shall be provided at one end of the damper, external to the ductwork, on manually adjusted dampers.
 - 2. Positioner extensions shall be provided for dampers installed in ductwork located in ceilings, walls or floors that is not directly accessible.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Align and install dampers in accordance with SMACNA standards, manufacturer's recommendations, and as shown on the Drawings.
- B. Locate the damper positioners for direct access at the duct or install extensions where necessary to accessibility
- C. Balancing dampers shall be single blade type unless otherwise specified.
- D. Damper motors installation and electrical and control wiring shall in accordance with the manufacturer's recommendations and as shown on the Drawings.

3.02 TEST AND ADJUSTMENT

- A. Single blade dampers and splitter dampers shall be tested to assure operation through their full range of movement without binding or interference following installation.
- B. Multiple blade dampers shall be manually tested, prior to installation and following installation to assure operation through their full range of movement without binding or interference.
- C. Final damper adjustments and positioning shall be performed during system balancing.

END OF SECTION

SECTION 23 33 13.16

FIRE DAMPERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies all fire dampers for heating, ventilating and air conditioning systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
SMACNA	HVAC Duct Construction Standards--Metal and Flexible
SMACNA	Fire Damper Guide
UL 555	Standard for Fire Dampers
UL 555S	Leakage Rated Dampers for Use in Smoke Control Systems
UMC	Uniform Mechanical Code (Seattle Mechanical Code)

1.03 SYSTEM DESCRIPTION

- A. Operating and Design Requirements:
1. Each fire damper shall cause a pressure drop of not more than 0.05-inch water column at an air velocity of 1,500 feet per minute through the device.
 2. Unless otherwise indicated, each damper shall have the same fire-stop rating as the surrounding structure in which it is installed.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Catalog data and dimensional drawings.
 2. Shop drawings.

1.05 QUALITY ASSURANCE

- A. Fire dampers and automatic smoke dampers shall be labeled by UL or other approved laboratory and constructed in accordance with NFPA 90A requirements.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturers:
1. Ruskin.
 2. Safe-Air.
 3. Air Balance.
 4. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Frame	Stainless steel
Curtain	Stainless steel
Sleeve	Stainless steel
Blades	Stainless steel

2.03 FIRE DAMPERS

- A. General:
1. Fire dampers shall be the curtain type, with blades out of the air stream.
 2. Fire damper frame shall be 20-gage channel or as required by the UL listing.
 3. The blades shall be 24-gage or as required by the UL listing, interlocked to form a curtain across the frame opening. The damper blades shall be held in place by fusible links rated for 165-degree F temperature operation.
 4. Fire damper sleeves shall be the same gage as the connecting ductwork.
- B. Access Door:
1. An access door shall be provided for each fire damper assembly.
 2. The access door and frame shall be constructed in accordance with SMACNA standards, of metal of the same or heavier gage thickness as the ductwork.
 3. The door frame shall be clinch locked or tee locked to the duct.
 4. The access door shall be 1 inch smaller than the duct opening and shall be provided with an airtight seal. Minimum size 12" x 12" or no more than 2" smaller than the duct height.

2.04 AUTOMATIC SMOKE CONTROL DAMPERS

- A. Two-position and operated by U.L. listed actuators.
- B. Frames shall not be less than 13-gauge material.
- C. Blades shall be 16-gauge roll-formed steel and not wider than 8 inches.
- D. Bearings shall be oiltite, ball bearing, or nylon with 1/2-inch shafts.
- E. Dampers and seals shall be suitable for temperature ranges of -40 to 250 degrees F.
- F. Classified under UL Standard 555S and Leakage Class III (maximum allowable leakage 40 cfm per square foot at 1 inch w.c. and 80 cfm per square foot at 4 inches w.c.).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fire Dampers:
1. Install fire dampers in ductwork penetrating fire-rated walls, floors and ceilings as required by the building code and the local authority.
 2. Electrolytically isolate fire dampers using a dielectric material when installing in ductwork systems constructed of aluminum or stainless steel.

3. Fire damper sleeve connections shall be as specified in SMACNA standards.
- B. Access Openings:
1. Provide an access opening in ductwork attached to each fire damper.
 2. The access opening shall be large enough to permit inspection and resetting of the fire damper it serves.
 3. Provide an access door to cover the access opening.
 4. Stencil each access door "FIRE DAMPER ACCESS" with 2-inch high red letters.
- C. Automatic Smoke Control Dampers:
1. Electrolytically isolate smoke dampers using a dielectric material when installing in ductwork systems constructed of aluminum or stainless steel.
 2. Install smoke dampers in accordance with manufacturer's instructions.

3.02 TESTING

- A. Fire Dampers: disconnect the fusible link and operate the fire damper several times to assure proper, unobstructed operation.
- B. Smoke Dampers: test smoke dampers for proper operation.

END OF SECTION

SECTION 23 34 13.10

PROPELLER WALL FANS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies wall mounted fans complete with fans, motors, dampers, and accessories required for ventilation systems.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-Sampling Enclosure Supply Fan	704-SF25AC011
West Boiler Room Supply Fan	705-F25BA012
East Boiler Room Exhaust Fan	705-F25BA021

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AMCA Standard 210	Laboratory Methods of Testing Fans for Rating
AMCA Standard 300	Test Code for Sound Rating
AFBMA Standard 9	Ball Bearing Load Ratings

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
1. Fan motors shall be non-overloading on all points of the operating curve.
 2. Fans shall be designed for continuous duty service.
 3. Sound and Vibration. Fans shall operate at noise levels below 30 sones, as defined by AMCA Standard 300, and at tip speeds below 10,000 fpm.
- B. Performance Requirements: Refer to schedules on the Drawings.

1.04 SUBMITTALS

- A. Procedures: Section 01 30 00.
- B. Provide the following submittals:
1. Fan performance curves for the specified operating conditions.
 2. Motor data Form 40 05 93-A.
 3. A copy of all related contract schematic, structural, and mechanical drawings with all piping, foundations, supports, and layout sizes and dimensions requiring Contractor confirmation marked.
 4. Dimensional drawings of fans.
 5. Certification that the units have been tested and rated in accordance with the applicable AMCA Standard Test Code and Certified Ratings Program.
 6. Applicable operation and maintenance data as specified in this specification.
 7. Manufacturer's certificate of installation on Form 43 05 01.

1.05 QUALITY ASSURANCE

- A. Fans shall bear the AMCA rating seal.

1.06 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Refer to the architectural code summary sheets and the Electrical Plan sheets.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturer:
 - 1. Loren Cook.
 - 2. Greenheck.
 - 3. Aerovent.
 - 4. Penn Ventilator.
 - 5. Approved Equal

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Propeller	Aluminum
Venturi	Steel
Wall panel	Steel
Fan propeller shaft	Steel
Fasteners	Stainless steel
Pillow blocks	Cast iron
Sheaves	Cast iron

2.03 EQUIPMENT

- A. Fan:
 - 1. The fan shall be wall-mounted V-belt or direct driven as specified.
 - 2. Bearings shall be rated for a minimum AFBMA L-10 bearing life of 50,000 hours.
 - 3. The fan shaft on V-belt driven fans shall be mounted in heavy-duty ball bearing pillow blocks with grease fittings with extended tubing for better access.
 - 4. Belt driven fans shall be furnished with adjustable pitch sheaves and adjustable motor bases suitable for a plus or minus 5 percent adjustment in operating speed. The V-belt drive shall be as specified in Section 43 05 01.

2.04 MOTOR

- A. Unless otherwise indicated, motors shall operate at 1750 rpm and shall be TEFC type as specified.
- B. Motor shall be electronically commutated (EC) motor with local speed control.

2.05 FAN PANEL

- A. Spun venturi to direct air smoothly to the propeller blades.
- B. The fan, drive motor, and fan guard shall be securely attached to the fan panel by means of a four-legged angle or tubular frame and mounting pads.
- C. Unless otherwise indicated, the fan panel, frame, and mounting pads shall receive the manufacturer's standard enamel coating unless otherwise specified.

2.06 ACCESSORIES:

- A. The fan shall be provided with a steel mounting collar, and a spring-loaded aluminum backdraft damper where specified. Mounting collars shall be protected with a baked epoxy finish.
- B. Fans shall be provided with inlet guards constructed of aluminum materials. Inlet guards shall conform to OSHA standards and shall be removable to provide motor access.
- C. Provide ½-inch bird screen on the building exterior side of the fan.
- D. Where the motor and drive assembly are specified to be installed in a weather-exposed location, such as the exterior side of an exterior wall, provide a sheet metal shroud or weather hood for the fan. This shroud shall protect the fan and drive assembly from direct exposure to the elements without restricting airflow to the fan. Provide a bird screen with the shroud.
- E. Boiler room supply fans: Constant pressure controller with remote transducer to control supply fan and maintain positive pressure within the boiler space. Controller to accept smoke detector relay for shut down upon smoke detection.
 - 1. Pressure controller: Greenheck Vari-Green constant pressure control. Or approved equal
- F. Boiler room supply fans: Local area smoke detector with relay module. 120 volt AC power. Coordinate relay operation with pressure controller.
 - 1. Smoke detector: Kidde model Pi2010 with SM120X relay module. Or approved equal.
- G. Finish: Phenolic based corrosion resistant coating: 3-mil dry thickness, air-dried coating, factory applied. Provide factory certification of application.

2.07 SOURCE QUALITY CONTROL

- A. Factory Test: Each fan shall be tested by the fan manufacturer prior to shipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install each fan as specified and in accordance with manufacturer's recommendations. Certify the installation and initial operation using Form 43 05 01-A.

3.02 TESTING

- B. After completion of installation, each fan shall be tested and balanced in accordance with specifications requirements to guarantee compliance with the fan performance as specified in this specification.

END OF SECTION

SECTION 23 34 16.20

IN-LINE CENTRIFUGAL FANS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies duct-mounted, in-line fans complete with fans, motors, and accessories required for ventilation systems.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
East Boiler Room Supply Fan	705-F25BA022
North Tunnel Exhaust Fan	706-EF25AR011

1.02 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AMCA Standard 210	Laboratory Methods of Testing Fans for Rating
AMCA Standard 300	Test Code for Sound Rating
AMCA Standard 0401	Classifications of Spark Resistant Construction

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
1. Fan motors shall be non-overloading on all points of the operating curve.
 2. Fans shall be designed for continuous duty service.
 3. Sound and Vibration. Fans specified in this section shall operate at noise levels below 30 sones, as defined by AMCA Standard 300 and at tip speeds below 8000 FPM.
- B. Performance Requirements: Refer to schedules on the Drawings.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Fan performance curves for the specified operating conditions.
 2. Motor data form 40 05 93-A as required in Section 40 05 93.
 3. Dimensional drawings of fans and installation shop drawings.
 4. Power and control wiring drawings as specified and shown on the Contract Documents.
 5. Applicable operating and maintenance data in accordance with Section 01 78 23.

1.05 QUALITY ASSURANCE

- A. Fans shall bear the AMCA rating seal.

1.06 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Refer to the architectural code summary sheets and the Electrical Plan sheets.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Loren Cook.
 - 2. Carnes.
 - 3. Greenheck.
 - 4. Penn.
 - 5. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Fan wheel	Aluminum
Fan wheel shaft	Stainless Steel
Fan housing	Aluminum
Fasteners	Stainless steel or aluminum

2.03 EQUIPMENT

- A. Fan:
 - 1. Fans shall be straight through centrifugal, in-line fans
 - 2. The fan housing shall be square or rectangular in design and shall be provided with duct mounting collars at the inlet and outlet for connection to rectangular ductwork.
 - 3. Fan housing shall be designed to provide access to the motor and fan unit through a gasketed access door.
 - 4. The fan inlet shall be provided with a venturi throat that is overlapped by the fan wheel.
 - 5. The fan wheel shall have backward inclined blades as provided standard by the manufacturer for the specified conditions. The wheel shall be statically and dynamically balanced at the factory. The fan wheel shaft, on belt-driven fans, shall be mounted in a heavy duty, permanently sealed, permanently lubricated, ball bearing pillow block. Bearings shall be rated for a minimum AFBMA L-10 bearing life of 100,000 hours.
 - 6. The entire drive assembly, as a unit, shall be removable without removing the fan assembly from the ductwork. Belt-driven fans shall be furnished with adjustable pitch sheaves and adjustable motor bases suitable for a plus or minus 5 percent adjustment in operating speed. The V-belt drive shall be as specified in Section 43 05 01.

2.04 MOTOR:

- A. The motor shall operate at 1750 rpm unless otherwise specified and shall be Type TEFC as specified in Section 40 05 93.
- B. Motor shall be electronically commutated (EC) motor with local speed control.

- C. Motors shall be mounted on vibration isolators and shall be sealed from the exhaust air stream.
- D. A motor and belt cover shall be provided on all belt-driven fans.
- E. A unit mounted disconnect switch shall be provided on each fan housing.
- F. A flexible conduit, connecting the disconnect to the fan motor, shall be provided. The conduit shall be of sufficient length to permit access to the motor and drive assembly without disconnecting the wiring.

2.05 ACCESSORIES:

- A. Each fan shall be provided with vibration isolators for fan mounting as specified. Fan inlet guards shall be provided on fans with non-ducted inlets.
- B. When specified, fan shall be provided with filter box constructed of the same material as the fan casing. Filters shall be 2-inch disposable.
- C. A differential pressure gauge for measuring the resistance to air flow through the filter shall be provided.
- D. When specified, fan shall be provided with gravity operated backdraft damper constructed of the same material as the fan casing.
- E. Constant pressure controller with remote transducer to control supply fan and maintain positive pressure within the boiler space. Controller to accept smoke detector relay for shut down upon smoke detection.
 - 1. Pressure controller: Greenheck Vari-Green constant pressure control. Or approved equal
- F. Local area smoke detector with relay module. 120 volt AC power. Coordinate relay operation with pressure controller.
 - 1. Smoke detector: Kidde model Pi2010 with SM120X relay module. Or approved equal.
- G. Finish: Phenolic based corrosion resistant coating: 3-mil dry thickness, air-dried coating, factory applied. Provide factory certification of application.

2.06 SOURCE QUALITY CONTROL

- A. Factory Test: Each fan shall be tested by the fan manufacturer prior to shipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install each fan as specified and in accordance with manufacturer's recommendations. Provide flexible duct connections where the fan connects to ductwork.
- B. The installation and initial operation shall be certified on Form 43 05 01-A

3.02 FIELD TESTING

- A. Conduct a complete field test of each fan in accordance with Section 23 05 93 to guarantee compliance with the specifications.

END OF SECTION

SECTION 23 34 16.30

CENTRIFUGAL ROOF EXHAUST FANS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies roof mounted exhaust fans complete with fans, motors, dampers, curbs and accessories required for ventilation systems.
- B. The general requirements applicable to all mechanical equipment, as specified in Section 43 05 01 are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-Exhaust Fan (401)	704-EF03GA011
RSP-Exhaust Fan (402)	704-EF03GA021
RSP-Exhaust Fan (403)	704-EF03GA031
RSP-Exhaust Fan (404)	704-EF03GA041
RSP-Exhaust Fan (405)	704-EF03GA051
West Boiler Room Exhaust Fan	705-F25BA011

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AMCA Standard 300	Test Code for Sound Rating
AFBMA	Antifriction Bearing Manufacturers Association Standards on Load Rating and Fatigue Life

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Fan motors shall be non-overloading on all points of the operating curve.
 - 2. Fans shall be designed for continuous duty service.
 - 3. Fans shall operate at noise levels below 20 sones, as defined by AMCA Standard 300 and at tip speed below 6000 fpm.
- B. Performance Requirements: Refer to schedules on the Drawings.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following information:
 - 1. Fan performance curves for the specified operating conditions.
 - 2. Bearing ratings for the fan and motor at operating conditions.
 - 3. Motor data form 40 05 93-A as required in Section 40 05 93.
 - 4. A copy of all related contract schematic, structural, and mechanical drawings with all dimensions requiring Contractor confirmation marked.

5. Dimensional drawings of fans.
6. Certification that the units have been tested and rated in accordance with the applicable AMCA Standard Test Code and Certified Ratings Program.
7. Applicable operation and maintenance data in accordance with Section 01 78 23.
8. Manufacturer's certificate of installation Form 43 05 01-A in Section 01 33 10

1.05 QUALITY ASSURANCE

- A. Fans shall bear the AMCA rating.
- B. Vibration and critical speeds: Section 43 05 50.

1.06 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Reference the Architectural code summary sheets and the Electrical Plan sheets.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturers
 1. Aerovent.
 2. Greenheck.
 3. Loren Cook.
 4. Penn.
 5. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Hood	Aluminum
Fan wheel	Aluminum
Fan wheel shaft	Stainless steel
Fan housing	Spun aluminum
Fasteners	Stainless steel
Curb	Aluminum

2.03 EQUIPMENT FEATURES AND COMPONENTS

- A. Fans:
 1. Fan housing shall be designed to provide easy access to the motor and fan unit. The fan inlet shall be provided with a venturi throat that is overlapped by the fan wheel.
 2. The fan wheel shall have forward curved, backward inclined or airfoil blades as provided standard by the manufacturer for the specified conditions. The wheel shall be statically and dynamically balanced at the factory. The fan wheel shaft, on belt-driven fans, shall be mounted in a heavy duty, permanently sealed, permanently lubricated, ball bearing pillow block. Bearings shall be rated for a minimum AFBMA L-50 bearing life of 200,000 hours.

3. The entire drive assembly, as a unit, shall be removable through the support structure without dismantling the fan housing. Belt-driven fans shall be furnished with adjustable pitch sheaves and adjustable motor bases suitable for a plus or minus 5 percent adjustment in operating speed. The V-belt drive shall be as specified in Section 43 05 01.

B. Motor:

1. Unless otherwise specified, motors shall operate at 1750 rpm TEFC and shall be as specified in Section 40 05 93.
2. Where indicated, motors shall be electronically commutated (EC) motor with local speed control.
3. Motors shall be mounted on vibration isolators and shall be sealed from the air stream.
4. Each fan housing shall contain a weatherproof motor shutoff switch, a wiring post and watertight conduit penetration.

C. Damper:

1. Each fan shall be provided with spring loaded barometric type, aluminum backdraft dampers at the fan inlet, unless otherwise specified.

D. Curb

1. Each fan shall be installed on a prefabricated mounting curb or fans shall be installed on the roof curb as shown on the Drawings.
2. The prefabricated mounting curb outer shell shall be formed with an integral cant strip and mounting flange. The corners shall be mitered and welded continuously to form a one piece leak-proof shell. The bottom of the curb shall have a baseplate which encloses the lower edge of the roof insulation. A damper holding tray shall be provided. Wooden nailing strips shall be bolted to the top of the curb shell to provide means for easily attaching the flashing material to the curb.
3. The fan mounting curb flange shall match the roof curb dimensions. Fan curb shall be as shown on the Drawings.

2.04 ACCESSORIES:

- A. All fans shall be provided with 1/2-inch aluminum bird screens.
- B. Provide OSHA fan inlet guard on unducted units

2.05 FINISHES:

- A. Phenolic based corrosion resistant coating: 3-mil dry thickness, air-dried coating, factory applied. Provide factory certification of application.

2.06 SOURCE QUALITY CONTROL

- A. Factory Test: Each fan shall be tested by the fan manufacturer prior to shipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install each fan as specified and in accordance with the manufacturer's recommendations.
- B. Certify installation and initial operation using Form 43 05 01-A.
- C. Field verify the roof curb dimension for the fan manufacturer.
- D. If roof insulation is damaged during fan installation, repair any damage to the roof insulation to match the existing roof insulation.

3.02 FIELD TESTING

- A. Perform a complete field test of each fan in accordance with Section 23 05 93 to guarantee compliance with this Section's requirements.

END OF SECTION

SECTION 23 37 13

CEILING DIFFUSERS, GRILLES, AND REGISTERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies ceiling diffusers, grilles, and registers for air distribution in the heating, air conditioning, and ventilating systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
SMACNA	HVAC Duct Construction Standards Metal and Flexible

1.03 TYPE

- A. All diffusers, grilles, and registers shall be designated as shown in the following table. The designation, size, and capacity shall be as indicated on the Drawings.

Item	Designation
Surface Mounted Ceiling Exhaust Register	CER-1
Lay-In Ceiling Exhaust Register	CER-2
Lay-In Ceiling Supply Diffuser	CSD-1
Surface Mounted Ceiling Supply Diffuser	CSD-2
Wall Exhaust Register	WER-1
Wall Supply Register	WSR-1
Wall Supply Register	WSR-2
Wall Supply Register	WSR-3

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. An 8½-inch by 11-inch manual with detail sheets or catalog data for diffusers, grilles, and registers.
 2. Manufacturer's catalog and or other data confirming conformance to specified design, material and equipment requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
1. Agitair.
 2. Carnes.
 3. Krueger.
 4. Titus.

5. Approved Equal.

2.02 MATERIALS

- A. Unless otherwise indicated, the diffusers, grilles, and registers shall be constructed of the same material as the ductwork in which they are installed.

2.03 WALL SUPPLY REGISTERS (WSR)

- A. Industrial Registers (WSR-1):
 1. Wall supply registers shall be the industrial, double deflection type with vertical front, and horizontal rear deflection blades.
 2. Blades shall be extruded aluminum with airfoil or streamlined cross section, spaced at 1-1/2-inches on center, and shall be manually and individually adjustable.
 3. Frames shall have a 1-1/4-inch border and shall be aluminum.
 4. Sponge rubber gaskets shall be provided on all register frames flush mounted to ductwork or building surfaces.
 5. Register sizes shall be as specified on the Drawings.
 6. Registers shall be Krueger 56880 series, Metal-Aire series 4100, or approved equal.
- B. Drum Louvers (WSR-2):
 1. Wall supply registers shall be drum louvers with vertical deflection blades and rotating drum.
 2. Drum louver blades, drum and frame shall be aluminum.
 3. Deflection blades shall be adjustable direction type, hinged at the rear.
 4. Drums shall be throw angle adjustable to 30 degrees above centerline and to 30 degrees below centerline of the supply air stream.
 5. Frames shall have a 1-1/4-inch border.
 6. Register sizes shall be as specified on the Drawings.
 7. Drum louvers shall be Krueger series DPL, Titus Model DL, Metal-Aire model RL, or approved equal.
- C. Standard Registers (WSR-3):
 1. Wall supply register shall be double deflection type with horizontal front and vertical rear blades.
 2. Blade shall be airfoil design spaced on .66-inch centers and adjustable.
 3. Frames shall have 1-1/4-inch borders.
 4. Sponge rubber gaskets shall be provided on all register frames flush mounted to ductwork or building surfaces.
 5. Opposed blade dampers shall be provided on all registers.
 6. Entire register and damper shall be constructed of aluminum.
 7. A brushed aluminum finish shall be provided.
 8. Registers shall be Metal-Aire, series 4000H; Krueger, series 5880H; Titus; or approved equal.

2.04 WALL EXHAUST REGISTERS (WER)

- A. The registers shall be the industrial, single deflection type.
- B. The blades shall be adjustable, set in the vertical position, and set at 45 degrees.
- C. Blades shall have an airfoil or streamlined cross section and shall be spaced at 1-1/2-inches on center.
- D. The frame shall have a 1-1/4-inch border.
- E. When attached to a galvanized steel, aluminum duct, or FRP pipe, the register shall be constructed of extruded aluminum and have an anodized finish. When attached to a stainless steel duct, the register shall be constructed of type 316 stainless steel.

- F. Sponge rubber gaskets shall be provided on all register frames flush mounted to ductwork or building surfaces.
- G. Register sizes shall be as specified on the Drawings.
- H. Registers shall be Krueger 56880 series, Metal-Aire series 4100, or approved equal.

2.05 FIXED BLADE CEILING DIFFUSERS (CSD)

- A. Ceiling diffuser shall be the square, fixed blade type.
 - 1. Diffusers provided in lay-in ceilings (CSD-1) shall have 24-inch by 24-inch frames and neck sizes as specified on the Drawings.
 - 2. Diffusers provided in plaster ceilings (CSD-2) shall have either 24-inch by 24-inch, or 12-inch by 12-inch frame sizes, surface mounted, with neck sizes as specified on the Drawings.
- B. The vanes shall have a four-way throw pattern unless otherwise specified.
- C. The diffuser shall be constructed of aluminum and shall have a white enamel finish.
- D. Ceiling diffusers shall be Krueger series "SH", Titus model TDC-AA, Metal-Aire series 5000, or approved equal.

2.06 CEILING EXHAUST REGISTERS (CER) / CEILING RETURN REGISTERS (CRR)

- A. Ceiling return and ceiling exhaust registers shall be square pattern, frame mounted, egg crate type core.
- B. Core and frame shall be aluminum with white enamel finish.
- C. Core shall have 1/2-inch square by 1/2-inch deep core openings.
- D. Registers provided in lay-in ceilings shall have 24-inch by 24-inch frames. Registers provided in plaster ceilings shall have 12-inch by 12-inch surface mounted frames.
- E. All neck sizes shall be as specified on the Drawings.
- F. Registers shall be Krueger series EGC-5, Titus model 50 F, Metal-Aire model CC5, or approved equal.

2.07 WALL RETURN GRILLES (WRG-1)

- A. Wall return grilles shall be heavy duty type with fixed blades curved to 45 degrees, set in horizontal position and vision proof.
- B. Deflection vanes shall be set on 1.33-inch centers.
- C. Grilles shall be constructed of 0.81-inch thickness of extruded aluminum.
- D. Frames shall have a 1-5/8-inch wide border.
- E. Anodized aluminum finish shall be provided.
- F. Grilles shall be Metal-Aire series HD RH; Krueger; Titus; or approved equal.

2.08 ACCESSORIES

- A. All ceiling diffusers and all registers shall be equipped with an opposed blade volume damper.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Align, connect and install diffusers, grilles, registers and extractors in accordance with the manufacturer's recommendations and with SMACNA.
- B. Coordinate ceiling diffuser, register, and grille layout with lighting fixtures.
- C. Each unit shall be set flat against the room surface finish and shall have a felt gasket or seal.
- D. Paint visible ductwork behind register and grill flat back. Touch up marks and abrasions to match original finish.

3.02 TESTING AND BALANCING

- A. Perform testing, adjusting, and balancing per Section 23 05 93.

END OF SECTION

SECTION 23 37 23

HVAC GRAVITY VENTILATORS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies roof-mounted gravity-relief or intake ventilators, complete with bird screens, curbs, and accessories required for installation. Gravity ventilators shall be circular low silhouette units.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
North Battery Room Intake Hood	704-ME25BR011
South Battery Room Intake Hood	704-ME25BR021

1.02 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AMCA 511	Certified Ratings Program Product Rating Manual for Air Control Devices

1.03 PERFORMANCE REQUIREMENTS

- A. General: Gravity ventilator shall be suitable for either intake or relief duty as scheduled.
- B. Operating Requirements: Refer to schedules on the Drawings.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00
- B. Provide the following submittals:
1. A complete description of the ventilators and accessories sufficient to demonstrate compliance with these Specifications, including performance data at given conditions.

1.05 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Refer to the architectural code summary sheets and the Electrical Plan sheets.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturers:
1. Greenheck Model GRS
 2. Cook Model PR
 3. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Louvers	Aluminum
Covers	Aluminum
Bird screens	Aluminum or stainless steel
Fasteners	Stainless steel

2.03 CONSTRUCTION

- A. Ventilators: Gravity ventilators shall be factory-made and shipped to the job site in preassembled sections including covers, curbs, and screens and all required fasteners.
- B. Performance: As scheduled on the Drawings.
1. Certify performance in accordance with AMCA 511.
- C. Prefabricated curbs:
1. Each unit shall be provided with a prefabricated mounting curb as shown on the Drawings. The outer shell of the curb shall be formed with an integral cant strip and mounting flange. The corners shall be mitered and welded continuously to form a 1-piece leakproof shell. The bottom of the curb shall have a baseplate which encloses the lower edge of the roof insulation.
 2. Wooden nailing strips shall be bolted to the top of the curb shell to provide means for easily attaching the flashing material to the curb.
- D. Dampers: Each unit shall be provided with a damper of the type specified.
- E. Screens: Provide each gravity ventilator with ½-inch aluminum bird screens.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install each ventilator and curb as shown on the Contract Drawings and in accordance with manufacturer's recommendations.

3.02 TESTING

- A. Test each gravity ventilator in accordance with Section 01 75 20.

END OF SECTION

SECTION 23 41 13
VENTILATION AIR FILTERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies air filters and accessories.

1.02 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASHRAE	Methods for Testing Air Cleaning Devices Used in General Ventilation
Standard 52	Removing Particulate Matter
UL 900	Safety Test Performance of Air Filter Units

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Shop drawings.
 2. Equipment data.
 3. UL Class 2 listing for filters.

1.04 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers – Air filters:
1. Farr Company.
 2. Airguard Industries, Inc.
 3. American Air Filter.
 4. Approved Equal.
- B. Acceptable manufacturers – Air filter gages:
1. Dwyer Instruments, Inc., Model 40.
 2. Branom Instrument Company.
 3. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.

- B. Filters:
 - 1. Filter media: reinforced non-woven cotton fabric.
 - 2. Enclosing frame: high wet strength beverage board.
 - 3. Media support grid: aluminum or stainless steel.
- C. Holding frames:
 - 1. 16-gage stainless steel, or aluminum.
 - 2. Stainless steel holding frames in RTP enclosures or at RTP ducts.
- D. Enclosures: Same material as connecting ducts.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Filter type: 2-inch, medium efficiency, pleated throwaway type.
- B. Sizes and capacities: as shown on the Drawings and as required for makeup air unit and air handling unit.
- C. Filter Minimum Efficiency Reporting Value (MERV) per ASHRAE Standard 52:
 - 1. All spaces: MERV 8.
- D. Initial resistance: not to exceed a 0.28-inch water column at an air approach velocity of 500 feet per minute.
- E. Air filter gages in locations shown on HVAC schematics.

2.04 FABRICATION AND MANUFACTURE

- A. Filters:
 - 1. Effective filter media for 2-inch thick filter: Not less and 4.5 square feet media per 1 square foot of filter face area, containing not less than 15 pleats per linear foot.
 - 2. Media support: Open area not less than 96%, bonded to media.
 - 3. Filter pack bonded to enclosing frame.
 - 4. UL Class 2 listing.
 - 5. Assemble large filters from multiple standard filter units.
- B. Holding frames:
 - 1. Individual holding frames may be riveted or bolted together to form a frame of the desired size.
 - 2. Pressure clamp each filter to a holding frame with removable fasteners so that the filter can be removed and replaced without disturbing adjoining filters and frames.
 - 3. Attach a knife edge seal or sealing gasket to the holding frame for airtight operation.
 - 4. Provide airtight frame to duct connection.
- C. Enclosures:
 - 1. Side access cabinet assembly with gasketed access door and filter holding frame.
 - 2. Positive sealing to prevent filter bypass.
 - 3. Flanged, gasketed connections to ducts.
 - 4. Factory fabricated and assembled.
- D. Air filter gages:
 - 1. One-piece molded plastic construction.
 - 2. Manometer type with zero adjustment.
 - 3. Epoxy coated aluminum scale.
 - 4. Inclined indicating tube.
 - 5. Built-in spirit level.
 - 6. Red and green signal flags to indicate dirty and clean filter.

7. Complete with plastic tubing, fluid and rapid shut-off connectors.
8. Ranges:
 - a. 0.10-1.00-inch W.C. for filter gages at all locations indicated on HVAC schematics.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with manufacturer's recommendations.
- B. Do not operate equipment during construction without filters.

3.02 TESTING

- A. Field-test filters and gages in conjunction with the testing of their respective air handling units and fans.

END OF SECTION

SECTION 23 52 39.16

STEEL FIRE TUBE BOILERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies hot water boilers for heating systems as scheduled on Contract Drawings.
- B. The general requirements equipment, as specified in Section 43 05 01, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Boiler 1, (400 BHP)	705-BO19FB011
Boiler 2, (100 BHP)	705-BO19FB021
Boiler 3, (400 BHP)	705-BO19FB031
Boiler 4, (100 BHP)	705-BO19FB041

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME	Boiler and Pressure Vessel Code, Section IV
ASME CSD-1	Code for Controls and Safety Devices for Automatically Fired Boilers
ANSI Z21.10.3/CSA 4.3	Gas-fired Water Heaters
ANSI Z21.13/CSA 4.9	Gas-fired Low Pressure Steam and Hot Water Boilers
CSA CAN1-3.1	Industrial and Commercial Gas-fired Packaged Boilers
NFPA 85-2001	Boiler and Combustion Systems Hazards Code
UL 795	Standard for Safety Commercial-Industrial Gas Heating Equipment
SDCI	Seattle Boiler and Pressure Vessel Code

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Unit(s) shall be digester gas/propane gas packaged boiler(s) consisting of a boiler, boiler fittings, burner equipment, forced draft fan, safety; controls and accessories; completely piped, wired and assembled on a steel base.
 - 2. Boilers are located indoors in a room that is unclassified. All panels, fittings and hardware shall be a minimum NEMA 4X Stainless steel.
 - 3. Boilers are hot water and piped primary-secondary. Boilers 2 and 4 each have a 3-way mixing valve and boiler circulation pump, and Boilers 1 and 3 each have two linked 2-way mixing valves and boiler circulation pump. Site elevation is 100 feet above mean sea level next to salt water. Minimum flue temperatures of all boilers are 220 F at low fire; at full fire, Boilers 1 and 3 must reach a minimum flue temperature of 300 F, and Boilers 2 and 4 must reach a minimum flue temperature of 315 F. Power is 460V/3 Phase/60 Hz.

4. Digester Gas has the following approximate properties:
 - a. Pressure will be supplied at inlet of gas train at minimum of 2.0 psi.
 - b. Methane 55 -70% by volume.
 - c. Carbon Dioxide: 30 - 45% by volume.
 - d. Inerts: Balance.
 - e. Lower Heating Value: 540 BTU/ cu-ft.
 - f. H2S Content: Less than 200 ppmv.
 - g. Siloxane: Less than 100 ppbv.
 - h. Moisture Content: Less than 2%.
5. Burners shall be capable of running on digester gas with propane gas as backup without needing physical changes to the burner.

B. Performance Requirements:

1. Unit(s) shall operate to meet the air pollution control district low NOx requirements.
 - a. Boilers at 100 boiler horsepower (BHP): Maximum 30 PPM NOx.
 - b. Boilers at 400 BHP: Maximum 30 PPM NOx.
 - c. Boiler emissions is the priority over boiler efficiency. No minimum efficiency.

C. System Operation: Local boiler control panel and remote monitoring and switching.

1. The following I/O signals shall be provided at the boiler:
 - a. Boiler Firing Rate Output.
 - b. Boiler Hot Water On.
 - c. Boiler Hot Water Call to Run.
 - d. Boiler Hot Water in Remote.
 - e. Boiler Hot Water Fail.
 - f. Boiler Hot Water MSG Feed Open.
 - g. Boiler Hot Water Propane Feed Open.
 - h. Boiler Hot Water Circulation Pump Demand.
 - i. Boiler Auto Fuel Select.
 - j. Boiler Digester Gas Fuel Select.
 - k. Monitor package boiler system status.

D. Boiler Combustion air information:

1. Each room is fitted high and low louvers directly to outside.
2. Due to ventilation requirements the rooms also get fans bringing in air at 6 ACH.

1.04 SUBMITTALS

A. Procedure: 01 33 00.

B. Provide the following submittals:

1. Shop drawings:
 - a. Dimensional drawings of boilers, burner, piping, access ladders, railings and platforms, installation details, and weights of all major components.
 - b. Wiring diagrams.
 - c. Component lists.
2. O&M manual: 01 78 23.
3. Installation certification: Form 43 05 01-A.
4. Training certification: Form 43 05 01-B.
5. Bill of Materials, including Form 01 78 45-A.
6. Structural design drawings and calculations of the access platforms, ladders, and railings.
7. Native file and PDF version of software configuration.
8. Available BACNet and Modbus TCP data registers to allow mapping for external network monitoring.
9. Complete control description including process and instrumentation diagrams for hot water boiler package system.

1.05 QUALITY ASSURANCE

- A. Vibration and critical speeds: Section 43 05 50.
- B. Fabricate and label boilers to meet the requirements of ASME Boiler and Pressure Vessel Code, Section IV. Boiler/water heater shall bear the ASME "H" stamp and be National Board listed for 160 psi working pressure and 210 Degrees F.
- C. Boilers with an input rating above 12 BHP (117 kW) and less than 373 BHP (3,660 kW) shall meet requirements of ASME CSD-1; and boilers with an input of 373 BHP (3,660 kW) or greater shall meet requirements of NFPA 85-2001, Boiler and Combustion Systems Hazards Code.
- D. Construct boilers in accordance with the ASME Code for 30 psi water and supplied with the ASME label.
- E. Boilers shall be provided with National Board Inspection. Report signed by an N.B. Inspector and furnished with and N.B. number prior to shipment.
- F. Boiler shall be tested and rated in accordance with the American Boiler Manufacturers Association (ABMA) and bear the ABMA emblem.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Section 26 05 00: Unclassified.

1.08 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.
- B. Each boiler pressure vessel shall be warranted against damage resulting from thermal stress for a period of 20 years from the date of shipment, provided the boiler is operated and maintained in accordance with the conditions specified in the owner's Operating and Maintenance Manual.
- C. The boilers shall be warranted to meet all the emission requirements, as required by PSCAA.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Cleaver Brooks.
 - 2. Johnson Hurst.
 - 3. Burnham Corporation.
 - 4. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.

B. Materials of construction:

Component	Material
Access ladders, platforms, and railings	Galvanized steel per Section 05 50 00
Control panels and boxes	Stainless steel
Digester gas train	Stainless steel
Propane gas train	Steel
Pipe Connections	150# steel flanges
Pressure Vessel	Steel ASME rated and certified
Outer Jacket, shell	Sheet metal sectional lagging over 2 inch blanket insulation
Skids and lifting eyes	Heavy Steel Framed
Doors and Seals	Steel doors with fiberglass gaskets fastened by screws that thread into replaceable brass nuts

2.03 EQUIPMENT FEATURES AND COMPONENTS

A. Hot water boilers:

1. The boiler shall be built to comply with the following insurance and codes: Factory Mutual and Industrial Risk Insurance.
2. Boiler pressure vessel shall be constructed in accordance with ASME boiler code. Each boiler must receive authorized boiler inspection prior to shipment. Inspection report shall be furnished to the purchaser. And high quality copies transmitted to the county.
3. Fire tubes easy to remove and replace without welding the tube attachment.
4. Constructed as gas-tight for pressure firing.
5. Entire boiler must be skid mounted on steel skids.
6. Access door for maintenance rear, top or both.
7. Flame observation port, minimum 1 in front.
8. Steel lifting points, for hoisting boiler off truck or into place.
9. Flue gas temperature gauge, readable from the floor, 200 to 1,000 degrees F.
10. Safety relief valves; to comply with ASME code for full burner input.
11. Gas-tight hinged front flue doors.
12. Gas-tight rear smoke boxes with side cleanout opening.
13. Field installation of industrial combustion burner.
14. Operating and high limit switches.
15. Modulating burner controls.
16. Float type, Low Water Cut-Off and Auxiliary Low Water Cut-Off. Wired to the burner control circuit to prevent operation if the boiler falls below a safe level.
17. Water relief valves (shipped loose) shall be of a type and size to comply with ASME Code requirements.
18. Temperature supply water and return water gauges readable from the floor.
19. Pressure gauge readable from the floor.
20. Required for Boilers 2 and 4 only due to common stack: An automatic modulating damper installed on each boiler for overfire draft protection controlled by boiler controller. Includes feedback to controller for position of damper.
21. Coordinate the control functions with Ovation DCS I/O points as indicated on P&IDs, and within the DCS control strategies described in Section 40 65 09. Plant-wide controller calls for boiler heating demand. The boiler start/stop, boiler firing rate, fuel selection, hot water mixing valve position, and boiler circulation pump operation, are operator-adjustable through the existing Ovation DCS system. Hot water boiler control system shall be replaced functionally in-kind to existing control system.

B. Burner:

1. Field installed pilot propane gas train shall include ignition transformer, electric gas valve, full lock-up regulator, test tapping, and shut-off valve.
2. Integral forced draft burner and burner controls, part of complete package approved as a unit by Underwriters Laboratories and shall bear the UL/ULC label.
3. Boiler burner shall be built to comply with the following insurance and codes: Factory Mutual and Industrial Risk Insurance.
4. The burner shall be equipped with suitable fuel and air controls to assure smooth main flame ignition. The burner shall utilize a proportional air flow damper design, including independent low-fire and high-fire air flow shutter assemblies for ease of adjustment and consistent excess air performance throughout the firing range.
5. Fuel-air control shall be synchronized. The fuel air drive unit shall be provided with a position indicating switch interlock with the flame safeguard system to assure starting at the low fire position. The flame guard system shall further program this drive unit to provide a full open louver of sufficient time to provide a four air change pre-ignition of the combustion chamber, heat exchanger, and flue passages.
6. Pre-ignition pure air flow rate, interlocks must be provided to monitor and prove 60% air flow purge when air inlet louvers are automatically opened to obtain this rate.
7. Electronic safety combustion controls shall be supplied, complete with ultra-violet flame scanner to monitor the pilot and main flame. It shall be so utilized as to provide intermittent type gas-electric ignition and pre-ignition timer. Flame rod is not permitted for proving pilot or main flame.
8. Combustion air from within the boiler room. Not piped to the boiler from outside. All combustion air shall be furnished by the burner fan, which shall be an integral part of the burner.
9. Burner Controls: Are 120 VAC, 1 phase, 60 Hz.
 - a. The full modulation of the burner shall be controlled by water temperature by means of a temperature control.
 - b. An additional high limit safety temperature control of the manual reset type shall be provided to control the burner.
 - c. Pre-and post- operation of the burner fan shall be provided per UL requirements.
 - d. The burner shall have a flame guard type flame safe programmer, incorporating indicator lights to annunciate the current operating status of the burner.
 - e. A manual restart of the burner shall be necessary in the event of shutdown due to flame failure.
 - f. Burner blower three phase motors shall be controlled and protected by an automatic starter with thermal overload protection. The starter shall be inter-locked to prevent burner operation when overload relays are tripped out.
 - g. Supply a burner-mounted diaphragm air flow switch to prevent energizing the main fuel valves in the event of insufficient combustion air, or to provide safety shutdown in the event of combustion air interruption.
 - h. A factory-wired control cabinet shall be supplied and mounted on the burner. The control cabinet shall house the safe controller, the programming timer, burner motor starter, fuses, control circuit transformer, control switches, indicator lamps, and relays as required.
 - i. Provide indicator lights at a minimum:
 - 1) Call for Heat.
 - 2) Main Fuel Valve "ON" or "OPEN".
 - 3) Low Water Level.
 - 4) Main Flame Failure.
 - j. Provide BACnet and Modbus TCP protocol communication for integration into Ovation DCS system.

C. Boiler stack:

1. Boiler breechings and boiler stack: See Section 42 11 40.

D. Boiler base:

1. Coordinate equipment pad size with boiler base skid size. Slab to extend 12 inches beyond boiler base on all sides. Boiler skid must be part of the boiler and be a heavy steel frame.

E. Connections:

1. Insulated hot water supply and return piping connections shall be as shown in Drawings and specified in Section 40 05 01. Assume hot water supply and return temperature is 210 F.
2. Gas piping shall be as shown in Drawings and specified in Section 40 05 01.

F. Power:

1. Provide connection to 460 VAC 3 phase 60 hertz power source for each boiler with connections to burner sequence controller panel:
 - a. Wiring shall be per Section 26 05 33.
 - b. Provide starters relays, transformers, and equipment for complete boiler/burner operation.
2. Emergency shutdown to be provided per AMSE CSD-1 with the added provisions:
 - a. Manually operated emergency shutoff switches are shown on the boiler plan sheets. These switches are marked for easy identification. Boiler 1 and 3 are now in the same room and the emergency boiler shutoff switch will be upgraded to a two pole type such that each boiler is shutoff when pushing the switch. Boiler 2 existing emergency switches must be upgraded to two pole type such that one pole serves boiler 2 and the other pole serves boiler 4. Each emergency switch will be approved by owner.
 - b. Each emergency switch must be tied in and powered by the burner and be set up to shut down all fuel systems supplying the burner.
 - c. Wiring shall be line voltage.
 - d. Alarms:
 - 1) Emergency Manual shut-down of any boiler shall cause alarm. Alarm shall be a bell mounted in the boiler room with reset switch.
 - 2) Coordinate the control functions with DCS I/O points as shown on P&IDs.

G. Access Ladder, Platform and Railing:

1. Platform, access ladder and railings: meets WISHA standards, WAC 296-24 and all subsections.
2. Access ladder: alternating tread stair which meets WISHA, WAC 296-24-740 and WAC 296-24-76555.
 - a. Locate access ladder and platform supports to avoid obstructing egress.
 - b. Locate access ladder and platform supports to avoid obstructing portions of equipment or piping that require access for cleaning and maintenance.
3. Handrail, stair rail and guardrail: meets WISHA standards, WAC 296-24-74015, WAC 296-24-750.
4. Located platform to serve each boiler and provide access for routine maintenance.
5. The access platform and any associated equipment, nonstructural elements, components, and elements permanently attached to any portion of the these, shall be anchored and braced to resist seismic forces in accordance with Section 01 73 00.
6. Platform, railing and ladder shall be designed to allow access to all regular maintenance points without removing platform frame, railing, or access ladder.
7. Platform width, minimum: 24 inches.

H. Plant-Wide Heating Loop Control Strategy: Refer to Section 40 65 09 for hot water boiler control narrative.

2.04 FINISHES

- A. Boiler shall be primed and painted with manufacturer's recommended product rated for boiler surface temperature.
- B. Finishes of all components ancillary to the boiler that are normally painted, shall be per Section 09 90 00.

2.05 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Units shall be tested in accordance to UL 795, CAN 1-3.1, ANSI Z21.13/CSA 4.9, and ANSI Z21.10.3/CSA 4.3.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions for compliance with requirements for installation tolerances and other conditions affecting boiler/water heater performance prior to installation.

3.02 INSTALLATION

- A. Installation of the boilers shall be in strict accordance with the boiler manufacturer's published recommendations.
- B. Install equipment in the locations shown and in accordance with the provisions of Section 43 05 60 Equipment Support Grouting.
- C. Alignment: Section 43 05 61 Machine alignment.
- D. Burner shall be field installed and attached to boiler by a factory certified technician.
- E. Proper installation and testing of the Emergency boiler stop is the responsibility of the boiler installer.
- F. Upon completion of the installation, each piece of equipment and each system shall be tested for satisfactory operation.
- G. Note on loose equipment: Equipment specified in this Section that comes partially assembled or with loose equipment parts shall be installed in accordance with boiler manufacturer recommendations.

3.03 FIELD QUALITY CONTROL

- A. Field Testing: 01 75 20.
- B. Services of the Manufacturer. Inspection, Startup, and Field Adjustment: An authorized service representative of the unit manufacturer shall visit the site to witness the following and to certify in writing that the equipment and controls are properly installed, adjusted and readied for operation:
 - 1. Installation of equipment.
 - 2. Inspection, checking and adjusting the equipment.
 - 3. Startup and field testing for proper operation.
 - 4. Performing field adjustments to ensure the installation and operation comply with the indicated requirements.
 - 5. Provide written certification that the equipment has been properly installed, inspected and adjusted and in proper working order.
- C. A factory trained representative of the burner manufacturer shall conduct a combustion test on both digester gas and propane gas. The fuel input rate shall be field adjusted to digester gas and propane. The equipment shall be adjusted to provide emissions as required by the Puget Sound Clean Air Agency (PSCAA).
- D. Full boiler demonstration to Seattle Boiler Code Inspector for safety and controls shall be the responsibility of the installing contractor.
- E. Hydrostatically test assembled boiler and piping, according to applicable sections of the ASME Boiler and Pressure Vessel Code.

3.04 CLEANING

- A. General requirements:

1. Follow MPS water treatment consultant's directions regarding boiler cleaning procedures.
2. For cleaning of the system and boiler boil-out requirements, refer to Section 23 25 00.
3. Contractor must isolate boiler/water heater when any cleaning or testing of system piping is being performed.

3.05 MANUFACTURER SERVICES

- A. Two visits from the unit manufacturer to the Plant 60 days prior to installation of boilers shall be scheduled. Intent of the meetings is to confirm communication with the existing control system to new local boiler controllers.
- B. Factory authorized service representative to do the field assembly of components and installation of burners, including piping, electrical connects, and start-up.
- C. Training
 1. Procedures: Section 01 79 00.
 2. Provide a minimum of 8 hours per training.

END OF SECTION

SECTION 23 75 00
CUSTOM AIR HANDLING UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies custom air handling units.
- B. The general requirements equipment, as specified in Section 43 05 01, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-CONTROL ROOM AIR HANDLER	704-AHU25AD011
RSP-CRANE HALL SUPPLY AIR HANDLER	704-AHU25AD012
RSP-CRANE HALL EXHAUST AIR HANDLER	704-AHU25BS011
RSP-SCREEN ROOM AIR HANDLER	704-AHU25AD013
RSP-GALLERY AIR HANDLER	704-AHU25BM011

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AMCA 204	Balance Quality and Vibration Levels for Fans
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	HVAC Applications Handbook
NEMA 250	Enclosures for Electrical Equipment
NFPA 70	National Electric Code
UL 507	Standard for Electric Fans

- B. Miscellaneous:
 - 1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
 - 2. Corrosion protection of equipment to be as specified herein.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Shop Drawings:
 - a. Fabrication and layout drawings.
 - 2. Product technical data including:

- a. Acknowledgement that products submitted meet requirements of standards referenced.
- b. Manufacturer's installation instructions.
- c. Wiring diagrams.
- d. Control diagrams.
- e. Manufacturer's catalog cuts and technical data.
- f. Corrosion-protection information.
- g. Fan curves.
- h. Sound data.
- i. Vibration isolation details.
- j. Control description.
- k. Performance data on all equipment.
- 3. O&M manual: Section 01 78 23.
- 4. Installation certification: Form 43 05 01-A.
- 5. Training certification: Form 43 05 01-B.
- 6. Bill of Materials, including Form 01 78 45-A.

1.04 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Reference Architectural Code Summary sheets and the Electrical Plan sheets.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Vibration isolation assemblies:
 - a. Mason.
 - b. Vibration Mounting and Controls Co.
 - c. Vibro-Acoustics.
 - d. Approved Equal.
 - 2. Corrosion-protective coatings:
 - a. Heresite and Chemical Co.; "Heresite".
 - b. Aero-Marine Engineering, Inc.
 - c. Luvata ElectroFin.
 - d. Approved Equal.
 - 3. Custom air handling units:
 - a. Scott Springfield Mfg.
 - b. Huntair / Nortek.
 - c. Haakon.
 - d. Approved Equal.

2.02 MATERIALS

- A. All manufactured units shall be constructed with corrosion-resistant materials and have corrosion-resistant coating:
 - 1. Type:
 - a. Corrosion-resistant materials:
 - 1) Aluminum.
 - 2) Stainless steel.
 - 3) FRP.
 - b. Corrosion-resistant coating:
 - 1) Phenolic-based coating:
 - a) 3 MIL minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 degrees F.

- b) 5 MIL baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 degrees F.
- c) Factory applied.
- d) Provide factory certification of application.

2.03 EQUIPMENT FEATURES AND COMPONENTS

A. All Manufactured Units:

- 1. Comply with Section 43 05 01.
- 2. Factory wired and assembled.
- 3. Use fasteners made of same material as unit.
- 4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
 - a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.

B. Equipment Coils:

- 1. Cooling coils and refrigerant heat recovery coils - direct expansion:
 - a. ARI certified.
 - b. Material:
 - 1) Copper with aluminum fins.
 - c. Fin spacing: Minimum 80 fins per foot.
 - d. Minimum standard operating limit: 250 psi.
 - e. Size and capacity as scheduled.
- 2. Heating coils - water:
 - a. ARI certified.
 - b. Material:
 - 1) Aluminum.
 - c. Fin spacing: Minimum 80 fins per foot.
 - d. Minimum standard operating limit: 200 psi.
 - e. Equip with vent, drain and condensate connections.
 - f. Size and capacity as scheduled in the Drawings.

C. Energy Recovery Units – Heat pipe type:

- 1. Operating temperature range: -50 to +180 degrees F.
- 2. Materials:
 - a. Heat pipes: 0.5 inch diameter seamless internally rifled copper.
 - b. Fins: 0.006 inch thick aluminum
 - c. Casing: 16 gauge galvanized.
 - d. Fluid: ASHRAE safety group A1 refrigerant.
- 3. Casing:
 - a. Gasketed and bolted access cover.
 - b. Integral connections to match air handler .
- 4. Accessories:
 - a. Corrosion-resistant coating.
 - b. Bypass plenum with bypass dampers.
 - 1) Modulating motor.
 - c. Stainless steel insulated drip pan.
- 5. Performance and capacity as scheduled in the Drawings.

D. Custom Air Handling Units:

- 1. ARI certified.
- 2. UL listed.
- 3. Unit Construction:
 - a. Base:
 - 1) Welded structural aluminum channel with removable lifting lugs.
 - b. Unit floor:
 - 1) Air handling unit floor:
 - a) 3/16-inch aluminum checker plate fully welded with integral water dam.

- b) The manufacturer shall provide a 1.5 inch perimeter collar around the entire unit and around each floor opening to ensure the unit is internally watertight. The entire base shall act as an auxiliary drain pan and hold up to 1.5 inches of water. Collar shall be continuously welded; caulk shall not be an acceptable means of providing a watertight floor.
- c) Drive screw attachment is not acceptable.
- d) Floor construction: Double wall and constructed to meet L/240 deflection based upon 300 pound concentrated load at mid-span.
- e) For adequate support, provide a base structural member centered under edges of each sheet of flooring material:
- f) Seal floor seams with a continuous weld to create watertight floor.
 - (1) Base supports above floor are not acceptable due to hazards to service personnel.
- g) Overlap floor on perimeter base channel to allow a means of attaching cabinet panels from exterior without penetrating structural steel.
- h) Lay floor flat and flush with top surface of base channel.
- c. Unit housing:
 - 1) Wall construction:
 - a) Double wall, 2 inch thick insulated, panelized construction such that all internal components can be easily accessed for service or removal without removal or disassembly of any exterior wall sections or panels or roof sections or panels.
 - b) All panel seams shall be sealed during assembly to produce an airtight unit. No gaps shall be present where panels are attached to each other or to the supporting structure.
 - c) Material:
 - (1) Aluminum or stainless steel:
 - (a) Minimum 14 gauge.
 - d) Deflection: L/240 at static pressure equivalent to Unit Construction Pressure Class.
 - 2) Outdoor air handling units:
 - a) The air handling unit shall be specifically designed for outdoor application.
 - b) Roof curb:
 - (1) Prefabricated, 0.125 inch aluminum mounting curb designed and manufactured by unit manufacturer for exterior units only:
 - (a) Verify field conditions prior to unit shipment.
 - (b) Complete perimeter support of unit.
 - (c) Minimum 16 inches high.
 - (d) Nominal 2 x 4 inch wood nailer strip.
 - (e) Provide gasketing for field mounting between unit base and curb.
 - c) Roof panels: Sloped or bowed roof with a minimum of 1/4 inch per foot slope to ensure rain runoff:
 - (1) Provide a rain lip or gutter around perimeter of roof to prevent water from running downside of unit. Provide rain lip above doors and intake louvers.
 - 3) Supply and return openings:
 - a) For supply air, provide openings with rectangular, round, or oval wide radiused, bellmouth fittings and duct collars to accept supply and return air connections as indicated.
 - b) Provide removable G90 galvanized steel grating over floor openings inside of air handling unit:
 - (1) Weight support: Capable of supporting 300 pounds.
 - (2) To avoid tripping hazard, grating shall be flush with the finished floor of the unit.
 - 4) Unit split modules:
 - a) Provide necessary hardware to reassemble equipment such as bolts, nuts, washers, sealant, and slip cleats.
 - b) Mark each corresponding module of cabinet with matching letters to assist in reassembly.
 - c) Shipping split shall be welded to the floor. No screw penetrations are acceptable through the floor.
 - 5) View windows: provided in access doors.
 - a) View window frame: Fabricated from aluminum or stainless steel.
 - b) Provide 3/4 IN thick thermopane wire glass window.

- c) Seal window frame to cabinet with open cell gasket on sides to ensure an airtight seal.
- d) Window open viewing size: 12 inch x 12 inch.
- d. Unit Insulation:
 - 1) Air handling unit insulation - general:
 - a) Meet NFPA-90A smoke and flame spread requirements.
 - b) Provide insulation materials with facings that will not promote microbial growth.
 - c) R-value of wall, roof, and floor assemblies: minimum of R-12.
 - d) Type: Foam.
- e. Unit Liners:
 - 1) Liners - general:
 - a) As a protective cover for insulation, provide liners on the interior of the air handling unit integral parts of the exterior panel system.
 - b) Consolidate internal reinforcing as well as interior lining surface together. Interior should be smooth; no gaps present:
 - (1) Allow attachment of interior liner to cabinet without exposing any drive screws or bolts which can be hazardous to service personnel.
 - (2) Provide a smooth, uninterrupted surface. No gaps in the wall are allowed.
 - (3) Exposed reinforcing is unacceptable due to impedance of air performance.
 - (4) Provide for full wash down liner for ease of service.
 - 2) Solid liner:
 - a) Liner material: Minimum 22 gauge aluminum, except where specifically indicated otherwise.
 - b) Do not allow exposure of any insulation to air stream.
 - c) Fabricated from a solid sheet without any perforations.
 - d) Cover openings and corners to completely contain insulation.
- f. Unit finish:
 - 1) Air dried phenolic-based coating per this Section.
- g. Acoustic performance:

Equipment No.	Octave Band Center Frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
704-AHU25AD011	82	78	90	86	89	87	80	80
704-AHU25AD012	80	83	99	92	84	84	83	79
704-F25BS011	89	91	96	97	94	89	87	84
704-AHU25AD013	78	89	99	86	83	80	77	73
704-AHU25BM011	84	88	93	89	86	82	75	68

- h. Fans:
 - 1) Fan base and support framing:
 - a) Mount motor on a slide rail motor base.
 - b) Bearings: Mounted on a structural steel channel or machined surface.
 - c) Vibration isolation:
 - (1) Internally isolated with base and thrust restraints.
 - (2) Install in a manner that a neoprene, fiberglass, or high frequency absorber is used to avoid continuous metal-to-metal contact between fan integral base and cabinet.
 - 2) Fan wheels:
 - a) Single width, single inlet centrifugal (SWSI) plug type, with the following components and construction:
 - (1) Material of construction:
 - (a) Direct drive units: Aluminum.
 - (2) Wheel blades: Solid welded to back plate and inlet shroud at both top and bottom surface of blade:
 - (a) Airfoil shaped backwardly inclined type.
 - (3) Inlet cones: Configured and designed so wheel inlet efficiency and stall-free performance is insured:
 - (a) Secured to fan intake with adjustable clip type fasteners.
 - 3) Balancing and shafting:

- a) Shafting: Sized not to exceed 75% of first critical speed for maximum RPM:
 - (1) Critical speed: Refer to the top of speed range for fans' AMCA class.
 - (2) Lateral static deflection: Not exceed 0.003 inch per foot of length of shaft.
 - b) Balancing:
 - (1) Direct drive fans: dynamically balance shafting and wheel in two planes as a complete unit to a maximum residual unbalance of 0.00019 LB-IN/lb of fan rotor mass, per AMCA 204, BV-5, grade G1.0.
- 4) Fan bearings: Ball or roller type.
 - a) Provide replaceable bearing inserts so entire housings need not be replaced.
 - b) Self-aligning.
 - c) Provide self-locking collars to secure bearing to shaft.
 - d) Bearing housings:
 - (1) Cast iron.
 - (2) Provide with pressure relief type grease fittings.
 - (3) Extend grease fittings to the accessible side of fan framing for ease of re-lubrication.
 - e) Minimum life: 200,000 L-10 hours.
- 5) Fan motors:
 - a) Fan motor(s):
 - (1) Efficiency: NEMA premium efficiency in compliance with MG-1.
 - (2) Type: Totally enclosed fan cooled (TEFC).
 - (3) VFD rated with Class H insulation and bearing grounding.
- 6) Drives and wiring:
 - a) Direct drive:
 - (1) Wiring sizing shall be determined in accordance with NEC standards.
 - (2) Fan shall be structurally designed to withstand the maximum motor RPM at 60 hertz.
- 7) Sound Pressure Levels:
 - a) Unit inlet and outlet discharge sound pressure levels and radiated sound pressure levels shall not exceed the values scheduled for the fan array.
- 8) OSHA compliant safety guards:
 - a) Provide inlet screens on inlet of fan.
 - (1) Adequately reinforce screen to prevent vibration while not having an appreciable effect on air flow through inlet.
 - b) For plug fans, provide expanded metal safety screen enclosure.
- 9) Fan isolation for units with dual supply and dual return fans:
 - a) Provide sheet metal blank off plate which can be placed and secured over the inlet of each fan. This will allow maintenance on the idle fan while the second fan is in operation. Provide flanges at inlet of fans which will allow blank-off plate to be secured without disturbing inlet air measuring station. Each air handling unit shall be furnished with two plates with interior storage mounting brackets on the side wall of the fan inlet sections.
- i. Filter Banks
 - 1) Filter banks (filter frames with filters) - General:
 - a) Factory fabricate as part of air handling unit.
 - b) Mount filter bank in air handling unit:
 - (1) Continuously bond periphery of filter frame to inside of air handling unit to eliminate air bypass.
 - 2) Filter frames - General:
 - a) Provide frames compatible with filters scheduled.
 - b) Aluminum.
 - c) Equip frame with protective diagonal support members on both air entering and air exiting sides of filters.
 - d) Equip frame with gaskets and heavy-duty, positive-sealing fasteners capable of being attached or removed without use of tools.
 - e) Filters shall be accessible from inside the unit.
 - 3) Filters:
 - a) Capacities and types: As scheduled.

- b) Section 23 41 13.
- j. Coils: Per this Section.
- k. Access Doors:
 - 1) Access doors: Hinged, double wall, insulated, thermal break type.
 - 2) Provide in following sections:
 - a) Fan sections.
 - b) Access sections.
 - c) Filter sections.
 - d) Supply and return plenums.
 - e) Section(s) where damper(s) are located.
 - 3) Provide additional access doors where shown in the Drawings.
 - 4) Door construction:
 - a) Door size, minimum: 24 inches wide x 60 inches high.
 - b) Doors should be the same thickness and construction as the casing.
 - c) Size door(s) to accommodate removal of following equipment through the door(s):
 - (1) Motors.
 - d) Exterior door skin: Same material and finish as unit housing.
 - e) Door interior liner: Same material and finish as interior liner of section in which door is installed.
 - f) Access door perimeter: One piece, welded.
 - g) Insulation: Same as unit wall insulation.
 - h) Provide with integral re-sealable pressure port for static pressure readings in door.
 - 5) Door frame: One piece, welded.
 - 6) Gasketing:
 - a) Provide full circumference gasketing with a closed cell, replaceable neoprene gasket.
 - b) Provide gasketing system that allows for easy removal for replacement.
 - c) Provide system that will maintain a tight seal without assistance of operating pressure.
 - 7) Hinges and latches:
 - a) Provide corrosion resistant, fully adjustable hinges and latches to allow for maintenance of a tight seal between door and unit as gasketing material compresses over time.
 - b) Provide stainless steel, removable hinge pins to allow door to be easily removed during servicing.
 - c) Provide stainless steel piano or fixed position non-adjustable hinges. If the door does not seal manufacturer shall provide a factory technician to fix the door to the point that it does not leak.
 - d) Provide for padlocking of latches to fan sections.
 - e) Latch and paw assemblies: One piece, bolted together.
 - 8) Hinge access doors so they open against unit operating pressure unless otherwise indicated.
- l. Pressure Relief Doors
 - 1) Pressure relief doors: Provide vertically mounted pressure relief doors in the supply air plenum and the return air plenum.
 - a) Quantity: As indicated.
 - b) Frame: 12 gauge galvanized steel, Z shaped.
 - c) Door: 12 gauge galvanized steel.
 - d) Seal: Polyurethane foam around door perimeter.
 - e) Pressure setting:
 - (1) Supply plenum: 5 inches WG positive.
 - (2) Return plenum: 5 inches WG negative.
 - f) Springs: Negator type for door closure upon loss of over pressurization.
 - g) Size: 18 inch x 18 inch.
 - h) Insulation: For the supply plenum pressure relief, provide 1 inch thick foil faced insulation on the inside surface.
- m. Electrical
 - 1) Wiring to comply with NEC requirements and conform with applicable U/L standards and Electrical Specification Divisions.
 - 2) Each unit shall be wired and tested at the factory before shipment.

- 3) Provide separate factory wired branch circuits for each supply and return air fan motors. Terminate with junction boxes at unit exterior.
- 4) Variable frequency drives for exterior air handling units:
 - a) Variable frequency drives (VFD): As specified in Section 26 29 23.
 - b) Factory mount VFD(s) in ventilated compartment integral with air handling unit.
 - c) VFD(s) to be mounted and pre-wired to motor.
 - d) VFD(s) to be interfaced with and be controlled by the direct digital control (DDC) system.
- 5) Lights:
 - a) Provide one factory installed light for each air handling section which has an access door.
 - b) Fixture: LED type.
 - c) Each fixture shall be controllable from externally mounted light switch with pilot light. Exterior units shall have weatherproof switch.
 - d) Provide a separate 120-volt factory wired circuit for unit lights. Terminate circuit at junction box at unit's exterior.
 - e) At shipping sections, provide additional junction boxes on each module to allow the installer to make final connections in the field.
 - (1) Clearly label wiring to ease final interconnections.
- 6) Outlets:
 - a) Rounding up to the next highest number, provide a minimum of one factory installed double grounded GFCI receptacle per 10 feet of air handling unit length (For example, 43 feet long unit would require 5 receptacles.). Exterior units shall have weatherproof receptacles.
 - b) Provide a separate 120-volt factory wired circuit for unit receptacles. Terminate circuit at junction box at unit's exterior.
 - c) At shipping sections, provide additional junction boxes on each module to allow the installer to make final connections in the field.
 - (1) Clearly label wiring to ease final interconnections.
4. Size and capacity as scheduled in the Drawings.

E. Variable Frequency Drive(s): As specified in Section 23 09 03.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with Section 43 05 01.
- B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.
- C. Install heat pipes in units and between units to meet manufacturer's level and slope requirements. Provide supports and insulation for all external piping per manufacturer's recommendations.

3.02 FIELD QUALITY CONTROL

- A. Comply with Section 23 05 93.

3.03 ADJUSTING

- A. Install new filters on units which have been running prior to acceptance of Contract.

END OF SECTION

SECTION 23 81 29

VARIABLE REFRIGERANT FLOW HVAC SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies a multiple evaporator, direct expansion, variable capacity air conditioning system with simultaneous cooling and heating. System includes multiple fan coil units, branch selector boxes, refrigerant piping joints and headers, control wiring, sensors and matched variable speed air-cooled outdoor heat recovery condensing units with fully ducted discharge.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
ELECTRICAL ROOM HEAT PUMP	704-CDR25BP011
RSP-VRF BRANCH CIRCUIT CONTROLLER	704-ME25BP011
ELECTRICAL ROOM FAN COIL 1	704-CC25BM011
ELECTRICAL ROOM FAN COIL 2	704-CC25BM021
ELECTRICAL ROOM FAN COIL 3	704-CC25BM031
ELECTRICAL ROOM FAN COIL 4	704-CC25BM041
ELECTRICAL ROOM FAN COIL 5	704-CC25BM051
SOUTH BATTERY ROOM FAN COIL	704-CC25BR011
NORTH BATTERY ROOM FAN COIL	704-CC25BR021

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AHRI 1230	Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment

1.03 SYSTEM DESCRIPTION

- A. Performance Requirements:
- Each fan coil unit or group of fan coil units associated with each individual branch cool/heat selector box capable of independently operating in either heating or cooling mode regardless of the modes of the other zones on the system.
 - Five minute maximum cooling/heating changeover time.
 - Each zone capable of operating separately with individual temperature controls.
- B. System Operation:
- On/Off Control: the VRF-FCU shall be commanded ON/OFF and its fan speed indexed to either a high or low setting by the DDC using an occupied/unoccupied schedule. The VRF-FCU for the Electrical and Battery Rooms rooms shall always be in its occupied mode.
 - All units serving the same room shall be in the same heating / cooling mode, simultaneous heating and cooling of the same room is not allowed.

3. Space Temperature Control: Once indexed into operation by the DDC, the VRF-FCU controller shall modulate its internal linear expansion valve (LEV) to maintain the temperature set point via the VRF-FCU unit's internal controls.
 - a. The set point is adjustable at the remote controller, central controller, or through a DDC interface.
4. Mode Control:
 - a. Auto Mode:
 - 1) The VRF-FCU unit shall determine whether it should be in auto-heat mode or auto-cool mode based on space temperature relative to temperature set point. If the VRF-FCU unit is in auto heat mode, the VRF-FCU unit control board shall follow the heat mode sequence. If the VRF-FCU unit is in auto cool mode, the VRF-FCU unit control board shall follow the cool mode sequence.
 - 2) The VRF-FCU unit shall switch from AutoHeat to AutoCool when the space temperature rises above and remains above the temperature set point plus the minimum 5 DegF dead band for 3 minutes.
 - 3) The VRF-FCU unit will switch from AutoCool to AutoHeat when the space temperature drops below and remains below the temperature set point minus the dead band for 3 minutes.
 - b. Heating Mode: the VRF-FCU unit shall modulate its linear expansion valve (LEV) to maintain temperature set point.
 - c. Cooling Mode: the VRF-FCU unit shall modulate its linear expansion valve (LEV) to maintain temperature set point.
5. Fan/Vane Control: fan speed and vane direction (if applicable) shall be adjustable by the user at the remote controller and/or the central controller.
6. Supplemental Heat during Defrost/Error:
 - a. When the VRF-FCU unit is operating in Defrost or Error conditions, the fan shall be enabled. The fan speed setting during Defrost and Error conditions is adjustable via dip switches and shall be established by the T&B contractor.

1.04 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 1. Product data and shop drawings:
 - a. Product literature indicating:
 - 1) Dimensions.
 - 2) Operating and shipping weights.
 - 3) Certified capacities.
 - 4) Ratings.
 - 5) Factory supplied accessories.
 - 6) Electrical characteristics.
 - 7) Connection requirements.
 - 8) Provide information on each unique component of the fully functional system.
 - b. Unit drawings indicating:
 - 1) Assembly details.
 - 2) Unit dimensions.
 - 3) Construction details.
 - 4) Service and air flow clearances.
 - 5) Connection details.
 - c. Wiring diagram:
 - 1) Details for both power and control systems.
 - 2) Differentiate between factory installed and field installed wiring.
 - 3) Indicate interconnections to all VRF system components required for proper operation.
 2. Refrigerant piping diagram:
 - a. Manufacturer generated detailed refrigerant piping diagram.

- b. Indicate each condensing unit system, each fan coil unit, each branch selector boxes, sub-main boxes, each line length and each line size.
 3. Support calculations made and signed by a professional engineer currently registered in the State of Washington.
 4. Comprehensive list of the total pounds of refrigerant and type of refrigerant required.
 5. Sequence of operation in narrative form.
 6. O&M manual: 01 78 23.
 7. Installation certification: Form 43 05 01-A.
 8. DDC system graphics and control details.
- C. Certifications:
1. Installing contractor.

1.05 QUALITY ASSURANCE

- A. Certifications:
1. Installing contractor:
 - a. Currently certified by the manufacturer to install the system required and in strict adherence to the manufacturer's recommendations.
 - b. A minimum of (5) successful installations of the proposed VRF system.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Section 26 05 00: Unclassified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
1. Trane / Mitsubishi Electric.
 2. Daikin
 3. LG
 4. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Frame and casing	Galvanized steel with powder coat baked enamel paint.
Refrigerant Coils	Copper tubes with mechanically bonded aluminum fins and aluminum end casings
Branch controller casing	Galvanized steel
Liquid distributor	Brass or copper

2.03 EQUIPMENT

A. Simultaneous Heat and Cooling Outdoor Unit.

1. General:
 - a. Only variable refrigerant volume system components of the same manufacturer.
 - b. Factory assembled and pre-wired unit with all necessary electronic and refrigerant controls. Dual and triple frame outdoor units shall be field piped with factory supplied fittings per the manufacturer's instruction.
 - c. Onboard controls perform all functions required to effectively and efficiently operate the variable refrigerant volume system.
 - d. Run test each unit at the factory.
 - e. The unit incorporates an auto-charging feature and a refrigerant charge check function. If units are provided without the auto-charge feature, a factory service representative must be present at startup.
 - f. Automatic oil recovery cycle which occurs 2 hours after startup and then once every 8 hours of operation.
 - g. Minimum of the following safety devices:
 - 1) High pressure switch.
 - 2) Control circuit fuses.
 - 3) Crankcase heaters.
 - 4) Fusible plug.
 - 5) Overload relay.
 - 6) Inverter overload protector.
 - 7) Thermal compressor protectors.
 - 8) Thermal fan motor protectors.
 - 9) Overcurrent protection for the inverter.
 - 10) Anti-short cycling timers.
 - h. All setting and programs stored such that reprogramming is not required upon power failure. In addition, the system shall automatically restart operation after a power failure.
 - i. Capable of operating in simultaneous cooling and heating mode down to 0°F and up to 105°F ambient dry bulb. Provide low ambient kit if required to meet these operating conditions.
 - j. Tested sound rating no higher than 58 dB throughout the full range of unit capacity modulation.
 - k. System designed for use with LEED compliant R410a refrigerant.
2. Frame and casing:
 - a. Access panels at control boards, fans, motors and expansion valves. Access panels do not require a unique tool for removal.
3. Compressor:
 - a. Hermetic digitally controlled inverter driven scroll type.
 - b. Each equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protection device.
 - c. The compressor inverter permits a capacity control range from 10% to 100%.
 - d. Compressors isolated from the frame with the compressor manufacturer's recommended rubber vibration isolators.
 - e. Unit utilizes a refrigerant not scheduled for phase out during life of the unit.
 - f. In the case of multiple condensing unit modules, the units' internal controls contain a duty cycling function to ensure balanced compressor service hours; sequential starting and starting of each module, completion of oil return and completion of defrost cycle.
4. Fan:
 - a. Direct drive variable speed propeller type.
 - b. Configured for vertical discharge airflow.
 - c. Switch or other device capable of switch over to a fully ducted discharge condition designed to maintain unit capacities with no further alterations. Capable of generating a minimum 0.32" w.g. of static pressure in fully ducted mode. Information on equipment performance based upon available louver area required.
 - d. Inherent protection on motor and have permanently lubricated bearings.
 - e. Raised guard to limit contact with moving parts for all fans.

- f. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature.
- g. Operation sound level selected from the following three steps:

Operation sound (dB)	Night mode maximum sound pressure level (dB)
Step 1	55
Step 2	50
Step 3	45

5. Condenser coil:
 - a. Tubes with mechanically bonded fins and end casings.
 - b. Factory applied corrosion resistant coating.
 6. Electrical and controls:
 - a. As specified and indicated in the Drawings
 - b. Capable of operation within voltage limits of $\pm 10\%$.
 - c. Low voltage control power provided from the factory supplied main power supply of the unit. A separate control voltage power supply shall not be required.
 - d. Controlled by integral microprocessors.
- B. Branch controllers:
1. Designed for use with VRF equipment of the same manufacturer.
 2. Internally insulated so as not to require a condensate drain.
 3. 4 through 16 ports as required for connection to zoned equipment.
 4. Piping, valves, and controls to divert refrigerant controlling each port to operate in either a heating or cooling mode required.
 5. Completely factory assembled, internally piped and wired.
 6. Factory installed control boards that interface with the VRF equipment controls and perform all functions to effectively and efficiently control simultaneous heat and cooling.
 7. Isolation valves field supplied and installed for ease of service to the branch controller without evacuating the entire system refrigerant charge.
 8. Where manufacturer's standard branch controllers cannot be provided in port configurations indicated on the submittal design drawings, provide additional sub-main controllers and branch controllers to match the design standard manufacturer's configuration.
- C. Variable Refrigerant Volume Indoor Units:
1. General:
 - a. Simultaneous heating and cooling variable refrigerant volume system of the same manufacturer.
 - b. Nominal capacities and performance as indicated in the Drawings.
 - c. Equipped with a factory installed electronic expansion valve.
 - d. Factory assemble, wire, and run test each unit.
 - e. Equipped with an insulated condensate pan.
 - f. Access panels required for servicing of unit.
 - g. Direct-drive type fans with statically and dynamically balanced impeller with a minimum of three fan speeds.
 - h. Fan motor ECM type.
 - i. Units filled with a dry nitrogen charge from the factory.
 - j. Factory installed and wired condensate pump and integral check valve capable to lift condensate 27 inches above the drain pan.
 - k. Wall mounted programmable thermostat for each unit. Thermostat communicates with a master controller.
 - l. Drain pan with condensate overflow switch in pan or primary outlet capable of unit shutdown and alarm to DDC.
 - m. Coils:
 - 1) Minimum Design: 300 psi. Clean, dehydrate, and seal with dry nitrogen charge.
 - 2) Liquid Distributors: Brass or copper venturi type distributor with seamless copper distributor tubes.

- 3) Configuration: Down feed with bottom suction to prevent trapping of oil.
2. Concealed horizontal ducted indoor unit:
 - a. Supply and return collars on ends of units for mounting to field supplied ductwork.
 - b. Unit Cabinet:
 - 1) Mill finish or factory standard painted.
 - c. Filter:
 - 1) Return air filtered with a factory supplied removable, MERV 8 throw away filter in a unit mounted rack.
- D. Controls:
 1. Unit control boards shall perform all functions required to effectively and efficiently operate the VRF system and communicate in a daisy chain configuration from outdoor unit to indoor units via RS485.
 2. Provide system with BACnet control interface module to communicate with the DDC. DDC shall have the ability to control ON/OFF of individual zone units, adjust operating set points and monitor trouble alarms.
 3. In addition to the integral temperature sensor, provide each space served with a remote wall mounted temperature controller with DDC communication capability and that shall report to the DDC and alarm on high temperature (setpoint = 90 degrees F, adjustable).
 4. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded, stranded 2 conductor cable. A separate control voltage power supply shall not be required. The control power voltage shall be factory provided from the indoor/outdoor unit's main incoming power.
 5. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation. Manufacturer shall provide control wiring diagram with equipment submittals.
 6. Provide central control module(s) with interface to DDC that is capable of accommodating total number of connected units for the project as a whole. Provide sub-control modules as required to interface with central modules.
 7. Provide perimeter serving units with auxiliary contacts and/or optional control packages capable of relaying need for auxiliary heat to the DDC once setpoint is outside of adjustable tolerance.
- E. Refrigerant piping:
 1. Factory assembled:
 - a. Designed for quick connect installation.
 - b. Pre-charged.
 - c. Assembled in standard lengths.
 - d. Female couplings.
 - e. Suction line: Foam plastic insulated.
 - f. Gauge port at condensers.
 2. Field assembled:
 - a. See Section 40 05 01.
- F. Control wiring:
 1. Provide wiring between components for control functions.

2.04 FINISHES

- A. Section 09 90 00.

2.05 SOURCE QUALITY CONTROL

- A. Factory Tests: Units tested by manufacturer prior to shipment

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation shall be installed by a manufacturer's factory trained and certified contractor.
- B. Install according to manufacturer's recommendations and as shown in the Drawings.
- C. Installing contractor shall install field install components, in accordance with Installation, Operation and Maintenance manual instructions.
- D. Manufacturer shall inspect, test and adjust field assembled components and equipment installation, including connection, and assist in field testing.
- E. Manufacturer or factory-authorized representative shall visit the site regularly during the installation process to ensure proper means and methods are being employed. Include a minimum of two (2) such visits.

3.02 FIELD QUALITY CONTROL

- A. Field Testing: Section 01 75 20.

END OF SECTION

SECTION 23 82 21

WATER COIL UNIT HEATERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies hydronic unit heaters for use in indoor space heating applications.
- B. The general requirements applicable to all mechanical equipment, as specified in Section 43 05 01 are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
East Boiler Room Unit Heater	705-UH25AL011
East Boiler Room Unit Heater	705-UH25AL021
West Boiler Room Unit Heater	705-UH25AM011
West Boiler Room Unit Heater	705-UH25AM021

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AHRI	Air Conditioning, Heating and Refrigeration Institute
UL Standard 1995	Heating and Cooling Equipment

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. A complete description of the water coils as follows:
 - 1. Coil model number.
 - 2. Coil capacity at rated conditions, Btu/hr.
 - 3. Number of tube connections per header.
 - 4. Number of passes per tube.
 - 5. Number of tube rows.
 - 6. Number of fins per inch.
 - 7. Finned face dimensions, length by width.
 - 8. Air pressure drop at rated conditions, inches water column.
 - 9. Water pressure drop at rated conditions, feet water column.
- C. Fan performance
 - 1. CFM
 - 2. Throw
- D. Controls
 - 1. Local line level thermostat
 - 2. 2-way control valve

- E. Operations and maintenance information per Section 01 78 23, except Items 2, 4, 8, 9 and 10.
- F. AHRI certification documentation.

1.04 ENVIRONMENTAL CONDITIONS

- A. Ambient temperature and relative humidity: Section 01 17 00.
- B. Elevation above sea level: Section 01 17 00.

1.05 DESIGN AND PERFORMANCE CONDITIONS

- A. Unit Heaters:
 1. Heating Coils: Supply heating coil units with water at a temperature of 140 degrees F.
 2. Water temperature drop shall be 20 degrees F minimum.
 3. Electric Fan with motor, type totally enclosed, with fan safety guard.
 - a. 115 VAC / 60 Hz / 1 Phase.
 - b. Thermal overload protected.
 - c. Motor type: Split phase.
 4. Connections: Female pipe threads
 5. Either top and bottom supply and return connections or side supply and return connections, Contractor to choose based on clearance areas.
 6. Factory painted, 2 piece casing for easy coil access.
 7. Tapped holes for suspension by threaded rod or optional pipe hanger adapter kit.
 8. Serpentine copper tube coil design.
 9. Mounted for horizontal air discharge past adjustable deflector blades.
 10. Acceptable manufacturers:
 - a. Vulcan Radiator, model HV-280
 - b. Approved Equal.
- B. Space Limitations:
 1. Locate the majority of the hot water coils as part of the modifications to existing buildings.
 2. Available space in these locations for equipment installation, access, and maintenance may be severely limited.
 3. Coil sizes shown on the Drawings are approximate.
 4. Prior to preparing any equipment submittals for these units, field verify exact space limitations and clearances to ensure compatibility with existing ductwork.
 5. Equipment from proposed manufacturers shall meet the physical dimensions for the equipment sizes shown on the Drawings. Be responsible for all costs resulting from modifications required to meet the physical dimensions.
 6. Provide all transitions and fill-ins necessary to accommodate new coils.

PART 2 PRODUCTS

2.01 MATERIALS

Component	Material
Water coils	Copper
Coil fins	Copper
Coil casings and side plates	Galvanized Steel

2.02 EQUIPMENT

- A. Heating coils shall be sized to be compatible with specified performance information.

- B. Coils shall be heavy-duty units with connections provided for universal right- or left-hand airflow applications and shall be circuited to provide the maximum mean effective temperature difference for maximum heat transfer rates.
- C. Provide vent and a drain on all water coils.
- D. Coils shall be suitable for handling pressures up to 250 psig.
- E. Fins shall be mechanically bonded to the tubes.
- F. 12-gage galvanized steel sheets shall support entire weight of coil.
- G. Tubes shall be brazed into steel pipe headers having pipe connections at both top and bottom with same end connections for supply and return water.
- H. All joints shall be brazed with silver solder.
- I. Water coils shall have serpentine type fin tubes with inlet and outlet headers on the same side; air-water flow configuration shall be counterflow.
- J. Provide local line level thermostat to control fan operation and 2-way hot water control valve.
 - 1. On a call for heat the hot water valve shall open and the fan shall run.
- K. Power disconnect by electrical.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install each coil as shown on the Drawings and in accordance with manufacturer's recommendations.

3.02 TESTING

- A. After the completion of installation, field test each coil in accordance with Section 01 75 20 and the manufacturers requirements.

END OF SECTION

SECTION 23 82 30

ENGINE COOLING SYSTEM WITH REMOTE RADIATORS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies all modifications to the existing raw sewage pump engines to convert to engine cooling by remote radiators including the addition of engine-driven jacket water pumps and appurtenances, reconfiguration of engine exhaust systems, and up to four new, temporary radiators.
- B. The general requirements applicable to all mechanical equipment, as specified in Section 43 05 01, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP Temporary Engine Jacket Water Radiator No. 1	704-RAD03AP011
RSP Temporary Engine Jacket Water Radiator No. 2	704-RAD03AP021
RSP Temporary Engine Jacket Water Head Tank No. 1	704-T03AV011
RSP Temporary Engine Jacket Water Head Tank No. 2	704-T03AV021
RSP Temporary Engine Jacket Water Radiator No. 1 Fan Motor	704-MTR03AP011
RSP Temporary Engine Jacket Water Radiator No. 2 Fan Motor	704-MTR03AP021
RSP Temporary Engine Silencer No. 1	704-S03RS011
RSP Temporary Engine Silencer No. 2	704-S03RS021
RSP Temporary Engine Silencer No. 3	704-S03RS031
RSP Temporary Engine Silencer No. 4	704-S03RS041

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM E1780	Measuring Outdoor Sound Received from a Nearby Fixed Source

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
1. Instruments shall conform to requirements in Section 40 70 10, 40 70 20, 40 70 30, 40 78 00 and 40 79 53.

2. AC Induction Motors shall conform to the requirements of Section 40 05 93.
3. Control Systems shall conform to the requirements of Section 40 61 13.

B. Performance Requirements:

704 RSP Engine Cooling Radiators	
Requirement	Value
Coolant Type	Glycol 50% Mix
Input Coolant Temp	180 °F
Output Coolant Temp	Maximum 160 °F
Flow	343 gpm
Engine Heat Rejection to Coolant	30,300 BTU/min
Fan Controls	Constant Speed
Radiator Controls	Local On/Off/Remote switch with automatic control and remote monitoring via plant Ovation control system
Maximum Noise	Section 44 05 10

C. System Operation and Controls:

1. Contractor is responsible for RSP engine cooling system controls, wiring, installation, etc. except Ovation programming, which will be completed by others.
2. Contractor shall be responsible for working with the radiator supplier and engine manufacturer in developing the changes to the existing engine control system to add the functions needed to operate the remote radiator engine cooling system. It is anticipated that radiator operation will be interlocked to operate automatically in tandem with RSP engine start/stop but controls design shall be the responsibility of the Contractor. The design basis assumes a constant speed radiator fan with the engine thermostats automatically modulating to maintain engine temperature within an acceptable range. A high temperature switch in the jacket water (JW) loop provides for shutting down the engine if JW temperature exceeds the high temperature setpoint. A temperature transmitter provides for continuous Ovation monitoring of the JW temperature.
3. The engine cooling system also includes provisions for automatically adding makeup water to the cooling water loop (ie, radiator head tank) for each engine. The design basis assumes control wires are routed to the solenoid valve and connected to the level transmitter for maintaining proper water level within the radiator's head tank. Ovation programming for this feature will be completed by others.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Provide the following submittals:

1. Shop drawings:
 - a. Dimensioned plan and elevation drawings of radiators and pumps.
2. Design data:
 - a. Equipment weight and anchoring requirements.
 - b. Catalog information and technical description.
 - c. Materials for components, valves, and major bearings and wear surfaces.
 - d. Complete list of accessories provided.
 - e. Radiator performance curves showing design rated output accounting for design altitude and ambient temperatures.

- f. Jacket water pump performance curves.
 - g. Functional description of internal and external instrumentation and controls, including list of parameters monitored, controlled, or alarmed.
 - h. Control narrative for remote radiator operation for cooling operating RSP engine.
- 3. Support calculations in accordance with Section 01 73 00, made and signed by a professional engineer currently registered in the State of Washington.
- 4. O&M manual: Section 01 78 23.
- 5. Installation certification: Form 43 05 01-A, Section 01 33 10.
- 6. Training certification: Form 43 05 01-B, Section 01 33 10.
- 7. Bill of Materials: Section 01 33 00, including Form 01 78 45-A, Section 01 33 10.
- 8. Submit motor data per Section 40 05 93.
- 9. Control and electrical panel elevation drawings showing construction and placement of operator interface devices and other elements.
- 10. Control panel instrument identification inscriptions.
- 11. Electrical schematic and wiring diagrams for the enclosed electrical components.
- 12. List of external electrical and control wiring interfaces.
- 13. Finish systems, including description of surface preparation and paint product information.
- 14. Certification, copies of analyses, or test reports demonstrating appropriate vibration analysis and design in all modes.
- 15. Factory Test Report.

1.05 QUALITY ASSURANCE

- A. General: Section 43 05 01.
- B. Qualifications:

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Section 26 05 00 and Electrical Schedules (WP700-E-50001).

PART 2 PRODUCTS

2.01 GENERAL

- A. Scope: Furnish complete and functional radiator systems, including but not limited to, radiators, control system, low-voltage switchgear, and all other required appurtenances.

2.02 MANUFACTURERS

- A. Acceptable radiator manufacturers:
 - 1. Young, Model HB44N.
 - 2. Chart.
 - 3. Approved Equal.

2.03 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.

B. Materials of construction:

Component	Material
Frame	Galvanized steel
Core	Heresite-coated steel
Head/Expansion Tank	Galvanized steel
Fan Hub	Die cast silumin alloy
Fan Blades	Glass-reinforced polyamide

2.04 RADIATOR FEATURES AND COMPONENTS

A. Remote-Mounted Radiators:

1. The radiators shall be a horizontal set of water tubes cooled with a single fan unit configured for vertical discharge.
2. Radiator shall be capable of providing cooling for the RSP engines as specified above.
3. Radiator Fan: Axial, belt-driven fan.
4. Radiator Noise: Provide low-noise radiator design and sizing to meet noise criteria listed in Article Noise Performance Requirements and Section 44 05 10
5. Fan Motors shall be provided in conformance with Section 40 05 93.
6. Head Tank/Expansion Tank: High pressure, internally braced steel tank or tanks sized by radiator supplier to meet engine manufacturer's requirements and rated for maximum JW system pressure; mounted integral to radiator assembly. Connections for makeup water, glycol addition, jacket water/radiator tie-in, engine vent line, JW pump static line, tank vent with pressure safety valve, and level instrumentation port.

B. Fan Motor

Motor (RSP Temporary Engine Jacket Water Radiator Fan)	704-F03EJ001/002
Horsepower	15
Type	TEFC
Duty	Continuous
Hazard rating	None
Inverter duty	No
Operating speed, rpm (max)	1,800
Voltage / Frequency / Phase	480 / 60 / 3
Motor starting type	Full voltage
Installation type	Vertical
Temperature sensing and protection	Yes
Space heater	Yes
Other features	NA

2.05 RSP ENGINE MODIFICATIONS

A. Engine coolant system

1. Modify existing RSP engines to convert from existing ebullient (heat recovery) engine cooling system to remote radiator cooling of circulated engine jacket water. Provide and install all components necessary to incorporate engine-driven jacket water (JW) pump including but not limited to the following as identified by Waukesha/Innio application engineering.
 - a. Jacket water pump
 - b. Water manifold

- c. JW Thermostat housing including thermostats and bypass tubes
 - d. All parts and appurtenances associated with these parts groups and as necessary to convert the engines to remote radiator cooling.
 - e. JW vents off engine high points ($\frac{1}{2}$ " vent pipes with $\frac{1}{4}$ " orifices); connected to two locations on top of the engine and routed to radiator head tank on roof. Install as recommended by engine and radiator manufacturers.
 - f. "Static Line" routed from head tank to connection on inlet of JW pump; $\frac{1}{2}$ " pipe, or as recommended by engine manufacturer.
- B. Engine Exhaust
 - 1. Reconfigure the existing exhaust system to relocate the exhaust outlets to the opposite end of the engine to allow for installation of JW pump.
 - 2. Reroute exhaust piping including catalyst unit as necessary for the new configuration.
 - 3. Provide temporary structure for supporting exhaust piping above the engine and as shown on the Drawings.
- C. Engine Exhaust Silencer
 - 1. Provide roof-mounted, cylindrical critical grade silencer for replacing existing heat reclaim boiler/silencer associated with the ebullient cooling system.
 - 2. Dual shell construction, aluminized/carbon steel construction with housings coated with satin black paint rated to 1200 deg F. Flange connections; 125/150 lb. ANSI bolt pattern. Typical attenuation of 25 to 35 dBA.
 - 3. Manufacturers:
 - a. Miratech Corp.
 - b. GT Exhaust.
 - c. IAC Acoustics.
 - d. Or Equal.

2.06 ACCESSORIES

- A. Special tools if required for equipment maintenance and repair.

2.07 FINISHES

- A. General: Provide high temperature resistant paint products where required.
- B. Section 09 90 00.
- C. Equipment:
 - 1. Color: Manufacturer's standard.
 - 2. Paint: Manufacturer's standard.
- D. Outdoor Equipment:
 - 1. Color: To be selected by Project Representative.
 - 2. Surface prepare, prime, and finish paint with ferrous metal epoxy based primer, high build epoxy intermediate coat, and polyurethane enamel top coat.

2.08 SOURCE QUALITY CONTROL

- A. County reserves the right to witness the tests specified herein and to inspect the fabrication procedures at any time during the fabrication stage(s) of the radiator, fan, and associated equipment. County's travel expenses will be borne by the County.
- B. Perform manufacturer's standard functional tests on each unit as follows:
 - 1. Gather and furnish test information necessary to show conformance to specified requirements.

2. Manufacturer's Test Representative shall certify test results.
 3. Perform tests on all components actually furnished.
 4. Subject equipment to performance tests to verify the full range of operating conditions. Test at full rated capacity for minimum of 1 hour. Record and report unit stability, and fluid temperatures upstream and downstream.
 5. Check all alarms, shutdown conditions, and automatic sequences to verify proper function.
 6. Simulate interlocks and signals from other connected equipment in order to demonstrate specified operator interface functions and controls.
 7. Simulate interlocks and signals to/from the Plant Control System in order to demonstrate specified communications.
 8. Radiator Pressure Test: Conduct manufacturer's standard pressure test on coil assembly.
 9. Notify Project Representative of the test schedule not less than 45 days in advance.
 10. Obtain acceptance of test reports from Project Representative prior to shipment of equipment.
- C. .Radiator Factory Noise Test: A-weighted and 1/3 octave band sound pressure levels at 50 feet from the edge of the radiator in a free field environment with a hard ground surface. A minimum of eight measurements at equal angles around the radiator shall be conducted following the procedures in ASTM E1780.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. Install equipment in the locations shown and in accordance with the provisions of Section 43 05 60.

3.03 FIELD QUALITY CONTROL

- A. Field Testing: Section 01 75 20.
- B. Functional Test:
1. Prior to startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance of all components by means of a functional test conducted by the Manufacturer's Representative, assisted by the installing Contractor, and as approved by Project Representative.
 2. Test radiator fans, recirculation pumps, and associated switchgear as a complete system to demonstrate required functionality, including all status and interlocks with the Plant PLC.
 3. A qualified Manufacturer's Representative shall supervise each test, analyze data, make all necessary adjustments, and certify the unit's performance during the test.
 4. Submit test log to Project Representative upon completion of each test.
 5. Complete and sign Manufacturer's Certificate of Equipment Installation Services, as specified in Section 01 91 14.
 6. Complete successful functional testing prior to performance testing.
- C. Performance Test:
1. Performance test shall be performed as a subportion of the Startup Test as specified in Section 01 91 14.
 2. Operate unit for a minimum 4-hour running test.
 3. Record and report the following:
 - a. PHW temperatures upstream and downstream of radiator.
 - b. Ambient air temperature.
 4. A qualified Manufacturer's Representative shall supervise each test, analyze data, make all necessary adjustments, and certify the unit's performance during the test.

5. Submit test log and test report to Project Representative upon completion of each test.
- D. Post-Testing Requirements:
1. Make final adjustments.
- E. Radiator Noise Tests: A-weighted and 1/3 octave band sound pressure levels at the closest accessible point on the property boundary to the radiators in a free field environment with a hard ground surface. A minimum of eight measurements at equal angles around the radiator shall be conducted following the procedures in ASTM E1780.

3.04 MANUFACTURER'S SERVICES

- A. Provide a factory-trained representative at the site for the specified quantity and duration of the following activities. Durations do not include travel time to or from the project site.
1. One Installation Inspection:
 - a. Assist, supervise, and inspect the Contractor's activities during installation.
 - b. Provide a minimum of 8 hours of installation inspection during installation of the first pump.
 - c. Complete Form 43 05 01-A, Section 01 33 10.
 2. Test Phase Assistance:
 - a. Assist, supervise, and inspect the Contractor's activities during testing.
 - b. Provide a minimum of 8 hours.
 - c. Complete Form 01 75 20-A, Section 01 33 10.
 3. Training:
 - a. Procedures: Section 01 79 00.
 - b. Provide a minimum of 4 hours per training.
- B. See Section 01 75 20 and Section 01 79 00.

END OF SECTION

SECTION 23 82 39

ELECTRIC UNIT SPACE HEATERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies electric unit heaters for indoor space heating applications.
- B. The general requirements applicable to all mechanical equipment, as summarized in Section 43 05 01 are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-SAMPLE ROOM UNIT HEATER	704-UH25AC011

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail..

Reference	Title
UL 823	Electric Heaters for Use in Hazardous (Classified) Locations
UL 1025	Electric Air Heaters
NFPA 70E	National Electrical Code (NEC)

1.03 OPERATING REQUIREMENTS

- A. The equipment shall meet the following requirements:

Equipment No.	704-UH25AC011
Type	Corrosion resistant
Performance	Refer to schedule on the Drawings
Thermostat set point	45 F

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
 - 2. Electrical and control diagrams.
 - 3. Applicable operating and maintenance information as specified.

1.05 QUALITY ASSURANCE

- A. Unit heaters shall bear the label of a rating agency recognized in the State of Washington and shall conform to NEC requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Chromalox.
 - 2. Indeeco.
 - 3. Markel.
 - 4. Reznor.
 - 5. Ruffneck.
 - 6. Trane.
 - 7. Approved Equal

2.02 EQUIPMENT FEATURES

- A. Corrosion Resistant Unit Heaters:
 - 1. Corrosion resistant unit heater shall be installed in corrosive, non-hazardous locations. The unit heaters shall be watertight and suitable for hosing down without disconnecting the electrical service. The unit shall be UL listed.
 - 2. Unit heater cabinet:
 - a. Welded 16 gauge stainless steel.
 - b. Adjustable discharge louvers mounted horizontally across the cabinet discharge opening.
 - c. Constructed to incorporate a means for mounting the unit heater by either suspension rods or mounting brackets.
 - d. Cabinet mounted electrical disconnect switch.
 - 3. Fan Motor:
 - a. The fan motor permanently lubricated and thermally protected.
 - 4. Heating Coil:
 - a. The heating elements shall be fabricated from Monel. Heating elements shall be in a shock proof mounting and enclosed within the unit heater cabinet.
 - b. Overheat protected.
 - 5. Controls:
 - a. An integral thermostat shall be provided for each unit heater.
 - b. Control box shall be NEMA 7X with built-in controls and terminals and overheat protected.
 - c. Manual over temperature reset.
 - d. Fused transformer for control circuit. The unit heater controls shall be 24V.
 - e. The unit heater shall be provided with ON/OFF/Fan Only selector switch.

PART 3 EXECUTION

3.01 GENERAL

- A. Install unit heaters as shown and in accordance with the manufacturer's recommendations and recommended clearances from combustibles.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies general requirements for electrical work. Detailed requirements for specific electrical items specified in other sections are subject to the requirements of this Section. The Electrical Drawings and Schedules included in the specification are functional in nature and do not specify exact locations of equipment or equipment terminations.
- B. All electrical Work included in this Contract including pre-fabricated assemblies shall conform to the requirements of this Section.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI A58.1	Minimum Design Loads for Buildings and Other Structures
ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
NEMA	National Electrical Manufacturers Association
ICEA	Insulated Cable Engineers Association
IBC / IBO	International Building Code
UL	Underwriters Laboratories
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts of equipment, devices, and materials requested by the specification sections.
 - 1. Catalog information includes technical specifications and application information, including ratings, range, weight, accuracy, etc.
 - 2. Catalog cuts shall be edited to show only the items, model numbers, and information which apply to the submittal requirements.
 - 3. Catalog cuts shall be assembled in a folder. Each folder shall contain a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.
- C. Applicable operation and maintenance information on an item-by-item basis in accordance with Section 01 78 23. Operation and maintenance information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of project completion as required by Section 01 78 23, whichever is the earlier. Full-size drawings shall be reduced to 11 x 17 inches.
- D. Test results for motors and electrical systems on the forms specified in Section 26 08 00 and found in Section 01 33 10. Maintain a file of the original test results and submit to the Project Representative prior to Final Acceptance.
- E. Description of functional checkout procedures, specified in this specification, 30 days prior to performing functional checkout tests.

- F. Interconnection diagrams depicting all cable requirements together with their actual terminations.
- G. Electrical room plan and elevation drawings showing conformance with electrical working clearances and installation clearances required by selected manufacturer.
- H. Protective measures to be incorporated during construction for the purpose of preventing exposure of electrical equipment to weather, debris, liquids, or damage and to be included in the Facility Equipment Protection Plan (FEPP) specified in Section 01 14 30.

1.04 QUALITY ASSURANCE

- A. Identification of Listed Products:
 - 1. Electrical equipment and materials shall be listed and labeled for the purpose for which they are to be used, by UL or equivalent NRTL agency approved lab as the independent testing laboratory. Independent testing laboratory shall meet the requirements of the local or state inspection authority having jurisdiction.
 - 2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection. All costs and expenses incurred for such inspections shall be included in the original contract price.
 - 3. When the product is an assemblage of individual parts, whether the individual parts are listed or not, the entire assemblage shall be listed and labeled as a complete unit for the purpose for which it is to be used.
- B. Factory Tests: Where specified in the specification section, perform factory tests at the place of fabrication. Perform on completion of manufacture or assembly.

1.05 DEFINITIONS

- A. Elementary or Schematic Diagram: A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
- B. One-Line Diagram: Shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices, or parts used therein. Physical relationships are usually disregarded.
- C. Block Diagram: A diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.
- D. Wiring Diagram or Connection System: A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.
- E. Interconnection Diagram:
 - 1. Show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices.
 - 2. References shall be shown to all connection diagrams which interface to the interconnection diagrams.
 - 3. Interconnection diagrams shall be of the continuous line type.
 - 4. Bundled wires shall be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable.
 - 5. Each wire identification as actually installed shall be shown.
 - 6. The wire identification for each end of the same wire shall be identical.

7. All devices and equipment shall be identified.
 8. Terminal blocks shall be shown as actually installed and identified in the equipment complete with individual terminal identification.
 9. All jumpers, shielding and grounding termination details not shown on the equipment connection diagrams shall be shown on the interconnection diagrams.
 10. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram.
 11. Signal and DC circuit polarities and wire pairs shall be shown.
 12. Spare wires and cables shall be shown.
- F. Arrangement, Layout, or Outline Drawings: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.06 DRAWINGS

- A. Prepare drawings specified as part of the work per Section 01 78 39 and submit per Section 01 33 00.
- B. Drawings shall be complete with borders and title blocks clearly identifying Contract name, equipment, and the scope of the drawing.
- C. Drawing standard requirements will be supplied by King County.

1.07 SITE CONDITIONS

- A. General: Unless otherwise indicated, size and derate equipment and materials for the ambient conditions, but not less than an ambient maximum temperature of 40 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated tolerances.
- B. Classified Areas: As shown on Drawings.
- C. Corrosive Areas: As shown on Environmental Conditions and Materials Application (EC&MA) Table on Drawings.
- D. Seismic:
 1. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - a. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance factor, $I_p = 1.0$.
 2. Fasten equipment that is front-accessible only, to the wall or ceiling as well as the floor.

1.08 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, Protection, and Storage: Section 01 67 00.
- B. Store indoor equipment and materials to be permanently located indoors and seal with plastic film wrap.
- C. Handle equipment and accessories in accordance with NEMA and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure, and finish.
- D. Storage/Transport Ambient Temperature: Minus 13 to 131 degrees F.
- E. Storage/Transport Altitude: Up to 50,000 feet without derating.

1.09 INDICATING LAMP COLORS

- A. Unless otherwise specified, equipment to follow with colored lenses in accordance with the following schedule:

Color	Function	Example
Red	Run, open valve	Equipment operating, motor running
Green	Ready, closed valve	Equipment ready, end of cycle
White/Clear	Normal condition	Control power on, status OK or clear
Amber/Yellow	Abnormal condition	Failure of equipment or status (yellow) abnormal, fault condition

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. General:
1. Equipment and materials shall be new and free from defects.
 2. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work.
 3. Standard production materials shall be used wherever possible.
- B. Equipment Finish: Unless otherwise indicated, electrical equipment and materials shall be painted by the manufacturer as specified per Section 09 90 00.
- C. Galvanizing: Per ASTM A123.

2.02 CONDUCTOR / WIRE MARKERS

- A. Identify each power and control conductor at each end of each terminal to which it is connected and in accessible locations such as manholes, handholes, and pull boxes.
- B. Conductors size No. 10 AWG or smaller shall have identification sleeves.
- C. Conductors:
1. Identify as shown on the Drawings.
 2. If not shown on the Drawings, identify conductor ends with the Equipment number, followed by - Cxx, where xx is a unique number for that wire.
- D. Machine print on sleeves with permanent black ink the letters and numbers that identify each wire.
- E. Figures: 1/8-inch high.
- F. Sleeves: Yellow or white tubing, sized to fit the conductor insulation.
- G. Acceptable Manufacturer:
1. TMS Thermofit Marker System by Raychem Co.
 2. Sleeve style wire marking system by W. H. Brady Co.
 3. Approved Equal.
- H. Adhesive strips are not acceptable.
- I. Use cable markers of the locking tab type for conductors No. 8 AWG and larger.
- J. Tabs: white plastic with conductor identification number permanently embossed.

2.03 NAMEPLATES

- A. Laminated phenolic plastic.
- B. Nominal Size: 3/4 inch high by 2 inches long.
- C. Black backgrounds with 3/16-inch white letters.
- D. If abbreviations are required because of space limitations, submit to the Project Representative prior to manufacture.
- E. Fastened using self-tapping stainless steel screws. The use of adhesives will not be permitted on the outside of enclosures.
- F. Explosion Proof enclosures shall be mounted per manufacturers requirements, to maintain enclosure integrity.

2.04 TERMINAL BLOCKS

- A. Unless otherwise indicated, panhead strap screw type.
- B. Terminals shall be provided with integral marking strips which shall be permanently identified with the connecting wire numbers as shown on the Drawings.
- C. Terminal blocks for P-circuits (power 208-600 volts): Rated not less than the conductor current rating and less than 600 VAC.
- D. Terminal blocks for C-circuits (control and/or power 120 volts or less power) and S-circuits (signal): Rated not less than 20 amperes and less than 600 VAC.
- E. Terminals: Tin-plated.
- F. Insulating material: Nylon.

2.05 PROGRAMMING AND SOFTWARE FOR SUPPLIED EQUIPMENT

- A. For any device that requires programming, the Contractor shall provide licensed programming software and documentation. License shall include updates for duration of contract and warranty period.
- B. Contractor shall provide final documented application program and software for each programmable device.
- C. Contractor shall provide any special hardware programming interfacing (i.e cable, dongles, etc.) required for programming devices.
- D. Submit documentation per Section 01 33 00.

2.06 ARC FLASH WARNING LABELS

- A. Arc flash warning labels printed in color on thermally bonded adhesive backed, UV- and weather-resistant labels. In accordance with NEMA Z535.4.
 - 1. For incident energy levels less than 40 cal/cm² provide label with respect to the "Warning" signal word.
 - 2. For incident energy levels greater than 40 cal/cm² provide label with respect to the "Danger" signal word.

PART 3 EXECUTION

3.01 GENERAL

- A. Construction:
 - 1. Field verify existing equipment, raceways, conductors, terminations and all other existing apparatuses prior to modifying or re-using.
 - 2. Unless otherwise indicated, electrical layout Drawings are diagrammatic.
 - 3. Coordinate the location of electrical material or equipment with other equipment and work.
 - 4. Make necessary minor changes in location of electrical material or equipment to avoid interferences with other work prior to installation.
- B. Housekeeping:
 - 1. Protect electrical equipment from dust, water and damage.
 - 2. Wipe motor control centers, switchgear, and buses free of dust and dirt on the outside keep dry and vacuumed on the inside within 30 days of Substantial Completion.
 - 3. Touch up any scratches on equipment as specified in Section 09 90 00.
 - 4. During construction, allow no electrical equipment to be temporarily exposed to weather, debris, liquids, or damage.
 - 5. Provide protective measures during construction for the purpose of preventing exposure of electrical equipment to weather, debris, liquids, or damage in compliance with the Facility Equipment Protection Plan (FEPP) specified in Section 01 14 30.
- C. Dust Free Areas:
 - 1. Protect electrical, instrumentation and control equipment from dust by wrapping the equipment in plastic film wrap until installed to prevent dust from entering the equipment.
 - 2. Once electrical, instrumentation and control equipment is installed, protect from dust. Rewrap the equipment if necessary to keep the equipment dust free.
- D. Coordination Study:
 - 1. Provide coordination with design engineer for applicable electrical equipment submittals.
 - 2. Notify design engineer 45 days prior to equipment energization to coordinate adjustable relay and breaker settings.
- E. Arc Flash Hazard Analysis:
 - 1. Provide coordination with design engineer for applicable electrical equipment submittals.
 - 2. Provide as-build information for installed power conductors, including size and length.
 - 3. Provide arc flash labels for all equipment identified in design engineer's arc flash hazard analysis, which will be provided after final submittals and as-build information is coordinated.

3.02 RECORD DOCUMENTS

- A. Provide record drawings in accordance with Section 01 78 39. Include the following schedules, lists, and drawings:
 - 1. Interconnection diagrams (Section 26 05 00).
 - 2. Original submittal drawings (Section 26 05 00).

END OF SECTION

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies conductors and cables rated 5,000 to 15,000 volts used for power distribution circuits and the certified skill set of the termination and splice installer.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AEIC CS8	Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 KV
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM B189	Lead Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
ASTM B496	Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors
ICEA S-93-639	Ethylene-Propylene-Rubber-Insulated Wire
IEEE 383	Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
IEEE 386	Separable Insulated Connector Systems for Power Distribution Systems Above 600V
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NETA	International Electrical Testing Association Inc. Acceptance Testing or Maintenance Testing
UL 1072	Standard for Medium Voltage Power Cables
IEEE 400	Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Catalog cuts showing general information of the conductors and cable.
 2. Cable pulling data.
 3. Test results.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00

- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 CONDUCTORS

- A. General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in this Section. The type, size, and number of conductors shall be as specified on the Drawings or Schedules.

2.02 CABLE TERMINATIONS

- A. Terminations shall be made with a tin-plated compression type lug and a compression pressure tool as approved by the manufacturer of the lug. Tool shall be of the hydraulic pump type or the type that crimps to the required size before releasing.
- B. All bare cable connections shall include stress cones. Electrical voltage stresses shall be controlled by high permittivity, high resistivity, heat shrinkable polymeric tubing or stress cones, seal using heat shrinkable tubing, and heat activated adhesive per the manufacturer's installation requirements. Corona extinction level for a completed termination on a cable shall not be less than 1-1/2 times the rated cable phase to ground voltage.
- C. Terminations may be made with cold shrinking preformed assemblies per the manufacturer's installation requirements.

2.03 ACCESSORIES FOR CONDUCTORS

- A. Molded Splice Kits:
 - 1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
 - 2. Capable of making splices with a current rating equal to, or greater than cable ampacity, conforming to IEEE 404.
 - 3. Class 15 kV, with compression connector, EPDM molded semiconductive insert, peroxide-cured EPDM insulation, and EPDM molded semiconductive outer shield.
 - 4. Premolded splice shall be rejaacketed with a heat shrinkable adhesive-lined sleeve to provide a waterproof seal.
 - 5. Acceptable Manufacturers:
 - a. Elastimold.
 - b. Cooper Industries.
 - c. Approved Equal.
- B. Heat Shrinkable Splice Kits:
 - 1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
 - 2. Capable of making splices with a current rating equal to, or greater than, cable ampacity, conforming to IEEE 404.
 - 3. Class 15 kV, with compression connector, splice insulating and conducting sleeves, stress-relief materials, shielding braid and mesh, and abrasion-resistant heat shrinkable adhesive-lined rejaacketing sleeve to provide a waterproof seal.
 - 4. Acceptable Manufacturers:

- a. Raychem.
 - b. 3M Co.
 - c. Approved Equal.
- C. Termination Kits:
 - 1. Capable of terminating 15 kV, single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.
 - 2. Capable of producing a termination with a current rating equal to, or greater than, cable ampacity meeting Class 1 requirements of IEEE 48.
 - 3. Capable of accommodating cable shielding or construction without need for special adapters or accessories.
 - 4. Acceptable Manufacturers:
 - a. Raychem.
 - b. 3M Co.
 - c. Approved Equal.
- D. Bus Connection Insulation:
 - 1. Heat shrinkable tubing, tape, and sheets of flexible cross-linked polymeric material formulated for high dielectric strength.
 - 2. Tape and sheet products to have coating to prevent adhesion to metal surfaces.
 - 3. Acceptable Manufacturer:
 - a. Raychem.
 - b. Approved Equal.
- E. Elbow Connector Systems:
 - 1. Molded, peroxide-cured, EPDM-insulated, Class 15kV 95kV BIL, 600A, 40,000 rms nonload-break elbows having copper current-carrying parts in accordance with IEEE 386.
 - 2. Protective Caps:
 - a. Provide for each unoccupied bushing.
 - b. Class 15kV, 95kV BIL, 600 amperes, with molded EPDM insulated body.
 - 3. Insulated Standoff Bushings: Class 15kV, 95kV BIL, 600 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.
 - 4. Bushing Inserts:
 - a. Class 15kV, 95 kV BIL, 600A, nonload-break with EPDM rubber body and all-copper, current-carrying parts.
 - b. Threaded, field replaceable.
 - 5. Junctions: Class 15 kV, 95kV two-way, or as required 600A, nonload-break,, having EPDM rubber body mounted on adjustable bracket.
 - 6. Junction Mounting Plates: Two or as required-way, stainless steel, complete with universal mounting brackets, grounding lugs and two parking stands.
 - 7. Acceptable Manufacturers:
 - a. Cooper Industries.
 - b. Elastimold.
 - c. Approved Equal.
- F. Conductor Lugs:
 - 1. In accordance with NEMA CC 1.
 - 2. Rated: 15 kV of same material as conductor metal.
 - 3. Manufacturers and Products, Uninsulated Compression Connectors and Terminators:
 - a. Burndy; Hydent.
 - b. Thomas & Betts; Color-Keyed.
 - c. ILSCO.
 - d. Approved Equal.
 - 4. Manufacturers and Products, Uninsulated, Bolted, Two-Way Connectors and Terminators:
 - a. Thomas & Betts; Locktite.
 - b. ILSCO.
 - c. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Each conductor shall be identified at each terminal to which it is connected with a marking system that shall comply with Section 26 05 00 or as indicated on the Drawings.
- B. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed.
- C. Pulling wire and cable into conduit shall be completed without damaging or putting undue stress on the cable insulation. UL listed and cable manufacturer recommended pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.
- D. Provide a cable support whenever a cable leaves a raceway. Prepare and treat with conductive compound each flat un-plated bus bar connection. Torque bolts to the bus manufacturer's recommendations.

3.02 INSTALLATION

- A. General
 - 1. Conductor installation shall be in accordance with the cable manufacturer's recommendations and the specifications herein.
 - 2. Qualified cable termination and splice installer shall be certified by the manufacturer or a training agency for the products used.
 - 3. Provide a copy of the installer certification certificate to the Project Representative prior to performing the work. Copy of the certification shall be present on the project site for review by King County.
- B. Cable Replacement:
 - 1. Cable shall be carefully checked and tested to verify the electrical condition, size, and length before being pulled into raceways. Cable pulled into the incorrect raceway or cut too short to rack, train, or splice as specified herein shall be removed and replaced by and at the expense of the Contractor.
 - 2. Cable in manholes: Cable shall be supported at all times during handling. Cable ends shall be sealed to prevent the entry of moisture or dirt. Cable racks or trays shall be provided for permanent support. Temporary support required during placement shall be with rope slings, timbers, or alternate method acceptable to the Project Representative.
 - 3. Supports: Cable supports and securing devices shall have bearing surfaces oriented parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation.
 - 4. Adequate cable end lengths shall be provided and properly placed in electrical equipment or manholes to avoid longitudinal strains and distorting pressures on the cable at termination points and duct end bells.
 - 5. Final inspection shall be made after all cable is in place. Where supports, bushings, and end bells deform the cable jacket, additional supports shall be provided as directed by the Project Representative.
 - 6. Cable Racks: Cable racks shall be furnished and installed as required to provide the proper cable support. Cable racks shall be installed and spaced 36 inches apart and bolted to permanent wall surfaces with anchors or continuous slot concrete inserts. Cable racks shall be commercially available for the purpose and non-metal. Cable racks not suited to the installation shall be replaced with commercial products at no expense to King County.
- C. Cable Pulling
 - 1. Pulling Lines: All raceway cleaning mandrels and cable pulling shall be done with material and pull-line to prevent damage to the raceway. Nylon or stranded steel pulling lines shall not be used. "Fishing" may be done with CO₂-propelled polyethylene cord.

2. Cable Grips: Factory-installed pulling eyes shall be used for pulling cable. Where pulling eyes are not available, woven wire cable grips shall be used to pull all single-conductor cable. When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal, plus 6 inches, shall be cut off and discarded when the pull is completed. As soon as the cable is pulled into place, the pulling eyes on cable grips shall be removed and the cable shall be resealed.
3. Swivels: A reliable, nonfreezing type of swivel, or swivel connection, shall be inserted between the pulling rope and the cable pulling eye, grip, or loop to prevent twisting under strain.
4. Reel Inspection And Insulation Testing:
 - a. Purchase cable with both ends available for insulation resistance testing. Before unreeling, the outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed.
 - b. Test the cable on the cable-reel with an insulation tester and record the results. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection.
 - c. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged during installation shall be replaced by the Contractor and at the expense of the Contractor.
5. Feeding Tubes:
 - a. A flexible feeding tube, with a removable nozzle sized to fit the raceway shall be used in pulling cable. The feeding tube shall be long enough to extend from the raceway entrance to the outside of the manhole and arranged so that it will be impossible for the cable to drag across the edge of the manhole ring or any other damaging surface.
 - b. Cable pulling into, through, or out of new manholes shall be done with the entire concrete manhole lid cover removed.
6. Lubricant: A cable lubricant shall be used on all conductors in all pulls, and shall be of the type, and applied in the quantity, recommended by the cable manufacturer.
7. Pulling Tension:
 - a. The pulling tension of the cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both manual and power types used by the Contractor shall have the rated capacity (in pounds) clearly marked on the mechanism.
 - b. A dynamometer shall indicate the tension on the cable during all pulls and the indicator shall be constantly watched. When excessive strain develops, the pulling operation shall be stopped and the difficulty determined and corrected. Cable shall not be pulled without using equipment monitored by a dynamometer.
 - c. The dynamometer shall have a maximum tension indicator to show the maximum tension developed during a pull. The maximum tension for each pull shall be recorded and submitted to the Project Representative within 5 days after the pull was made.
 - d. Consult with the Project Representative for installations that do not require a dynamometer for short or non-difficult pulls, otherwise pulling without a dynamometer is prohibited.
 - e. The information submitted to the Project Representative shall include the dynamometer reading, the angle alpha, the lubricant used, the actual maximum tension of each pull measured while the cable is in motion, and the tension upon initial start of the pull just before the cable begins to move. The cable play-out reel shall be equipped with a suitable brake and shall be constantly manned during all pulls.
 - f. The use of motor vehicles as cable pulling devices is prohibited. Any cable so pulled shall be removed, replaced, and the new cable installed at the Contractor's expense.
8. Sidewall Pressure: To avoid insulation damage from excessive sidewall pressure at bends in raceway runs, the pulling tension in pounds exiting a bend shall not exceed 200 times the radius of the bend in feet.
9. Cable Bends: Extreme care shall be exercised during the placement of all cable to prevent tension and bending conditions in excess of the manufacturer's recommendations. The permanent radius of bend after cable installation shall be in accordance with the cable manufacturer's recommendations.

D. Moisture Seals:

1. Cable ends shall be kept sealed except when termination and splicing work is being performed. Seal with heat-shrinkable caps with the sizes recommended by the cap manufacturer for the cable

outside diameter and insulation. Cold seal kit method provided by the manufacturer of the kit is an accepted method

2. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive, watertight seal. Heat-shrinkable caps shall be "Thermofit" as manufactured by Raychem Corporation, or approved equal.
3. Before and after pulling, the leading end seal of each length of cable shall be examined and replaced if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated immediately.

3.03 TERMINATIONS

- A. Cable shall be trained into place without bending the cable in a radius less than the manufacturer's recommended minimum bending radius. If the cable is bent to a radius less than the minimum bending radius, the Contractor shall at his own expense, re-terminate the cable at a point at least 6 inches below the bend.
- B. Where the shape and configuration of terminal fittings make workmanlike insulation of the bare connection impractical, the contours of the connection shall be smoothed by filling voids and molding over irregular surfaces with a moldable filler material as recommended by the terminator kit manufacturer before application of the recommended thickness of insulating material.
- C. Terminations shall be in exact conformance with the written instructions accompanying the splicing or terminator kits and work shall only be performed by personnel that are specifically trained and experienced in medium voltage cable termination and splicing.
- D. Special care shall be exercised to ensure that cable insulation is not damaged during stripping back of jacket, semiconductor layers, shields; or penciling operations.
- E. Stripping-back operations involving the cutting of nonmetallic layers of the cable shall be accomplished using a ringing tool. The usage of pocket or jack knives for stripping back or penciling operations is prohibited.

3.04 CONDUCTOR AND CABLE ARC AND FIREPROOFING

- A. See conduit transit systems in Section 26 05 33.
- B. Install arc and fireproofing tape on 15 kV cables throughout entire exposed length, at splices in vaults, and other indicated locations.
- C. Wrap conductors of same circuit entering from separate conduit together as single cable.
- D. Follow tape manufacturer's installation instructions.
- E. Secure tape at intervals of 5 feet with bands of tapebinder. Each band to consist of a minimum of two wraps directly over each other.

3.05 TESTING

- A. Cable assembly and factory testing shall comply with manufacturer's standard and applicable requirements of ICEA Publication No. S-93-639/NEMA WC74 - 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electrical Energy. In addition to the tests specified below, the Contractor shall test conductors and cable and submit test results for review by the Project Representative. Field testing shall be done after cable is installed in the raceways and cable trays. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the Project Representative for review and acceptance. Cables failing the

tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

- B. Cables rated 5 kV and above shall be tested using one of the following test methods:
1. Partial Discharge Test:
 - a. Cables rated 5 kV and above shall be tested using the Partial Discharge test method as defined in IEEE 400.3. Testing shall be performed using the Off-Line method.
 - b. Test equipment used for the Partial Discharge Test shall be specifically designed for performing testing in the field. Test equipment shall have a current calibration certificate from a recognized calibration lab.
 - c. Cable Test Report: The test results from the Partial Discharge Test shall be software analyzed, recorded and provided to King County.
 2. Very Low Frequency (VLF) Test:
 - a. Cables rated 5 kV and above shall be tested using the non-destructive diagnostic VLF Tan Delta test method as defined in IEEE 400.2. Testing shall be performed using the Off-Line method. Tan Delta testing shall be performed at $2.5V_0 - 3V_0$ (normal line-to-ground voltage) for at least 30 minutes.
 - b. Test equipment used for the VLF Test shall be specifically designed for performing testing in the field. Test equipment shall have a current calibration certificate from a recognized calibration lab.
 - c. Cable Test Report: The test results from the test shall be software analyzed, recorded and provided to King County.

3.06 CABLE SPECIFICATION SHEETS (CABLESPEC)

- A. Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC SHEETS.
- B. The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
15EP-S	15000	Single Conductor Shielded Power Cable	13.8kV Medium Voltage circuits
15CLX-C	15000	Three conductor + ground CLX Power Cable	13.8kV Medium Voltage circuits

Cable System Identification:**15EP-S**

Description:

Single conductor shielded power cable, tray rated

Voltage Rating:

15000 volts

Conductor Material:

Single conductor, uncoated copper;
Class B stranded in accordance with ASTM B-496.

Strand screen:

Extruded semi-conducting EPR.

Insulation:

Ethylene propylene rubber (EPR) no polyethylene component, Type MV-105, rated continuous 105 degrees C, wall thickness rated for 133 percent insulation level.

Insulation screen:

Extruded semi-conducting EPR.

Shield:

5 mil bare copper tape with minimum 12.5 percent overlap.

Jacket:

Polyvinylchloride (PVC).

Acceptable Manufacturer(s):

Okonite Okoguard-Okoseal Series;
Kerite;
or approved equal.

Installation:

Install in accordance with this Section and per the manufacturer's instructions.

Testing:

As specified herein.

Cable System Identification:**15CLX-C****Description:**

Multi- conductor shielded power cable, in a continuously corrugated welded aluminum sheath wrapped in a PVC jacket. Cable tray rated, sunlight resistant and suitable for direct burial

Voltage Rating:

15000 volts

Conductor Material:

Compact Stranded conductor, uncoated copper;
Class B stranded in accordance with ASTM B-496.

Strand screen:

Extruded semi-conducting EPR.

Insulation:

Ethylene propylene rubber (EPR), no polyethylene component, Type MV-105, rated continuous 105 degrees C, wall thickness rated for 133 percent insulation level.

Insulation screen:

Extruded semi-conducting EPR.

Shield:

5 mil bare copper tape with minimum 12.5% percent overlap.

Jacket:

Continuously corrugated welded aluminum sheath wrapped in a Polyvinylchloride (PVC) jacket.

Acceptable Manufacturer(s):

Okonite Okoguard-C-L-X Okoseal Series;
General Cable;
or approved equal.

Installation:

Install in accordance with this Section and per the manufacturer's instructions.

Testing:

As specified herein.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies conductors and cables rated 2000 volts and below used for power, lighting, receptacle, signal, and control circuits.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM B189	Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
IEEE 1202	Type Test for Flame-Propagation Testing of Wire & Cable
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NEMA WC57/ICEA S-73-532	Standard for Control Cables
NEMA WC70/ICEA S-95-658	Non-Shielded Power Cables Rated 2000 V or less
NEC 310-12	General Conductors Color Code
NFPA 70	National Electric Code (NEC)
NFPA 820	Fire Protection in Wastewater Treatment and Collection Facilities
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables
UL 1277	Type TC Power and Control Tray Cable
UL 1581	Reference Standards for Electrical Wires, Cables, and Flexible Cords

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts showing general information of the conductors and cable.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.

- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to the Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unscheduled Conductors and Cables:
1. With the exception of lighting, communication, paging, security and receptacle circuits, the type, size and number of conductors shall be as specified on the Drawings.
 2. Lighting and receptacle circuit conductors are not shown on the Drawings and shall be sized by the Contractor in accordance with the NEC to limit voltage drop to 3 percent.
 3. Minimum size of lighting and receptacle circuits shall be #12 AWG.
 4. Number and types of communication, paging, and security cables shall be as required for the particular equipment provided.
 5. Unless otherwise indicated, provide lighting and receptacle circuit conductors in accordance with CABLESPEC "XHHW-2".
- B. Cable Specification Sheets (CABLESPEC): General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in this Section.

2.02 COLOR CODING

- A. General:
1. Multiconductor power and control cable colors shall be manufacturer's standard.
 2. Single conductor control conductor color shall be yellow, except for the grounded conductor which shall be white.
- B. Power Conductors:
1. Single-conductor power conductors shall be color coded in accordance with the following:

Use	Cable	Color
DC, up to 2000-volt power	Positive	Red
	Negative	Black
	Ground	Green
Three-phase, 480-volt power or 480/277	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
	Ground	Green
	Neutral	Gray
Three-phase, 120/208-volt power	Phase A	Black
	Phase B	Red
	Phase C	Blue
	Neutral	White
	Ground	Green
Single-phase, 120/240-volt power	Line 1	Red
	Line 2	Black
	Neutral	White

	Ground	Green
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2. Cables sized No. 4 AWG and larger may be black with colored 3/4-inch vinyl plastic tape applied in 3-inch lengths around the cable at each end.
 3. Tag the cables at terminations and in pull boxes, handholes, and manholes.
- C. Signal Conductors: Unless otherwise indicated, cables shall be color coded black and white for pairs or black, red, and white for triads.
- D. Control Conductors: Control conductors color coding shall be manufacturer's standard.

2.03 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

- A. Single Conductor:
1. Stranded and used in conduits for power and control circuits.
 2. Unless otherwise indicated, provide in accordance with CABLESPEC "XHHW-2".
- B. Multiconductor Cable:
1. Used for power and control circuits routed in cable tray.
 2. Cables shall be UL labeled,
 3. Cables installed within cable tray shall be type TC, designed for cable tray installation in accordance with NEC 340 and NEC 392.
 4. The type of insulation, number of conductors, and size of conductor shall be as specified.
 5. Unless otherwise indicated, provide multiconductor power and control cable in accordance with CABLESPEC "MC".
 6. Power Cable: Containing three or four conductors, as specified, plus an equipment grounding conductor.
 7. Control Cable: Unless otherwise indicated, shall be size 14 AWG.

2.04 SIGNAL CABLES

- A. General:
1. Provide signal cable for instrument signal transmission, alarm, communication and other circuits as specified. Circuit shielding shall be provided in addition to cable shielding.
 2. Provide circuits for Type A and B signals specified in Section 40 61 13 in compliance with the instrument manufacturer's recommendations.
 3. Unless otherwise indicated, provide single circuit signal cable in accordance with CABLESPEC "SIC1".
 4. Unless otherwise indicated, provide multi-circuit signal in accordance with CABLESPEC "MIC1".
- B. Communication System Cables: Communication, system cables shall be as specified in Divisions 27.

2.05 PORTABLE CORD

- A. Unless otherwise indicated, provide portable cord in accordance with CABLESPEC "CORD".
- B. Cords shall contain an equipment grounding conductor.

2.06 SPLICING AND TERMINATING MATERIALS

- A. Connectors:
1. Tool applied compression type of correct size and UL listed for the specific application.
 2. Tin-plated high conductivity copper.
 3. For wire sizes No. 10 AWG and smaller: Nylon self-insulated, ring tongue or locking-spade terminals.

4. For wire sizes No. 8 AWG and larger: One-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger.
5. Mechanical clamp, dimple, screw-type connectors are not acceptable.
6. Wires for current transformer circuits shall be terminated in ring lugs.

B. Motor Connection Kits:

1. Shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination.
2. Shall accommodate a range of cable sizes for both in-line and stub-type configurations.
3. Shall be independent of cable manufacturer's tolerances.

C. Splicing is not allowed without prior approval from the Project Representative.

2.07 ARMORED CABLE FITTINGS AND GLANDS

A. Non-classified Locations:

1. Terminates and seals jacketed metal clad cable
2. NEMA 4X listed, suitable for wet locations, corrosion resistant
3. Suitable for Class 1 Division 2 Group D
4. Copper free aluminum
5. Acceptable Manufacturers:
 - a. Appleton TMC
 - b. Approved Equal.

B. Classified Locations:

1. Terminates and seals jacketed metal clad cables in Classified locations
2. Nema 4X listed, suitable for wet locations, corrosion resistant
3. Epoxy Sealing compound
4. Copper free aluminum
5. Explosion proof
6. Acceptable Manufacturers:
 - a. Appleton TMCX
 - b. Approved Equal.

2.08 TC CABLE FITTINGS, SEALS AND GLANDS

A. Seals cable at enclosures and conduit

B. NEMA 4X where outdoors and NEMA 12 indoors

C. Class 1 Division 2 (where required for installation area)

D. Material:

1. Areas that are not corrosive, copper free aluminum fittings and lock nuts
2. Areas that are corrosive, 316 stainless steel fittings and lock nuts

E. Acceptable Manufacturers:

1. Appleton TC
2. CMP TC
3. Approved Equal

2.09 SUPPORTS

A. Non-metallic material against cable

B. Provides compression but does not damage the cable

- C. Acceptable Manufacturers:
 - 1. EFCO CLIC, plastic cable clamp
 - 2. Thomas & Betts Superstrut A716, Cushioned Cable Clamp
 - 3. Approved Equal

2.10 FIRESTOPS

- A. See conduit/cable transit systems in Section 26 05 33.

PART 3 EXECUTION

3.01 GENERAL

- A. Cable and wire installations shall meet the NEC. Instrumentation circuits such as analog signal circuits and Data circuits such as network circuits shall not be combined with power and control circuits. All wires within conduit, cable tray and junction boxes shall be of the same voltage insulation level unless suitable separation meeting the NEC is provided.
- B. Identify each power and control conductor at each terminal to which it is connected and in accessible locations such as manholes, handholes, and pull boxes. The marking system shall comply with Section 26 05 00.
- C. Wire Pulling:
 - 1. Complete the pulling of wire and cable into conduit or trays without damaging or putting undue stress on the cable insulation.
 - 2. Soapstone, talc or UL listed pulling compounds are acceptable lubricants for pulling wire and cable.
 - 3. Grease is not acceptable.
 - 4. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed.
- D. Whenever a cable leaves a raceway, provide a cable support.
- E. When flat bus bar connections are made with unplated bar scratch-brush the contact areas. Torque bolts to the bus manufacturer's recommendations.
- F. Provide and install yellow three-strand copolymer polyolefin pull string in all new conduits. String shall extend at least 1 foot beyond each end of the conduit and be tied off on bushing or in other manner acceptable to the Project Representative
- G. Splicing is not allowed without prior approval from the Project Representative.

3.02 600 VOLT CONDUCTOR AND CABLE

- A. Lacing and Bundling:
 - 1. Lace and bundle conductors in panels and electrical equipment, No. 6 AWG and smaller, at intervals not greater than 6 inches, spread into trees and connected to their respective terminals.
 - 2. Lacing shall be made up with plastic cable ties.
 - 3. Lacing is not necessary in plastic panel wiring duct.
 - 4. Bundle conductors crossing hinges into groups not exceeding 12 and arrange so that they will be protected from chafing when the hinged member is moved.
- B. Slack:
 - 1. Provide slack in junction and pull boxes, handholes and manholes.
 - 2. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box.
 - 3. Amount of slack shall be equal to largest dimension of the box.
 - 4. Where plastic panel wiring duct is provided for wire runs, lacing is not required.

5. Do not use plastic panel wiring duct in manholes and handholes.
- C. Stranded Conductors:
1. Terminate as described in this Section, except where terminals will not accept such terminations.
 2. In these cases, terminate the conductors directly on the terminal block.
 3. Install compression lugs and connectors using manufacturer's recommended tools.
- D. Raceway fill limitations shall be as defined by NEC and the following:
1. Lighting and receptacle circuits may be in the same conduit in accordance with derating requirements of the NEC.
 2. However, lighting and receptacle circuits shall not be in conduits with power or control conductors.
- E. Make terminations at solenoid valves, 120 volt motors, and other devices provided with pigtail leads using self-insulating tubular compression connectors.

3.03 SIGNAL CABLE

- A. Circuits:
1. Run as individually shielded twisted pairs or triads.
 2. Do not, in any case, make up a circuit using conductors from different pairs or triads.
 3. Use triads wherever 3-wire circuits are required.
 4. Unless otherwise indicated, provide terminal blocks at instrument cable junctions, and identify circuits at such junctions.
 5. Run signal circuits without splices between instruments, terminal boxes, or panels.
- B. Maintain a minimum of 12 inch separation from power cables, conductors and raceways, except when crossing at right angles. Where separation is not possible or practical, upon written approval, a metal barrier or armor may be installed.
- C. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables.
- D. Common grounded return conductors for two or more circuits are not acceptable.
- E. Unless otherwise indicated, bond shields to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Provide terminals for running signal leads and shield drain wires through junction boxes.
- F. Shield Drain Wire:
1. Terminate spare circuits and the shield drain wire on terminal blocks at both ends of the cable run and cause to be electrically continuous through terminal boxes.
 2. Do not ground shield drain wires for spare circuits at either end of the cable run.
- G. Terminal Boxes:
1. Provide at instrument cable splices.
 2. If cable is buried or in raceway below grade at splice, provide an instrument stand as specified with terminal box mounted approximately 3 feet above grade.
- H. Install and terminate cable for telephone systems in compliance with the manufacturer's recommendations.

3.04 PORTABLE CORD

- A. Portable cord feeding permanent equipment, such as pendant cords, pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination.

- B. Connect portable cords to permanent wiring with the use of terminals.
- C. Use in-line taps and splices only where specified.

3.05 FIRESTOPS

- A. Fire stops shall be applied to all cables that penetrate a floor, wall or ceiling that is routed without a raceway. Where a penetration also penetrates a classified boundary the fire stop shall also be rated for the area classification.
- B. Apply in accordance with manufacturer's recommendations.

3.06 TESTING

- A. General: Test conductors and cable in accordance with Section 26 05 00 and Section 26 08 00.
- B. Signal Cable:
 - 1. Test each signal pair or triad for electrical continuity.
 - 2. Test each shield drain conductor for continuity. Shield drain conductor resistance shall not exceed the loop resistance of the pair or triad.
 - 3. Test each conductor (signal and shield drain) for insulation resistance with all other conductors in the cable grounded.
 - 4. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. Use a 500 volt megohmmeter for insulation resistance measurements.

3.07 SCHEDULES

- A. Cables are scheduled on the Drawings.

3.08 CABLE SPECIFICATION SHEETS (CABLESPEC)

- A. General:
 - 1. Conductor and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets (CABLESPECS).
 - 2. Install scheduled and unscheduled conductors and cables in accordance with the CABLESPECS.
- B. CABLESPEC SHEETS: CABLESPEC sheets follow.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	2RHW-S
Description:	Single conductor, photovoltaic cable in accordance with UL 4703.
Voltage:	2000 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	RHW-2, 90 degree C wet/dry, cross-linked polyethylene (XLPE) in accordance with NEMA WC70/ ICEA S-95-658 (power cable) and UL 44.
Jacket:	None.
Flame Resistance:	N/A.
Acceptable Manufacturer(s):	Service Wire; Southwire; or Approved Equal.
Uses Permitted:	Conduit
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	MC
Description:	Armored Multiconductor power and control cable approved for tray installation and in accordance with UL 1569 and 2225, NEC type MC-HL
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	XHHW-2, 90 degree C wet/dry, crosslinked polyethylene (XLPE) in accordance with NEMA WC57 / ICEA S-73-532 (control cable), NEMA WC70 / ICEA S-95-658 (Power Cable), and UL 44.
Assembly:	Individual conductors cabled together with nonhydroscopic fillers and binding tape.
Aarmor:	Impervious, continuous, corrugated aluminum welded over cable core. Armor shall meet the grounding conductor requirements of NEC table 250-95.
Jacket:	50 mil minimum, polyvinylchloride (PVC) in accordance with UL 1569.
Flame Resistance:	IEEE 1202.
Acceptable Manufacturer(s):	Okonite, CLX-HL; Southwire, ARMOR-X; Approved Equal.
Uses Permitted:	Cable tray, conduit, normal or classified locations.
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	TCER
Description:	Multiconductor power and control cable, approved for tray installation and in accordance with UL 1581
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	XHHW-2, 90 degree C dry, 75 degree C wet, crosslinked polyethylene in accordance with NEMA WC57 / ICEA S-73-532 (control cable), NEMA WC70 / ICEA S-95-658 (Power Cable)
Assembly:	Individual conductors cabled together with nonhydroscopic fillers and binding tape.
Jacket:	50 mil minimum, polyvinylchloride (PVC) in accordance with UL 1581.
Flame Resistance:	IEEE 383.
Acceptable Manufacturer(s):	Okonite, Houston Wire & Cable, Approved Equal.
Uses Permitted:	Cable tray, direct burial, Class 1, Division 2 atmospheres.
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	XHHW-2
Description:	Single conductor Cross-linked polyethylene power and control cable for sizes No. 14 AWG through No. 600 kCMIL.
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	XHHW-2, 90 degree C dry, 75 degree C wet, cross-linked polyethylene (XLPE) in accordance with NEMA WC57/ ICEA S-73-532 (control cable), NEMA WC70/ ICEA S-95-658 (power cable).
Jacket:	None.
Flame Resistance:	N/A.
Acceptable Manufacturer(s):	Okonite, X-Olene; Southwire; Approved Equal.
Uses Permitted:	Conduit
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	SIC1
Description:	Armored Single twisted, shielded pair or triad, 18 or 16 AWG, instrumentation cable, UL listed, NEC type MC-HL.
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	Flame Retardant polyvinyl chloride, 90 degrees C Wet/Dry.
Lay:	Twisted on a 2-inch lay.
Shield:	100 percent coverage, aluminum-Mylar tape, with a 7-strand tinned copper drain wire, same size as conductor.
Armor	Impervious, continuous, corrugated aluminum welded over cable core in accordance with UL1569.
Jacket:	Polyvinylchloride (PVC).
Flame Resistance:	IEEE 1202.
Acceptable Manufacturer(s):	Okonite, CLX type P-OS; Approved Equal.
Uses Permitted:	Cable tray, conduit, normal or classified locations.
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:**SIC2**

Description:

Single twisted, shielded pair or triad, 18 or 16 AWG, instrumentation cable, UL listed, NEC type TC.

Voltage:

600 volts.

Conductor Material:

Bare annealed copper; stranded in accordance with ASTM B8.

Insulation:

Flame Retardant polyvinyl chloride, 90 degrees C Wet/Dry.

Lay:

Twisted on a 2-inch lay.

Shield:

100 percent coverage, aluminum-Mylar tape with a 7-strand tinned copper drain wire, same size as conductor.

Jacket:

45 mil polyvinylchloride (PVC).

Flame Resistance:

IEEE 1202.

Acceptable Manufacturer(s):

Okonite, Okoseal-N type P-OS; Approved Equal.

Uses Permitted:

Conduit

Execution:

Installation: Install in accordance with this Section.

Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	MIC1
Description:	Armored, Multiple twisted, shielded pairs or triads, 18 or 16 AWG, instrumentation cable, UL listed, NEC type MC-HL.
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	Flame Retardant polyvinyl chloride, 90 degrees C Wet/Dry.
Lay:	Twisted on a 2-inch lay.
Shield:	100 percent coverage, aluminum-Mylar tape with a 7-strand tinned copper drain wire, same size as conductor.
Overall Shield:	100 percent coverage, aluminum-Mylar tape with a 7-strand tinned copper drain wire, two sizes smaller than conductor.
Aarmor	Impervious, continuous, corrugated aluminum welded over cable core in accordance with UL1569.
Jacket:	45 mil polyvinylchloride (PVC).
Flame Resistance:	IEEE 1202.
Acceptable Manufacturer(s):	Okonite, CLX type SP-OS; Approved Equal.
Uses Permitted:	Cable tray, conduit, normal or classified locations.
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	MIC2
Description:	Multiple twisted, shielded pairs or triads, 18 or 16 AWG, instrumentation cable, UL listed, NEC Type TC.
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	Flame Retardant polyvinyl chloride, 90 degrees C Wet/Dry.
Lay:	Twisted on a 2-inch lay.
Shield:	100 percent coverage, aluminum-Mylar tape with a 7-strand tinned copper drain wire, same size as conductor.
Overall Shield:	100 percent coverage, aluminum-Mylar tape with a 7-strand tinned copper drain wire, two sizes smaller than conductor.
Jacket:	45 mil polyvinylchloride (PVC).
Flame Resistance:	UL 1202.
Acceptable Manufacturer(s):	Okonite, Okoseal-N type SP-OS; Approved Equal.
Uses Permitted:	Conduit
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	MIC3
Description:	Multiconductor with overall twisting and shield, 16 AWG, communication and control cable, UL listed, NEC Type 800.
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	Flame Retardant polyvinyl chloride, 90 degrees C Wet/Dry.
Lay:	Twisted on a 3-inch lay.
Overall Shield:	100 percent coverage, aluminum-Mylar tape with a 7-strand tinned copper drain wire.
Jacket:	25 mil polyvinylchloride (PVC).
Flame Resistance:	NFPA 262 Plenum.
Acceptable Manufacturer(s):	Alpha-Wire, 3248; Approved Equal.
Uses Permitted:	When required by field device manufacturer
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	NC4
Description:	Category 6 Ethernet, 1 Gigabit Ethernet, ISO/IEC Class E. 4 pair with overall shield. UL CMR
Voltage:	600V rms UL Rated
Conductor Material:	Solid bare copper 23 AWG.
Insulation:	Polypropylene (PP).
Jacket:	PVC, Blue unless specified otherwise
Shield	Overall aluminum foil. Solid tinned copper 24 AWG drain wire
Flame Resistance:	UL 1666 riser
Electrical Characteristics:	Maximum Insertion loss 32.8 dB at 100 meters and 250MHz IEEE 802.3af/at/bt (PoE/PoE+) rated for applications up to 100 watts
Acceptable Manufacturer(s):	Belden 7953A; Approved Equal.
Uses Permitted:	Conduit
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	CORD
Description:	Portable Cord, 10 AWG and smaller, UL listed, type SOOW; larger than 10 AWG, UL listed type G. Weather and water resistant.
Voltage:	600 volts.
Conductor Material:	Flexible rope stranded per ASTM B189 and B33. Conductors shall be coated except ground conductors may be uncoated.
Insulation:	Ethylene propylene (EPR) as per ICEA S-68-516 and rated for continuous operation at 90 degrees C.
Jacket:	Heavy-duty neoprene as per ICEA S-68-516
Flame Resistance:	UL 1202.
Acceptable Manufacturer(s):	Southwire Royal; Approved Equal.
Uses Permitted:	Pendants, portable equipment
Execution:	Installation: Install in accordance with this Section. Testing: Test in accordance with this Section.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the system for grounding electrical equipment, exposed non-energized metal surfaces of equipment, and metal structures.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth
NEC	National Electrical Code Article 250 Grounding and Bonding
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data.
- C. Grounding System Test Results.

1.04 QUALITY ASSURANCE

- A. Comply with requirements of NEC Article 250.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.06 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.07 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 GROUND CABLE

- A. Annealed bare copper, concentric stranded as specified. If cable sizes are not indicated, the minimum sizes shall be per NEC 250 or as follows, whichever is greater:
 - 1. 15kV - 480V transformer: 250 MCM.
 - 2. 15kV Load Interrupter: 4/0 AWG.
 - 3. 480V switchgear: 4/0 AWG.
 - 4. 480V MCC and switchboards: 2/0 AWG.
 - 5. Lighting panels: 1/0 AWG.
 - 6. Exposed metal: 2 AWG.
 - 7. Grounding electrode conductor: 1/0 AWG.

2.02 GROUND RODS

- A. Copper covered steel, 3/4-inch diameter and ten feet long.
- B. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

2.03 COMPRESSION CONNECTORS

- A. Cast copper.
- B. Acceptable Manufacturer:
 - 1. Thomas and Betts.
 - 2. Burndy.
 - 3. Approved Equal.

2.04 BOLTED CONNECTORS

- A. Acceptable Manufacturer:
 - 1. Burndy.
 - 2. O. Z. Gedney.
 - 3. Approved Equal.

2.05 EXOTHERMIC CONNECTORS

- A. Acceptable Manufacturer:
 - 1. Thermoweld.
 - 2. Cadweld.
 - 3. Approved Equal.

2.06 GROUNDING PLATE – CAST IN CONCRETE

- A. Cast copper plate for use with future two-hole lug connection. Flush mounted in concrete.
- B. Acceptable Manufacturers:
 - 1. Burndy.
 - 2. Erico.
 - 3. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Make embedded and buried ground connections by compression connectors utilizing diamond or hexagon dies. Use a hand compression tool for wire sizes 2/0 AWG and smaller and a hydraulic pump and compression head for wire sizes larger than 2/0 AWG.
- B. Tools and dies:
 - 1. Approved for purpose used.
 - 2. Dimple compressions are not acceptable.
- C. Prepare compression connections in accordance with the manufacturer's instructions.
- D. Unless otherwise indicated, make exposed ground connections to equipment by bolted clamps.
- E. Do not use solder in any part of the ground circuits.
- F. Cables:
 - 1. Securely attach embedded ground cables and fittings to concrete reinforcing steel with tie wires and prevent from displacement during concrete placement.
 - 2. As each part of the grounding system below finished grade is completed, notify the Project Representative a minimum of four hours prior to backfilling.
- G. Extensions:
 - 1. Extend grounding conductors that are extended beyond concrete surfaces for equipment connection a sufficient length to reach the final connection point without splicing.
 - 2. Minimum extensions: 3 feet.
- H. Conductors:
 - 1. Locate grounding conductors that project from a concrete surface as close as possible to a corner of the equipment pad, protected by conduit, or terminated in a flush grounding plate.
 - 2. Terminate grounding conductors for future equipment using a two-hole copper flush mounted grounding plate.
 - 3. Support exposed grounding conductors by non-corrosive metallic hardware at 4-foot intervals or less.
 - 4. Ground conductors, except signal conductor shields entering enclosures:
 - a. Bonded together to the enclosure if it is metallic and to metallic raceways within or terminating at the enclosure.
 - 5. Grounding conductor shall not be used as a system neutral.
- I. Use compression-type lugs in accordance with manufacturer's recommendations.
- J. Directly connect lightning arresters to the ground system using copper conductors, sized as specified.
- K. Metallic sheaths or shields of shielded power cable:
 - 1. Terminated by a copper grounding strip provided with cable connection for connection to the grounding system.
- L. Prior to making ground connections or bonds, clean metal surface at the point of connection.
- M. For all control devices with sealed cable connection, include a ground conductor in the control cable.
- N. Prior to burying of the ground conductors, record location for Record Drawings.

3.02 RACEWAY GROUND

- A. Metallic conduits:
 - 1. Assembled to provide a continuous ground path and bonded using insulated grounding bushings.
 - 2. Bond using insulated grounding bushings.
- B. Non-metallic conduits: Insulated ground conductor sized in compliance with the NEC.
- C. Grounding bushings: Connected to the grounding system using conductors sized in compliance with NFPA 70.
- D. Cable trays:
 - 1. No. 2/0 AWG bare copper ground conductor run on the outside of each tray.
 - 2. Conductor to be connected to each section or fitting using a carriage bolt and clamp.
- E. Every conduit shall contain an insulated green ground conductor sized in compliance with NEC.

3.03 EQUIPMENT AND ENCLOSURE GROUND

- A. Connect electrical and distribution equipment to the grounding system. Cables sized as indicated.
- B. Connect non-electrical equipment with metallic enclosures to the grounding system.

3.04 ISOLATED GROUNDING

- A. Where the manufacturer of equipment supplied from 120 volt instrument power panels requires an isolated ground, provide an additional isolated ground conductor from the equipment through the instrument power panel for connection to a single point ground bus in the automatic transfer switch enclosure.
- B. Conductor: Green insulation with a yellow stripe and run in the same raceway as the power and neutral conductors.
- C. Neutral conductor from the ultra-isolation transformers:
 - 1. Grounded only at the single point ground bus in the automatic transfer switch.

END OF SECTION

SECTION 26 05 33

RACEWAYS, BOXES, AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the electrical conduits, wireways, pull boxes, cable vault, cable trays, fittings, and supports.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI C80.1	Rigid Steel Conduit-Zinc Coated
ANSI C80.3	Electrical Metallic Tubing-Zinc Coated
ASTM A 48 REV A	Gray Iron Castings
ASTM A193 REV C	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM F512	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
FEDSPEC WW-C-581E	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC W-C-1094A	Conduit and Conduit Fitting Plastic, Rigid
NEC 500	Classified Locations, Classes I, II, and III, Divisions 1 and 2
NEMA ICS 6	Industrial Control and Systems Enclosures
NEMA RN1	Polyvinyl Chloride (PVC) externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA VE-1	Metal Cable Tray Systems
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 79	Electrical Standards for Industrial Machinery
UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 360	Liquid Tight Flexible Electrical Conduit
UL 651	Rigid Nonmetal Electrical Conduit
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Include manufacturer's catalog cuts as specified by Section 26 05 00. Include general information and detailed specifications for the products specified in this Section.
- C. Certifications and calculations that raceway supports meet the seismic requirements specified in Sections 26 05 00, 01 73 00, and this Section.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 RACEWAY

- A. General requirements for raceway materials specified in this Section are listed in the RACESPECS sheets at the end of this Section. The type of raceway to be used for any given area and application shall conform to the requirements of Table A in this Section.

2.02 BOXES AND FITTINGS

- A. Pull Boxes and Wiring Gutters:
 - 1. Device and junction boxes less than 6 inches square shall be Type FD galvanized cast ferrous. Boxes larger than FD boxes shall be constructed of sheet steel, galvanized after fabrication, or NEMA 4X stainless steel or nonmetallic.
 - 2. Outdoor boxes and enclosures shall be provided with neoprene gaskets on the hinged doors or removable covers.
 - 3. Conduit bodies shall be ferrous alloy with screw taps for fastening covers. Gaskets shall be made of neoprene.
 - 4. Boxes and enclosures in corrosive areas shall be NEMA 4X stainless steel or nonmetallic.
 - 5. Boxes in classified areas shall be NEMA Class 7 galvanized cast ferrous.
 - 6. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code.
 - 7. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle.
 - 8. Covers larger than 3 by 4 feet shall be split.
- B. Terminal Cabinets:
 - 1. Terminal cabinets located indoors shall be NEMA 4.
 - 2. Cabinets located outdoors and in corrosive areas shall be NEMA 4X.
 - 3. Cabinets shall be provided with hinged doors.
 - 4. Adjustable terminal strip mounting accessories shall be provided.
 - 5. Cabinets shall be provided with channel mounted terminal blocks rated 30 A, 600 Vac.
 - 6. Terminals shall be No. 8 minimum strap-screw type, suitable for ring tongue or locking spade terminals.
- C. Conduit Seals:
 - 1. Install conduit seals in classified areas in conduit runs leaving the space. They shall be of the EYS or EZS type with male and female hubs.
 - 2. Use PVC-coated fittings with urethane interior coating for PVC-coated GRS; use copper free cast aluminum for rigid aluminum.

3. The sealing compound shall be as prescribed by the manufacturer of the sealing conduit body.
4. Use the sealant, such as Chico, in areas that are defined as classified and meet the NEC requirements for Article 500.

D. Expansion/Deflection Coupling:

1. The coupling housing shall be watertight and made with the following materials:
 - a. Sleeve: neoprene
 - b. Bands: Stainless steel
 - c. Bonding Jumper: tinned copper braid
2. Expansion/Deflection shall provide a minimum axial expansion or contraction of $\frac{3}{4}$ " and angular misalignment of 30°.
3. Acceptable Manufacturer:
 - a. OZ-Gedney, "Type DX"
 - b. Crouse-Hinds "Type XD"
 - c. Approved Equal.

2.03 RACEWAY SUPPORTS

A. Conduit Supports:

1. Provide hot-dip galvanized framing channel with end caps to support groups of conduit.
2. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required.
3. Conduit supports for PVC-coated rigid steel and PVC conduit systems shall be one-hole PVC-coated rigid steel or clamps conduit wall hangers.

B. Ceiling Hangers:

1. Ceiling hangers shall be adjustable galvanized carbon steel rod hangers as specified. Straps or hangers of plumber's perforated tape are not acceptable.
2. Unless otherwise indicated, hanger rods shall be 1/2-inch all-thread rod and shall meet ASTM A193.
3. Hanger rods in corrosive areas and those exposed to weather or moisture shall be stainless steel.

C. Suspended Raceway Supports (Racks):

1. Suspended raceway supports shall consist of concrete inserts, galvanized carbon steel rod hangers, and jamb nuts supporting hot-dip galvanized framing channel or lay-in pipe hangers as required.
2. Unless otherwise indicated, hanger rods shall be 1/2-inch all-thread rod and shall meet ASTM A193.
3. Brace all suspended raceway supports at 30-foot intervals (alternating from one side to the other) to meet specified seismic requirements.

D. Design by Professional Engineer:

1. Raceway supporting systems, structures, and elements shall be designed to meet seismic and other building structural requirements and to support the static and dynamic load of the wiring and raceways that they will carry. Systems to be installed shall be prepared by a Professional Engineer registered in the state of Washington to ensure conformance with Seattle Building code and ASCE 7 Chapter 13 as identified in ASCE 7 Table 13.2-1 for seismic, building, and load requirements.
2. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00
 - a. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$

2.04 NAMEPLATES

- A. Provide nameplates for all boxes in accordance with the requirements of Section 26 05 00. Nameplate wording shall be as indicated on the Drawings.

- B. Where no wording is specified, the Contractor shall provide the functional description of the device on the nameplate.

2.05 FIRESTOPS

- A. General:
 - 1. All firestops shall be in accordance with the requirements of Section 07 84 00.
 - 2. Apply in accordance with manufacturer's recommendations.
 - 3. Maintain fire and area ratings of raceways and cables passing through floors, ceilings, and fire rated walls.
- B. Sealant:
 - 1. Products which are affected by water are not acceptable.
 - 2. Acceptable Manufacturer:
 - a. 3M CP25WB+
 - b. Vimasco WC-5 FR
 - c. Flamemastic 77
 - d. Approved Equal.
- C. Penetrations:
 - 1. Penetrations to be sealed using expandable cable/conduit transit system:
 - a. Fire rated to UL 1479.
 - b. Water and dust-tight.
 - c. Hardware: Stainless steel.
 - d. Applications:
 - 1) Concrete & Brick: Cast in place, or core drilled hole with mechanical expanding rubber seal.
 - 2) Gypsum: Bolt on frame penetration, or core drilled hole with mechanical expanding seal.
 - 3) Metal Enclosure: Welded, or bolt on frame penetration.
 - e. Size frame to leave minimum 25% spare space for future cable penetrations.
 - 2. When passing through existing penetrations remove existing fire caulk, pillows or grout and replace with transit system.
 - 3. Acceptable Manufacturer:
 - a. Roxtec,
 - b. Nelson,
 - c. Hawke
 - d. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Specific raceway types and applications are indicated on the Drawings and/or in the raceway schedule. When not indicated on the Drawings and/or in the schedule Table A specifies the type of raceway required for each location and application by RACESPEC sheet. Use fittings, hubs and boxes as specified by the raceway type in RACESPEC. Unless otherwise indicated, in Table A, unscheduled conduit shall be galvanized rigid steel, RACESPEC type GRS.

TABLE A

Location	Application/Condition	RACESPEC
Indoor noncorrosive	Exposed	GRS
Indoor corrosive	Exposed	PGRS
Outdoor	Exposed	PGRS
Concealed	Embedded in concrete structure or beneath slab-on-grade	PGRS
Underground	Instrumentation, communications and data signals encased in concrete, duct bank	PGRS
Underground	Instrumentation, communications and data signals directly buried	PGRS
Underground	Power and control signals directly buried	PGRS
Non-Classified	Final connection to equipment and light fixtures	LFS
Non-Classified Corrosive/Wet	Final connection to equipment and light fixtures	LFNC
Architecturally finished areas	Final connection to light fixtures	FLEX
All Locations	Classified	PGRS

3.02 RACEWAY NUMBERING SYSTEM

A. General:

1. Identify each conduit; rack shall be identified by a unique number shown in the Drawings.

B. Conduit Identification:

1. Pressure stamp conduit numbers into a non-corrosive metal tag. Fix a tag with number to each end of each conduit and at each manhole, pullbox, handhole and penetration with Type 304 Stainless Steel wire.

3.03 CONDUIT

A. General:

1. The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.
2. Conduit runs shall be limited to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.
3. Raceways shall be provided for lighting, receptacles, power, control, fire alarm, instrumentation, signaling, and grounding systems.

B. Indoor and Outdoor Conduit Systems:

1. Unless otherwise indicated, in general, conduit inside structures shall be exposed.
2. Unless otherwise indicated, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein.
3. Install conduit to conform to the requirements of the RACESPEC sheets and the following:
 - a. Install exposed conduit either parallel or perpendicular to structural members and surfaces.
 - b. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.
 - c. Exposed conduit shall be run on supports spaced not more than 8 feet apart.
 - d. Where three or more conduits are located in parallel run, space them out from the wall using framing channel.
 - e. Where conduits are suspended from the ceiling, support systems shall comply with the requirements of this Section.
 - f. Secure conduit rack supports to concrete walls and ceilings by means of cast-in-place anchors or framing channel concrete inserts.
 - g. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degrees C.

- h. Install conduits between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, place conduits under the reinforcement.
- i. Route conduit clear of structural openings and indicate future openings.
- j. Flash and seal watertight those conduits which pass through roofs or metal walls.
- k. Neatly group conduit into any openings cut into concrete and masonry structures, and grout using non-shrink type grout.
- l. During construction, cap conduits to prevent entrance of dirt, trash, and water.
- m. Terminate exposed conduit stubs for future use with galvanized pipe caps.
- n. Determine concealed conduit stubup locations from the manufacturer's shop drawings.
- o. Terminate concealed conduit for future use in equipment or by galvanized couplings plugged flush with structural surfaces.
- p. Where the Drawings indicate future duplication of equipment wired hereunder, provide concealed portions of conduits for future equipment.
- q. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.
- r. Terminate all conduits that enter enclosures by fittings that ensure that the NEMA rating of the enclosure is not affected or changed.
- s. Connect underground metallic or nonmetallic conduit that turns out of concrete, masonry or earth to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.
- t. Transitions from concealed or underground or embedded locations to exposed or aboveground or above-grade locations shall be made using type PGRS conduit for a distance of at least 12 inches on either side of transition.
- u. Conduit across structural joints where structural movement is allowed shall have weathertight expansion and deflection fitting of that conduit size.

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

A. The following RACESPECS are included in this Section:

RACESPEC Symbol	Raceway Description
FLEX	Flexible steel conduit
GRS	Galvanized rigid steel conduit
LFS	Liquidtight flexible steel conduit
PGRS	PVC coated rigid steel conduit
LFNC	Liquidtight flexible non-metallic conduit
WW	Wireway and auxiliary gutter

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

Raceway Identification:	FLEX
Description:	Flexible steel conduit.
Application:	Final connection to lighting fixtures in architecturally finished areas only.
Compliance:	UL 1.
Construction:	Spirally wound galvanized steel strip with successive convolutions securely interlocked.
Minimum Size:	1/2 inch.
Fittings:	Compression type.
Other:	FLEX shall be provided with an internal ground wire.
Installation	Flexible steel conduit shall be made up tight and with conductive "coppershield" thread compound.

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

Raceway Identification:	GRS
Description:	Galvanized rigid steel conduit.
Compliance:	ANSI C80.1, UL 6.
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Acceptable Manufacturers:	Allied Tube and Conduit Corp., Wheatland Tube Co., Approved Equal.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	Hubs: Insulated throat with bonding locknut, hot-dip galvanized. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection. O-Z Gedney, CHM-XXT, or Approved Equal.
Unions:	Electrogalvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or Approved Equal. Threadless fittings are not acceptable.
Boxes:	
Indoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA 12 welded steel 6 inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4 watertight. Conduit Bodies: Ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.
Outdoor and Wet Areas:	Type FD cast ferrous for all devices and for junction boxes less than 6 inches square. NEMA 4X stainless steel or nonmetallic for 6 inches square and larger.
Corrosive:	NEMA 4X stainless steel or nonmetallic.
Classified:	NEMA Class 7 cast ferrous.
Elbows:	
3/4" through 1-1/2":	Factory fabricated or field bent.
2" through 6":	Factory fabricated only.
Conduit Bodies:	
3/4" through 4":	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
5" and 6":	Electrogalvanized iron or cast iron box.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
Acceptable Manufacturers:	Appleton, Crouse-Hinds, Hubbel, O.Z. Gedney, Approved Equal.

Raceway Identification:**GRS****Installation:**

Galvanized rigid steel conduit shall be made up tight and with conductive "coppershield" thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs.

Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.

Exposed male threads on galvanized rigid steel conduit shall be coated with zinc-rich paint.

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

Raceway Identification:	LFS
Description:	Liquidtight flexible steel conduit.
Application:	Final connection to equipment subject to vibration or adjustment.
Compliance:	UL 360.
Construction:	Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum Size:	3/4 inch.
Fittings:	Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90-degree fittings shall be used where applicable.
Installation:	<p>The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches.</p> <p>Liquid-tight flexible steel conduit shall be made up tight and with conductive "coppershield" thread compound.</p>

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

Raceway Identification:	PGRS
Description:	Galvanized rigid steel conduit, corrosion-resistant, polyvinyl chloride (PVC) coated.
Compliance:	ANSI C80.1, UL 6, NEMA RN1.
Finish:	PGRS shall be hot dipped galvanized rigid steel conduit. The inside and outside, as well as the threads shall be galvanized. A minimum 40-mil thick PVC coating shall be bonded to the outside of the conduit and the inside shall be coated with 2-mil urethane. Coating shall be free of pinholes. Bending of conduit shall not damage either the interior or exterior coating. Bond strength shall exceed the tensile strength of the PVC coat. Elbows shall be factory made and coated.
Minimum Size:	3/4 inch.
Fittings:	Similarly coated to the same thickness as the conduit and provided with Type 304 stainless steel hardware. A 2-mil urethane coating shall be applied to the interior, and the threads of all fittings and couplings. Conduit and fittings shall be manufactured by the same company.
Hubs:	Hubs for connection of conduit to junction, device, pull or terminal boxes shall be threaded and made of cast ferrous alloy. Hubs shall be galvanized steel and have insulating bushings with bonding locknuts. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection.
Boxes:	
Non-Classified:	NEMA 250, Type 4X stainless steel or nonmetallic.
Classified:	NEMA 250, Type 7D cast ferrous.
Installation:	PVC-coated conduit shall be supported away from the structure using PVC-coated conduit wall hangers. All conduit threads shall be covered by a plastic overlap which shall be coated and sealed per manufacturer's recommendations. Plastic coated conduit shall be made tight with special wrenches and fittings designed for tightening PVC-coated conduit. All threads shall be protected against corrosion per NEC 300.6 (a) by liberally applying an approved electrically conductive, corrosion-resistant compound – "coppershield." Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

Raceway Identification:	LFNC
Description:	Liquidtight flexible non-metallic conduit.
Application:	Final connection to equipment subject to vibration or adjustment.
Compliance:	UL 1660.
Construction:	PVC Core with fused flexible PVC jacket.
Minimum Size:	3/4 inch.
Fittings:	High strength plastic body complete with lock nut, o-ring, threaded ferrule, sealing ring, and compression nut. Forty-five and 90-degree fittings shall be used where applicable.
Installation:	The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches.

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

Raceway Identification:	WW
Description:	Wireway and auxiliary gutter, flanged, oiltight type with hinged covers.
Compliance:	JIC EMP-1.
Minimum Size:	4-inch by 4-inch.
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Application:	As indicated on the Drawings.

END OF SECTION

SECTION 26 05 36

CABLE TRAYS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the requirements cable tray including, design, installation, and testing.
- B. Equipment list:

Type	Location	Support Span (Feet)	Rung Spacing (Inches)	Barrier	Width (Inches)
CTP2	RSP Electrical Room (411) to RSP Battery Rooms (407 & 408)	20	12	No	24

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NEMA VE 1-1998	Metallic Cable Tray Systems
NEMA VE 2-2000	Cable Tray Installation Guidelines
NFPA 70	National Electrical Code (NEC)
UL	Underwriters Laboratories, Inc.
IBC	International Building Code
WAC	Washington Administrative Code

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00 and Section 26 05 00.
- B. Items to be submitted for this Section:
1. Manufacturer's descriptive literature for all materials.
 2. Test results for all specified testing.
 3. Contractor's certifications and calculations that the cable tray support systems meet the seismic requirements specified in Sections 26 05 00 and 01 73 00 and this Section.
 4. The qualifications of the design professional to be charged with design, inspection and certification of tray supports and seismic restraint systems.
 5. Tray layouts and layout schedule showing cable tray locations for all tray systems in each area with respect to structures, other piping and utilities (ductwork, etc.) and details and location of joints, anchors, supports, fittings, connections, penetrations, fire stop barriers, supports, expansions joints, appurtenances, and flexible couplings, as applicable. Drawings shall be original layouts by the Contractor; photocopies of Contract Drawings are not acceptable.
 6. Design drawings and calculations for tray supports and maximum simple beam deflections, anchorage, and seismic restraints, and expansion control systems as specified in Section 01 73 00 and this Section. The drawings and calculations shall be sealed and submitted by the design professional.

7. Inspection reports, authored, sealed, and signed by the design professional retained under this Section and submitted to the Project Representative each week, as specified within this Section. The design professional's final report shall be submitted to the Project Representative before beneficial occupancy.
8. Design details and materials for firestopping.

1.04 DESIGN OF CABLE TRAY SYSTEMS

- A. General: The cable tray support system shall be subject to the same design requirements as specified for support systems under Section 26 05 33.
- B. Procedures: In addition to materials and labor required to construct cable tray systems, Contractor shall provide professional engineering services ("design professional") for the design of the cable tray systems.
- C. Qualifications: Cable Tray systems, structures, and elements shall be designed to meet seismic and other building structural requirements and to support the static and dynamic load of the wiring and raceways that they will carry. Systems to be installed shall be prepared by a Professional Structural Engineer registered in the state of Washington to ensure conformance with IBC seismic, building, and load requirements. The design professional shall have not less than five years' experience in the type of cable tray support, and seismic restraint design work required for this project.
- D. Coordination with Drawings and Specifications: If a particular type of support, anchor, seismic restraint, or expansion element is detailed on the Drawings, those elements shall be incorporated into the Contractor's design. Cable tray system submittals by the Contractor shall include all elements, including unscheduled trays.
- E. Coordination with cable installation requirements: The tray system design shall be coordinated with the cable installation means to ensure that the cables can be installed without exceeding the cable manufacturer's limits for pulling tensions, sidewall pressures and minimum bending radii.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.06 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.07 WARRANTY

- A. Refer to the Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/PRODUCTS

- A. Candidate manufacturers of cable tray include Cooper B-Line, MP Husky, Approved Equal.

2.02 GENERAL

- A. Unless noted otherwise in this Section, support hardware for cable trays shall be Type 316 stainless steel.

2.03 TWO SIDE RAIL TYPE

- A. Two side rail cable trays shall be ladder type.
- B. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung shall be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200-pound concentrated load when tested in accordance with NEMA VE-1, Section 5.4.
- C. Materials and Finish: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
- D. Tray sizes shall have 4-inch minimum usable load depth.
- E. Straight tray sections shall have side rails fabricated as I-beams or channels.
- F. The Contractor shall size fittings for the radius of the cable with the largest bending radius in that cable tray.
- G. Splice plates shall be the bolted type, made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed 0.00033 ohm. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
 - 1. Aluminum Tray: Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be Type 316 stainless.

2.04 LOADING CAPACITIES

- A. Cable trays shall be designed to meet the following maximum simple beam deflections at the maximum specified loading capacities listed. The maximum simple beam deflection for the maximum loading of each tray type and width shall not exceed 1/180th of the tray span (deflection factor = 0.005556).
- B. Maximum allowable tray weight capacities for trays is 100 pounds per foot.

2.05 CABLE TRAY SCHEDULE

- A. Per equipment list in this Section.
- B. Type:
 - 1. CTP1: Power (<600V, less than 4/0 AWG).
 - 2. CTP2: Power (<600V, 4/0 AWG and greater).
 - 3. CTHV: Medium Voltage Power.
 - 4. CTC: Control (120V).
 - 5. CTS: Signal (dc).
- C. Support Span: Is the maximum distance between cable tray supports.

2.06 NAMEPLATES

- A. Provide nameplates in accordance with the requirements of Section 26 05 00. Nameplate wording shall be as indicated on the Drawings and Schedules.
- B. Where no wording is specified, the Contractor shall provide the functional description of the device on the nameplate.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install cable trays as per approved design submittal. Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment complies with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.
- B. Cable tray hangers and supports shall be installed per the applicable requirements specified for pipe hangers and supports specified in Section 26 05 33.
- C. Coordinate cable tray with other electrical work as necessary to properly integrate installation of cable tray work with other work.
- D. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.
- E. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions.
- F. Seismic Anchorage and Bracing: Sections 26 05 00 and 01 73 00.
- G. Provide expansion capability at all building expansion joints. Provide 12" gap in tray at expansion joints. Tie cables to tray at one side of gap only to allow movement.
- H. Provide for seismic movement at seismic joints as defined in the structural design documents at all structure seismic joints.
- I. Provide 3" gap at pipe crossings.
- J. Ground and bond metal cable tray in accordance with Section 26 05 26.

3.02 TESTING

- A. In addition to any testing herein, perform all testing for this product or system, the applicable codes, and the manufacturers' current quality assurance program.
- B. Test cable trays to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B for testing and test methods.
- C. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1; including test reports verifying rung load capacity in accordance with NEMA VE-1 Section 5.4.

3.03 CABLE TRAY SUPPORT INSPECTION

- A. The Contractor shall cause the design professional retained under the provisions of this Section to inspect the installation of the cable tray supports and seismic restraints provided under this Contract. The design professional shall be at the site of the work during the installation work and shall provide the Project Representative with weekly reports indicating progress of the work.
- B. The Project Representative will provide special inspection in accordance with Section 01 73 00 for certain cable tray seismic anchorage and bracing systems as shown on the Drawings.
- C. Upon completion of construction, but prior to beneficial occupancy of the cable tray systems by King County, the design professional shall conduct a detailed final inspection and furnish the Project Representative with a final report certifying, without qualification, that all work has been accomplished in accordance with applicable requirements. All reports shall bear the design professional's seal and signature in accordance with the laws, rules, and regulations of the state of Washington.

END OF SECTION

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the acceptance testing of electrical materials, equipment, and systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI	American National Standards Institute
ICEA	Insulated Cable Engineers Association
NEMA	National Electrical Manufacturer's Association
NETA	International Electrical Testing Association [NETA]

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Draft Test Plan and Procedures in accordance with the latest NETA requirements, 90 days prior to initial functional checkout. Contractor shall use NETA Acceptance Testing Specifications for all new equipment installed under this contract and NETA Maintenance Testing Specifications for all existing equipment reused under this contract unless otherwise requested by the Project Representative.
- C. Completed test report Forms 26 05 00-A, 26 05 00-B, 26 05 00-C, 26 05 00-D, 26 05 00-F and 26 05 00-G contained in Section 01 33 10.
- D. Functional checkout procedures 45 days prior to performing initial functional checkout tests.
- E. Final Test Report documenting test results and equipment and device settings.
- F. NETA certification of Testing Contractor provided as part of test plan submittal.

1.04 QUALITY ASSURANCE

- A. Qualifications: Testing Contractor shall be NETA certified.

1.05 APPLICATION

- A. Requirements for testing in accordance with this Section are specified in this and other sections of Divisions 26, 27, 28, and 40. Where testing in accordance with this Section is required, the required tests, including correction of defects and retesting, shall be completed prior to energization of material, equipment, or systems.

1.06 TEST EQUIPMENT AND MATERIALS

- A. Test instruments shall be calibrated to references traceable to the National Institute of Standards and Testing Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date of recalibration.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 TESTING

- A. General:
 - 1. Prior to energizing the electrical circuits, perform the following tests. Unless otherwise indicated, a 1,000 volt megohmmeter shall be used for resistance measurements.
 - 2. Record test measurements on the Forms 26 05 00-A and 26 05 00-B.
 - 3. Submit a description of the proposed functional test procedures 45 days prior to the performance of functional checkout.
- B. Insulation Resistance Measurements:
 - 1. General:
 - a. Make general insulation resistance measurements on conductors and energized parts of electrical equipment.
 - b. Unless otherwise indicated, minimum acceptable values of insulation resistance shall be in accordance with the applicable ANSI, ICEA, NEMA, or NETA standards for the equipment or material being tested.
 - c. Record the ambient temperature at which insulation resistance is measured on the test form.
 - d. Record insulation resistance measurements on Form 26 05 00-A.
 - e. Insulation with resistance of less than 100 megohms is not acceptable.
 - f. Document checks and measurements.
- C. Conductor and cable tests:
 - 1. Measure phase-to-ground insulation resistance for all circuits 120 volts and above, except lighting circuits. Make measurements with motors and other equipment disconnected, except that solid state equipment shall be disconnected unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.
- D. Motor Tests:
 - 1. Complete Form 26 05 00-B for each motor after installation.
 - 2. Measure insulation resistance for all motors before being connected.
 - 3. Motors 50 HP and larger: Make insulation resistance measurements at the time of delivery and when connected.
 - 4. Insulation resistance values less than 100 megohms are not acceptable.
 - 5. Verify motor phase rotation.
 - 6. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.
 - 7. Measure current on each phase with motor running at full load.
 - 8. Verify energy efficiency performance meets or exceeds design requirements.
- E. Distribution Equipment: Measure insulation resistance for transformers, panelboards, and other distribution equipment phase-to-phase and phase-to-ground.
 - 1. Functional Checkout:
 - a. Perform functional testing in accordance with the manufacturer's requirements and the procedure provided in test plan and procedures.
 - b. Prior to functional testing, adjust and make operational all protective devices.
 - c. Have Project Representative witness the testing.
 - d. Check that circuit breakers, meters and monitors are installed and function properly.

- e. Check functional operation of switchboards, motor control centers, control panels, automatic transfer switches and other electrical equipment.
 - f. Prior to energization of equipment, perform a functional checkout of the control circuit. Checkout shall consist of energizing each control circuit and operating each control, alarm, or malfunction device and each interlock in turn to verify that the specified action occurs.
 - g. Document all test results and device settings in the final test report.
 - h. Verify energy efficiency performance meets or exceeds design requirements.
2. Complete Form 26 05 00-C, 26 05 00-D, 26 05 00-F and 26 05 00-G for each device as applicable. Where the test forms provided do not cover the necessary testing requirements, prepare a Test Report with similar format summarizing the final test procedures and test results.

END OF SECTION

SECTION 26 09 11

INSTRUMENT TRANSFORMERS, METERS, SWITCHES, AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies accessories for switchboard assemblies

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/IEEE C37.21	IEEE Standard for Control Switchboards
ANSI/IEEE C39.1	Requirements for Electrical Analog Indicating Instruments
ANSI/IEEE C57.13	Standard Requirements for Instrument Transformers

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's catalog cut sheets indicating the general features and dimensions of devices.
 2. Interconnection requirements.
 3. Burden, accuracy class and ratio data for instrument transformers.
 4. Applicable operation and maintenance items: See Section 01 78 23.
 5. Material list.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 INSTRUMENT TRANSFORMERS

- A. General:
1. Molded dry-type in accordance with ANSI/IEEE C57.13.

2. Volt-ampere rating suitable for carrying the specified load without overheating or exceeding the permissible accuracy for the transformer.
 3. Thermal Capacity: Minimum 55 degrees rise above 30 degrees C ambient.
 4. Mechanical Rating: Equal to short-time current carrying capability of circuit breaker.
 5. Identify polarity with standard mark or symbol.
- B. Potential Transformers (PT):
1. Voltage ratings as shown on drawings, with ANSI accuracy class of 0.3 for connected burden.
 2. Equipped with two primary and one secondary current limiting fuses.
- C. Current Transformers (CT):
1. Ratios as shown on drawings, with accuracy's conforming to ANSI C57.13.
 - a. Class C20 or greater for relaying.
 - b. Class 1.2 maximum for imposed burden for metering.
 2. Type:
 - a. Window for relaying
 - b. Wound for metering
 3. Shorting type terminal boards for current transformer leads.
 4. Secondary Wiring: Install in wiring trough.
 5. Isolate from adjacent components and circuits by removable insulating or metal barriers.
 6. Window type CTs accessible for replacement without removing high voltage insulated connections.

2.02 PANEL METERS

- A. Indicating meters:
1. 4-1/2-inch square, semi-flush, mounted switchboard type.
 2. Movement taut-band with an accuracy of plus or minus 1 percent of full scale.
 3. Case: Black.
 4. Scale: White with black markings with length of the scale greater than 7 inches over a deflection angle of 250 degrees.
 5. Manufactured in accordance with applicable requirements of ANSI C39.1.

2.03 KEY INTERLOCK

- A. Two or more identically keyed brass bolt locks. The bolt on the lock shall prevent the operation of the electrical equipment.
- B. Provide one brass key for each group of identical locks.
- C. Key to be held captive when the lock is positioned to allow equipment operation

2.04 INDICATING LIGHTS

- A. Switchboard Indicating Lights: PTT (Push To Test) LED type.

2.05 NAMEPLATES

- A. Nameplates: Section 26 05 00.

2.06 POWER METERS

- A. Digital Line Meter Analyzer and Protection (MA&P) Device.
- B. See Contract Drawings for IP Addresses.
- C. Schneider ION Analyzer having the features and functions specified below:

1. Direct reading metered or calculated values of the items listed below and shall auto range between Units, kilo-units, and Mega-units for all metered values.
 2. Capable of displaying multiple parameters at once, including two user configurable custom screens displaying any seven of the parameters listed.
 3. Indicator LED shall status for safety and troubleshooting purposes.
 4. Time, date, software version and network address shall also be displayed.
 5. Accuracies indicated below to be of read or calculated values:
 - a. AC Current (amperes) in A, B, and C phases, 3-Phase Average, Neutral (N) and Ground (G). Accuracy +0.2% (provide neutral and ground current transformer).
 - b. AC Voltage (volts) for A-B, B-C and C-A, Phase Average, A-N, B-N and C-N, Average Phase to N, and N to G. Accuracy +0.2%.
 - c. Real Power (watts), Reactive Power (vars), Apparent Power (VA) for each phase and system. Accuracy +0.4%.
 - d. Real Energy (Whr), Reactive Energy (varhr), Apparent Energy (Vahr) for each phase and system. Accuracy +0.4%. Forward/Reverse/Net indication shall be provided.
 - e. Frequency (hz). Accuracy +0.4%.
 - f. Demand values for System Current (amperes), System Real Power (watts), System Reactive Power (vars) and System Apparent Power (VA).
 - g. Power Factor both Displacement (60-cycle fundamental watts to VA) and Apparent (total watts to total vars including harmonics for A, B and C phases and system). Accuracy +0.8%.
 - h. Current Percent Total Harmonic Distortion (THD) in A, B and C phases, and N.
 - i. Voltage percent THD in A-B, B-C, and C-A phases, and A-N, B-N, C-N.
 - j. K-Factor.
 - k. Transformer Derating Factor (CBEMA Factor).
 - l. Crest Factor.
- D. Provide the following advanced analysis features:
1. Trend Analysis Screens displaying the minimum and maximum values for each metered value, with all parameters time stamped to 1-second resolution.
 2. Demand Analysis screens displaying current (phases A, B, C and Average) and power (system real, reactive, and apparent, present demands and peak demands). Peak demands shall display time and date, stamped to within 1-second resolution. Demand Window Selection for metered demand values shall be selectable either as:
 - a. A user selectable fixed window (programmable from 1 to 60 minutes).
 - b. Sliding window method with programmable 1- to 60-minute subintervals, for power (kW, kvar, kVA) demand only.
 - c. Initiated from a synch pulse for power (kW, kvar, kVA) demand only.
 3. Harmonic Analysis Screens shall be capable of being function key triggered to capture a high-speed wave form of 2 cycles of data sampled at 128 samples per cycle, simultaneously recording current in A, B and C phases, N, and G as well as all voltages A-B, B-C, and C-A phases, A-N, B-N and C-N. Data captured shall include the magnitude or percent of the fundamental and the direction of harmonic source (phase angle) for all odd and even multiples of fundamentals from 2nd through the 50th.
 4. Event Analysis Screens shall display data recorded for up to ten event conditions. The initiation level of the declaration of an event condition shall be field programmable for all measured parameters. For each event a description of the event, date, and time of event (1 - second resolution) shall be displayed. In addition, a capture shall be made of all metered values available and current and voltage distortion information harmonic.
 5. Unit shall have logging capabilities, historical retrieval and removable storage media.
 6. Capable of transmitting all data at time of the event via communications to the PLC or SCADA (Ovation) system interface for creating and displaying wave forms.
 7. Event Condition Levels: Capable of being triggered when the programmed threshold is exceeded. All triggers shall have programmable time delays from 0.1 to 60 seconds except voltage disturbance, which shall be programmable from 2 to 3600 cycles.
 8. Provide additional licensed copy of software to the county for programming and configuration.
 9. Provide cables and other devices required for communication with device.
 10. Provide training for county staff on the set-up, programming and use of monitor.

11. See Drawings for IP addresses.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install all accessories and devices per manufacturer's instructions.

END OF SECTION

SECTION 26 09 16

MISCELLANEOUS ELECTRICAL DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies miscellaneous electrical control and power devices, relays, magnetic contactors, disconnect switches, manual starters, and overcurrent protection.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)
NEMA ICS 1	Industrial Controls and Systems: General Requirements
NEMA ICS 2	Industrial Controls and Systems: Controllers, Contactors, and Overload Relays, Rated 600 Volts AC
NEMA KS 1	Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's catalog data for products to be provided in the Work.
- C. Applicable operation and maintenance information: Section 01 78 23.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 CONTROL DEVICES

- A. Pushbuttons:
1. Flush head, heavy-duty, with NEMA rating to match enclosure type.
 2. Operators: Red for stop functions and black for all other functions.
 3. Provide pushbuttons designated "Lock-Out-Stop" (LOS) with a padlockable attachment to maintain the device in a depressed (stop or open) position.

4. Escutcheon legend as specified on the Drawings.
 5. Unless otherwise specified, use momentary contact type.
 6. Contact blocks:
 - a. NEMA ICS 2 designation A600 except when switching circuits monitored by programmable controllers or other solid state circuits.
 - b. Hermetically sealed, logic-read type.
 - c. Acceptable manufacturer:
 - 1) Allen-Bradley.
 - 2) Square D.
 - 3) Approved Equal.
- B. Indicating Lights:
1. Indicating lights: 5 to 6 VDC light emitting diodes (LEDs) with push-to-test feature.
 2. Testing: As a group using a common lamp test button.
 3. Indicating light colors: Per Section 26 05 00.
 4. Heavy-duty, with NEMA rated socket/wiring to match enclosure type.
- C. Control Stations:
1. Classification, unless otherwise specified:
 - a. Indoor locations: NEMA 12.
 - b. Outdoor locations: NEMA 3R or 4.
 - c. Corrosive areas: Nonmetallic NEMA 4X.
 - d. Hazardous areas: NEMA 7.
 2. Pushbuttons: Protective Hypalon boots.
 3. When indicating lights are specified, size to accommodate the transformer type lights.
 4. Acceptable Manufacturer:
 - a. Allen-Bradley, 800 H series.
 - b. Crouse-Hinds, NCS series.
 - c. Approved Equal.

2.02 CONTROL RELAYS

- A. Load-switching Control Relays:
1. When used for switching loads (solenoids, actuators, contactors, motor starter coils, etc.): Heavy-duty machine tool type.
 2. Relays that have contacts used for remote interlocking or when the switching load is not shown: Heavy-duty machine tool type.
 3. Contacts: As a minimum, 4-pole and field interchangeable to either normally open or normally closed. Relay shall be capable of accepting a 4-pole adder.
 4. AC relays: NEMA A600 contact ratings and electrical clearances for up to 600 volts.
 5. DC relays: NEMA P300 contact ratings and electrical clearances for up to 250 volts.
 6. Acceptable Manufacturer:
 - a. Allen Bradley Bulletin 700.
 - b. Square D Class 8501.
 - c. Approved Equal.
- B. Logic Level Switching Control Relays:
1. Four Form C (4PDT), gold-silver-nickel contacts rated 2 amps resistive at 120V AC or 28V DC.
 2. Plug-in type with heavy-duty, barrier-protected screw terminal sockets and clear polycarbonate dust cover with clip fastener.
 3. AC models: Neon lamp indicator wired in parallel with coil.
 4. Acceptable manufacturer (Control relays used for switching solid-state logic and signal circuits):
 - a. Potter Brumfield series KHA.
 - b. Allen Bradley Bulletin 700-HC14
 - c. Approved Equal.
- C. Latching Relay:

1. Electrically actuated latching relay or an industrial relay with an electrically operated latching attachment.
2. Latching mechanism: One SET coil and one RESET coil rated for continuous duty on 120 VAC, or as otherwise shown on the Drawings.
3. Maintain the last state upon a power failure.
4. Contacts: Rated B300 and hermetically sealed in a glass envelope.
5. Normally open and normally closed as shown on the Drawings.
6. Acceptable manufacturer:
 - a. Allen-Bradley.
 - b. Cutler-Hammer.
 - c. Approved Equal.

D. Timers:

1. Timing relays:
 - a. Solid-state, pulse count type using a high frequency RC oscillator and integrated circuit counter for timing.
 - b. Do not use electrolytic capacitors in the timing circuits.
 - c. Time delays from 0.1 seconds to 48 hours, adjustable over a 20:1 range.
 - d. Timing adjustment: Knob adjustment on the top of the unit.
 - e. On-delay, off-delay, and single-shot timing models.
 - f. Reset in 0.03 seconds or less.
 - g. Timer accuracy: Plus or minus 2.0 percent under normal conditions.
 - h. Two NEMA form-C timed contacts.
 - i. Acceptable manufacturer:
 - 1) Agastat, STA series.
 - 2) Agastat BTSALISC with locking bail STAOOI if equal socket.
 - 3) General Electric.
 - 4) Approved Equal.
2. Logic level control relay:
 - a. General:
 - 1) Power supply: as indicated in Drawings or as required.
 - b. Type 1 - Time delay "on" relay.
 - 1) DPDT contacts rated 3 A at 120 VAC.
 - 2) Repeatability: + 0.2% maximum.
 - 3) Setting error: + 10% maximum.
 - 4) Temperature error: + 3% maximum.
 - 5) Range: As specified, 0.1 - 3600 seconds.
 - 6) Lifetime - electrical: 200,000 operations mechanical: 50,000,000 operations.
 - 7) Coil voltage: As specified.
 - 8) Acceptable Manufacturers:
 - a) Allen-Bradley 700-HR series.
 - b) Omron H3CR-A series.
 - c) Approved Equal.
 - c. Type 2 - Time delay "off" relay.
 - 1) "True off" delay: timed contact remains energized after power is removed from coil terminals up to 600 seconds.
 - 2) DPDT contacts rated 3 A at 120 VAC.
 - 3) Repeatability: + 0.4% maximum.
 - 4) Setting error: + 10% maximum.
 - 5) Temperature error: + 0.2% maximum.
 - 6) Range: As specified, 0.1 - 600 seconds.
 - 7) Lifetime - electrical: 100,000 operations mechanical: 20,000,000 operations.
 - 8) Coil voltage: As specified.
 - 9) Acceptable Manufacturers:
 - a) Allen-Bradley 700-HRQ series.
 - b) Omron H3CR-H series.
 - c) Approved Equal.

3. Motor-driven timers:
 - a. Mounted in a one-piece molded case, permanently mounted and wired.
 - b. Driven by a synchronous motor which starts timing when initiated by an external signal.
 - c. Time settings: Made by turning a knob on the front of the dial.
 - d. Neon pilot light visible from the front of the timer shall glow red when the timer motor is energized.
 - e. Visual indication by a cycle progress pointer which advances to zero from the setting back to zero as time progresses.
 - f. Two sets of "instantaneous" NEMA form-C contacts which actuate when the timing is initiated.
 - g. One set of "delayed" NEMA form-C contacts which actuates when the unit has timed out.
 - h. Reset: Unless otherwise indicated, when the timing cycle is completed, timer automatically resets.
 - i. Acceptable manufacturer:
 - 1) Eagle Cycle-flex reset timer HP5 series.
 - 2) Automatic Timing Controls Series 305E.
 - 3) Approved Equal.

2.03 MAGNETIC CONTACTORS

- A. Lighting contactors:
 1. Electrically held contactors used to switch current to light emitting diode (LED) incandescent filament, fluorescent and high intensity discharge (HID) lamp loads.
 2. Rated 600V AC, 60 hertz.
 3. Coil voltage contact rating and number of phase: As specified.
 4. Unless otherwise specified, house in a NEMA 1 enclosure.
- B. Motor contactors:
 1. Designed for continuous operation of induction motors at 600 volts or less at 60 Hz and comply with NEMA ICS 2-321.
 2. Minimum contactor size: Unless otherwise indicated, NEMA size 1.
 3. Supply the contactor with a normally open auxiliary contact for use as a hold-in contact as a minimum. Provide additional contacts as indicated.
 4. Additional contacts as needed.
 5. The coil voltage, frequency, and number of poles to be as specified.

2.04 SAFETY DISCONNECT SWITCHES

- A. Heavy-duty, safety type rated 600 volts AC complete with or without current limiting fuses sized to match ampere rating as shown on the Drawings.
- B. Classification, unless otherwise specified:
 1. Indoor enclosures: Unless otherwise indicated, NEMA 12. See Section 26 05 33.
 2. Outdoor or corrosive areas: NEMA 4X, nonmetallic.
 3. Hazardous areas: NEMA 7.
 4. Classified areas: Suitable for the specified classification.
- C. Operating handle: Capable of being padlocked in the "off" position.
- D. Operator: Positive, quick-make, quick-break mechanism.
- E. Switch Mechanisms: One auxiliary contact rated B150, per NEMA ICS 2-125, that opens before the switch blades.
- F. Horsepower rated for motors and comply with NEMA KS 1.
- G. Defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position.

H. Switches shall have line terminal shields.

I. Acceptable Manufacturer:

1. Cutler Hammer.
2. General Electric.
3. Siemens.
4. Square D.
5. Approved Equal.

2.05 OVERCURRENT PROTECTION

A. Circuit Breakers:

1. Thermal magnetic, molded-case type with the ampere rating as specified.
2. Unless otherwise indicated, circuit breaker interrupting rating:
 - a. 25,000 amperes symmetrical minimum for service at 240 volts and below.
 - b. 65,000 amperes symmetrical minimum for 480-volt service.

2.06 ELAPSED TIME INDICATORS

A. Panel-mounted, non-resettable, six-digit, hour indicator, rated 120 volts AC, 60 Hz.

2.07 TEMPERATURE TRIP RELAY

- A. Capable of monitoring electric motor winding temperatures based on input signals from three 10 ohm copper 3-wire resistance temperature detectors (RTD).
- B. Equipped with light emitting diodes (LED) to indicate which RTD is at the highest temperature. The highest temperature shall be internally compared to two trip settings to trip SPDT output relays. The output relays shall be settable at different temperatures and shall de-energize at the set point on increasing temperature.
- C. Relay Contact Minimum Rating: 240 VAC, 5A non-inductive.
- D. Output Signal: 0 to 1 mA, linearly proportional to the temperature of the hottest RTD.
- E. Powered by 120 VAC, 60 Hz.
- F. Acceptable Manufacturer:
1. Allen Bradley.
 2. Cutler Hammer.
 3. Approved Equal.

2.08 SPEED ADJUSTMENT POTENTIOMETER

- A. Single-turn, heavy-duty potentiometer.
- B. Molded resistance track rated at 2 watts 500 volts. Resistance value: As shown on the Drawings, or if not shown, then suitable for the application.
- C. Equipped with a positive positioning feature to prevent backlash and movement due to vibration.
- D. Bushing mounted using a NEMA Type 13 oil-tight mounting. Include a legend plate with graduated markings from 0 to 100 percent and the word "SPEED."
- E. Acceptable Manufacturer:
1. Cutler Hammer
 2. Allen-Bradley 800T.

3. Approved Equal.

2.09 SELECTOR SWITCHES

- A. For Fans: 600V, heavy duty two-position, four-circuit, suitable for Class 1, Division 2 area.
- B. Unless otherwise shown on Drawings, indicating plate markings as follows: "Enable-Stop."
- C. Acceptable Manufacturer:
 1. Appleton.
 2. Crouse-Hinds EDS 21272.
 3. Approved Equal.

2.10 NAMEPLATES

- A. For all control stations, relays, timers, motor contactors and disconnect switches: Per Section 26 05 00.

PART 3 EXECUTION

3.01 GENERAL

- A. Mount control stations, contactors, and safety disconnect switches 48 inches above finished floor.

3.02 FIELD CHECKOUT AND TESTING

- A. Checkout each miscellaneous electrical device for:
 1. Proper mounting.
 2. Proper interconnections.
 3. Absence of shorts and grounds.
 4. Proper function of motor start and control equipment.
 5. Power supply.
 6. Field devices.
- B. Checkout systems:
 1. Proper interconnections.
 2. Absence of shorts and grounds.
- C. Field Testing:
 1. To be provided as part of the system and operational testing.
 2. Test all products per Section 26 08 00.

END OF SECTION

SECTION 26 12 16
LARGE DRY-TYPE POWER TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies large dry-type transformers with primary windings rated over 600 volts used for power distribution systems.
- B. The general requirements for electrical equipment, as specified in Section 26 05 00, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-Pump 1 Stepdown Transformer	704-TFR03DC011
RSP-Pump 2 Stepdown Transformer	704- TFR03DC021
RSP-Pump 3 Stepdown Transformer	704- TFR03DC031
RSP-Pump 4 Stepdown Transformer	704- TFR03DC041

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/ASQ Q9001	Quality Management Systems Requirements
BS EN ISO 9001	Quality Management Systems Requirements
EN ISO 9001	Quality Management Systems Requirements
ISO 9001	Quality Management Systems Requirements
ANSI/IEEE C57.12.01	Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings
ANSI/IEEE C57.12.55	Transformers Used in Unit Installations, Including Unit Substations
ANSI/IEEE C57.12.91	Test Code for Dry-Type Distribution and Power Transformers
Energy Policy and Conservation Act 1975 and Energy Policy Act 2005, 10 CFR 429	Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment
Energy Policy and Conservation Act 1975 and Energy Policy Act 2005, 10 CFR 431	Energy Efficient Program for Certain Commercial and Industrial Equipment
UL 1561	Standard for Dry-Type General Purpose and Power Transformers
NEMA TP 1	Guide for Determining Energy Efficiency for Distribution Transformers

1.03 DESIGN REQUIREMENTS

- A. System Configuration: 13.8KV, 3PH, 3W (Delta) Primary and 480V, 3PH, 4W (Wye), solidly grounded Secondary.
- B. Components: System includes dry type transformer to step down the voltage level for the RSP motors, air terminal chambers for both primary and secondary sides to transition to external equipment, and necessary monitors, sensors, and control circuits.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Descriptive production information.
 - 2. Itemized Bill of Material including Form 01 78 45-A
 - 3. Dimensional drawings.
 - 4. Operational description.
 - 5. Connection and interconnection drawings.
 - 6. Transformer section equipment data.
 - 7. Nameplate data: Capacities and ratings including noise. Short circuit withstand capability, including thermal and mechanical ratings. Performance characteristics: no-load and full-load losses in kW; efficiency and heat loss at 50, 75, 100 percent load.
 - 8. Conduit entrance locations.
 - 9. Anchorage and bracing drawings and cut sheets, as required by Section 01 73 00.
 - 10. Anchorage and bracing calculations as required by Section 01 73 00.
 - 11. Manufacturer's installation instructions.
 - 12. Certified Factory Test Reports.
 - 13. Operations and Maintenance manuals: Section 01 78 23.
 - 14. Qualifications.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer shall be experienced in the manufacture, operation, and servicing of equipment equal to the type, size, quality, performance, and reliability specified.
 - 2. Manufacturers of equipment finished under this Section shall have a minimum of 10 years experience in the manufacture of such equipment.
 - 3. The transformer shall be manufactured by a company that is certified to ISO 9001, EN ISO 9001, BS EN ISO 9001, or ANSI/ASQ Q9001 for design and manufacture of Power, Distribution, and Specialty Dry Type Transformers. A Certificate of Compliance to this requirement shall be provided.
- B. Provide the Work in accordance with NFPA 70, NEC. Material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
- C. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark.
- D. Transformer coils shall be vacuum cast in the USA to ensure availability of replacement coils should it ever become necessary to have service. In addition, the manufacturer shall have complete in-house capability to perform all ANSI required production tests, and the following optional tests when required:
 - 1. Temperature rise.
 - 2. Sound level.
 - 3. Full wave impulse.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, Protection, and Storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.08 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. ABB.
 - 2. Federal Pacific.
 - 3. SGB-SMIT Group.
 - 4. Square D.
 - 5. Approved Equal.

2.02 GENERAL

- A. Equipment suitable for 13,800 volts, three-phase, three-wire solid grounded-wye electrical system having an available short-circuit current at line terminals of amperes rms symmetrical as shown.
- B. Designed, tested, and assembled in accordance with standards of ANSI, IEEE, and NEMA, applicable to its three major sections.
- C. Unit substation and all its major components to be manufactured and assembled by a single manufacturer in order to achieve standardization for appearance, operation, maintenance, and replacement, and manufacturer's services.
- D. Lifting lugs on equipment and devices weighing over 100 pounds.
- E. Anchor Bolts: Galvanized, sized by equipment manufacturer, and as specified in Section 05 50 00.
- F. Operating Conditions: Equipment to be fully rated without any derating for operating conditions.
- G. Enclosure: IEEE C57.12.55 outdoor enclosure type 103.
- H. Equipment Finish:
 - 1. Manufacturer's standard paint process.
 - 2. Electrocoating process applied over rust-inhibiting 3phosphate base coating.
 - 3. Color:
 - a. Exterior: Gray finish as approved by Project Representative.

2.03 RATINGS

- A. Temperature Ratings: 150 degrees C maximum average temperature rise when transformer operated at full nameplate rating in 30 degree C ambient (average), 40 degree C maximum per ANSI/IEEE C57.

- B. Transformer Cooling and Power Rating:
 - 1. Natural convection cooling/Ambient Air (AA).
 - 2. Power ratings per drawings.
- C. Primary:
 - 1. Voltage: 13.8kV.
 - 2. Connection type: 3-phase, 4-wire, delta-connected.
 - 3. BIL: 95kV.
- D. Secondary:
 - 1. Voltage ratings: 480V.
 - 2. Connection type: 3-phase, 4wire, wye-connected, solidly grounded.
 - 3. BIL: 10kV.
- E. Frequency: 60 Hz.
- F. Impedance: per Drawings, plus or minus 7 1/2 percent.
- G. Sound Level: maximum sound levels per NEMA TR-1.
- H. Efficiency: minimum efficiency per Code of Federal Regulations 10 CFR 431.196.

2.04 CONSTRUCTION

- A. Windings:
 - 1. High- and Low-voltage Windings: copper.
 - 2. Nonhygroscopic and nonhydrophylic windings suitable for prolonged storage and operation at 95 percent relative humidity from minus 40 degrees C to plus 40 degrees C.
 - 3. Separately wound high and low voltage windings as one rigid, coaxially arranged, tubular coil.
 - 4. Class H, 220 degree C, vacuum impregnated, resin encapsulated coil insulation.
 - 5. Cast bottom coil supports and space blocks to absorb thermal expansion/contraction and vibration of coils.
 - 6. Primary Winding Taps:
 - a. Fully rated no-load taps.
 - b. Two 2-1/2 percent taps above rated voltage.
 - c. Two 2-1/2 percent taps below rated voltage.
 - d. Taps are manually adjustable when transformer is de-energized. Accessible through front of transformer.
 - 7. Secondary Winding with full capacity insulated neutral bushing
- B. Core:
 - 1. Three-legged, High-grade, high-magnetic permeability, grain-oriented nonaging laminated silicon steel laminations.
 - 2. Cruciform in shape core with mitered joints.
 - 3. Exposed surfaces: corrosion-resistant coating.
 - 4. Ground core to frame with flexible grounding strap.
 - 5. Isolated from enclosure with rubber vibration isolating pads.
- C. Terminations:
 - 1. Primary (High-voltage) Terminations:
 - a. Air-filled compartment, full height sized to accommodate conduit and conductors per Drawings. Compression lugs suitable for copper conductors. Bottom fed.
 - b. Bushings: porcelain or cast resin epoxy, mounted on opposite side of transformer from secondary bushings. Bushings located above bottom of transformer at elevation approximately 50 percent of overall height of unit for units with air-filled terminal chambers.
 - c. Tin-plated copper bus bars.
 - 2. Secondary (Low-voltage) Terminations:
 - a. Air-filled compartment, full height sized to accommodate conduit and conductors per Drawings. Compression lugs suitable for copper conductors. Top fed.

- b. Bushings: porcelain or cast resin epoxy, mounted on opposite side of transformer from primary bushings. Bushings located above bottom of transformer at elevation approximately 50 percent of overall height of unit for units with air-filled terminal chambers.
 - c. Tin-plated copper bus bars.
- D. Enclosure:
 - 1. Outdoor ventilated type enclosure with barrier between high and low voltage sections in accordance with IEEE C57.12.01, IEEE C57.12.55, and IEEE C57.12.51.
 - 2. Heavy-gauge steel with ventilating opens in accordance with NEMA and NEC requirements.
 - 3. Secondary devices shall be isolated by grounded steel barrier
 - 4. Base: allow jacking, rolling, or skidding in any direction. Flush jack pads with enclosure and four lifting lugs.
 - 5. Full cabinet lineup must fit within a space no larger than 69" deep by 134" wide by 100" tall completely installed.
 - 6. Finish:
 - a. Manufacturer's standard point process.
 - b. Electrocoating process applied over rust-inhibiting phosphated base coating.
 - c. Color: Exterior: Gray finish as approved by Project Representative.

2.05 ACCESSORIES

- A. Attach copper ground pads with NEMA-spaced holes to frame on low- and high-voltage ends of transformer.
- B. Temperature Controller:
 - 1. Meters: Section 26 09 11.
 - 2. Power supply self-contained in transformer assembly and factory wired.
 - 3. Continuously monitor each phase windings.
 - 4. Display: Solid state device with LED or backlit LCD display.
 - 5. Controls, with programmable on and off set points
 - a. Output relay for high temperature alarm.
 - b. Output relay for high temperature trip.
 - c. Local audible alarm.
 - d. Alarm Contacts: 5 amperes, 120-volt.
 - 6. Monitoring:
 - a. Temperature trending (Average and max) per phase winding.
 - b. Alarm Log.
 - c. Trip Log.
 - d. Test Mode.
 - e. Failed sensors.
 - f. Self-diagnostics.
 - 7. Communications: Modbus/TCP.
- C. Nameplates:
 - 1. Mount stainless steel diagrammatic nameplate to unit per ANSI requirements.
 - 2. Nameplates shall be provided in accordance with the requirements of Section 26 05 00.
- D. Secondary Bushing CTs:
 - 1. Primary current rating as indicated on drawings. CTs: accuracy class C100.
 - 2. Connect CTs to shorting-type terminal strips located in NEMA 4X terminal junction box.
 - 3. Type SIS secondary conductors for CT, size 10 AWG, with ring-tongue crimp lugs. Route secondary conductors to terminal junction box by means of flexible, watertight conduit.

2.06 SOURCE QUALITY CONTROL

- A. Factory Tests:
 - 1. Transformer Section: Perform production tests on dry type in accordance with IEEE C57.12.01 and C57.12.91.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions and recommendations.
- B. Secure equipment to mounting pads with anchor bolts.
- C. Install equipment plumb and in longitudinal alignment with pad or wall.
- D. Coordinate terminal connections with installation of secondary feeders.

3.03 FIELD QUALITY CONTROL

- A. Inspect.
- B. Field Testing: Section 01 75 20 and Section 26 08 00.

END OF SECTION

SECTION 26 13 13

MEDIUM-VOLTAGE CIRCUIT BREAKER SWITCHGEAR, GAS INSULATED

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies medium-voltage, vacuum circuit breaker gas-insulated switchgear and its associated auxiliary equipment. Equipment shall consist of indoor enclosure switchgear.
- B. The general requirements for electrical equipment, as specified in Section 26 05 00, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP- MV SWGR Side "A"	704-MSG02
RSP- MV SWGR Side "B"	704-MSG02

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
DIN ISO 9001	Quality management systems
IEEE C37.20.7	Standard for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE C37.04	Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.06	AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis Preferred Ratings and Related Required Capabilities
IEEE C37.09	Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.20.9	Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems
IEEE C62.11	Metal-Oxide Surge Arrestors for Alternating Current Power Circuits (>1KV)
NEMA SG 4	Alternating-Current High-Voltage Circuit Breakers
NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum)
NFPA 70	National Electrical Code (NEC)

1.03 DESIGN REQUIREMENTS

- A. System Description:

1. Switchgear shall be gas insulated, fixed circuit breaker type with all the operations and cable termination for front-access. There should not be a need of rear access for any work.
2. Suitable for 13,800 volts, three-phase, three-wire, 60Hz, solidly grounded-wye electrical service having a continuous current rating and an available short-circuit current at line terminals as shown on Drawings.
3. The switchgear shall be compartmentalized with each vertical switchgear section consisting of sealed tight gas vessel, solid insulated type busbar system compartment, an air-insulated cable termination compartment, local operator compartment, and low voltage metering and relaying control compartment.
 - a. Gas vessel shall contain:
 - 1) Housing for vacuum circuit breakers.
 - 2) Bus Disconnect/ground switch.
 - 3) Main bus with connection ports to exterior bussing.
 - 4) Pressure relief device relieving pressure in an integrated arc duct.
 - b. Bus compartment shall contain:
 - 1) Insulated bus and support system.
 - 2) Voltage transformers.
 - 3) Control power transformers.
 - c. Cable termination compartments shall contain:
 - 1) Cable entry from bottom.
 - 2) Current transformers.
 - 3) Insulated bushings for primary disconnecting devices.
 - 4) Ground bus extending full width of switchgear.
 - 5) Dead Break elbow, Outer Cone type cable lug for 15 kV conductors.
 - 6) Cable surge arrestors.
 - d. Local Operator compartment shall contain:
 - 1) Circuit breaker operator mechanism.
 - 2) Disconnect and ground switch operator mechanism.
 - 3) Indicating device for Breaker position, Spring position, Disconnect and ground switch position and live bus.
 - 4) Mimic Diagram.
 - e. Low Voltage Control compartment shall contain:
 - 1) Relays, meters, and instrumentation.
 - 2) Terminal block, small wiring, control bus, and cable supports.
 - 3) CT and PT connections.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
 1. Descriptive product information.
 2. Dimensional drawings.
 3. Panel arrangement drawings showing layout of devices on the panel doors
 4. Itemized bill of material including Form 01 78 45-A.
 5. Protective device time-current characteristics on transparencies.
 6. Operational description.
 7. Installation instructions.
 8. Bus data including configuration, size, current rating, and number of conductors for each phase, neutral and ground bus of main and branch buses.
 9. Short-time and short-circuit ratings of switchgear assembly.
 10. One-line, three-line, and control schematic drawings.
 11. Control power requirement in coordination with external UPS supply per Section 40 67 63.
 12. Connection and interconnection drawings.
 13. Conduit entrance locations.
 14. Mimic bus layout.
 15. Nameplate schedule.
 16. Bill of Materials, including Form 01 78 45-A.

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17. Anchoring instructions and details.
18. Anchorage and bracing drawings and cut sheets, as required by Section 01 73 00.
19. Anchorage and bracing calculations as required by Section 01 73 00.
20. Operations and Maintenance manuals: Section 01 78 23.
21. Certified factory test reports.

1.05 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
 1. Provide the Work in accordance with NFPA 70, NEC. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
 2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.
 3. Fully assembled switchgear shall be NRTL listed.
- B. Manufacturer Qualifications:
 1. The manufacturer shall have at least 10 years of proven medium voltage gas-insulated, vacuum circuit breaker switchgear experience in the United States of America.
 2. The manufacturer of the medium voltage gas-insulated switchgear shall also manufacture the medium voltage circuit breakers.
 3. Shall be third party certified to DIN ISO 9001.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, Protection, and Storage: Section 01 67 00 and 26 05 00.
- B. Shipping Splits: Established by Contractor to facilitate ingress of equipment to final installation location within the building.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.08 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 1. Siemens.
 2. ABB.
 3. Approved Equal.

2.02 GENERAL

- A. Furnish switchgear that is the product of a single manufacturer. Assembled units with component parts of several manufacturers will not be acceptable with the exception that such minor items as terminal blocks, test switches, fuses, and wiring, may be manufactured by others.

- B. Design, test, and assemble in accordance with IEEE C37.04, IEEE C37.06, IEEE C37.20.7 and IEEE C37.20.9 and NEMA SG 4.
- C. Suitable for 13,800 volts, three-phase, three-wire, 60Hz, solidly grounded-wye electrical service having a continuous current rating and an available short-circuit current at line terminals as shown on Drawings.
- D. Rated impulse withstand voltage: 60 kV BIL.
- E. Operating Conditions: Equipment shall be fully rated without derating per Section Environmental Conditions.
- F. Equipment and devices weighing in excess of 100 pounds shall have lifting lugs.

2.03 ENCLOSURE

- A. The switchgear shall be designed in such a way that no gas work shall be required for installation, extension, or panel replacement, and throughout the entire service life of the switchgear.
- B. Indoor switchgear assembled to form a rigid, free standing, metal enclosed structure with all ventilations or similar openings designed so that foreign objects inserted through these openings are deflected from energized parts in accordance with NEC article 110.31(B)(1).
- C. Material: 11-gauge minimum cold-rolled steel, formed with reinforced steel members.
- D. The total width shall not exceed 235 inches by a total depth of 50" including protruding components and ventilation requirements.
- E. The switchgear shall be designed so that normal service, inspection, maintenance, grounding of high-voltage cables, and elimination of electrostatic charges can be carried out safely with adjacent sections energized.
- F. For future upgrading or repair it shall be possible to exchange panels or circuit breakers within an installed switchgear without having to remove or evacuate adjacent panels.
- G. Finish: Baked enamel applied over rust-inhibiting, phosphated base coating.
 - 1. Color:
 - a. Exterior: Gray finish as approved by Project Representative.
 - b. Interior: White.
 - c. Unpainted Parts: Plated for corrosion resistance.
- H. Indoor Enclosure:
 - 1. NEMA 250, Type 1, with formed edges on hinged and nonhinged panels.
 - 2. Front access, full height, bolt-on panels for each enclosure section.

2.04 INSULATING GAS SYSTEM REQUIREMENTS

- A. The gas-insulated sealed pressure system compartments shall be designed and manufactured with a tightness to allow for 40 years of operation, maintenance free. The gas-insulated compartments and associated structure shall withstand repeatedly, without distortion, forces caused by closing and opening of the circuit breakers.
- B. Vessel walls and bushings for electrical connections and operating mechanisms shall be joined by qualified welding procedures, thus forming a sealed pressure system.
- C. The leakage rate of the sealed pressure systems shall be less than 0.1% per year.

- D. No gas sharing shall take place between gas compartments. Each gas compartment shall be built with stainless steel such as to minimize potential leakage.
- E. The switchgear shall be operated at minimum overpressure to avoid putting unnecessary stress on the gaskets. Operating pressure shall be above atmospheric but less than 150 kPa.
- F. Each gas compartment shall include its own non-return filling valve and self-supervising temperature-compensated pressure monitoring device. Once the operating pressure falls below a pre-defined threshold a low gas alarm shall be provided.
- G. Each gas compartment shall be provided with a pressure relief device to limit the pressure in the event of an internal fault. The pressure relief devices shall be designed such that discharges resulting from internal faults shall be directed away from locations where personnel may be present and such that gases are exhausted through the top of the enclosures with integrated absorbers. All pressure relief device designs shall be proven by arc-fault design tests in accordance with IEEE C37.20.7.
- H. Each section shall have a gas indication system to indicate safe gas pressure inside the vessel for operation. This indicator system shall not require any auxiliary power to work and provide dry contacts to connect to facility alarm system.

2.05 BUS BARS AND INTERCONNECTIONS

- A. Continuous Current Rating: As shown on Drawings with sufficient cross-section to limit temperature rise at rated current to 40 degrees C.
- B. Phase Arrangement: Phases A-B-C, left-to-right, top-to-bottom, and front-to-rear as viewed from switchgear front.
- C. Main Bus:
 - 1. Material: Bar, rounded edge, flat tin-plated copper.
 - 2. Shall be isolated from environmental influences by means of solid-insulated couplings interconnected between section, outside the gas-filled vessel, in order to build a continuous busbar system.
 - 3. Solid insulators shall be non-hygroscopic, epoxy cast-resin, free from voids and contaminants
 - 4. System shall feature the ability to have direct plug-in connections for potential transformers or plug-in power conductors to facilitate measurements directly off the busbar..
- D. Ground Bus:
 - 1. Material: Same as main bus.
 - 2. Current Rating: 33 percent of main bus rating.
 - 3. Length: Extend entire width of switchgear.
 - 4. Bolted to ground contact in each breaker compartment and auxiliary section.
 - 5. Pads or terminals at each end for connection to building ground grid as required by NFPA 70.
- E. Control Bus:
 - 1. 600-volt insulated copper conductors.
 - 2. Maximum current rating determined by application.
 - 3. Extend from control power source to terminal boards in each unit of grouped lineup.
- F. Potential Bus:
 - 1. 600-volt insulated copper conductors.
 - 2. Maximum current rating determined by application.
 - 3. Connected to terminal boards mounted inside enclosure.
- G. Bus Bar Connections:
 - 1. Material:
 - a. Joints, Splice Plates, and Bar Ends: Tin-plated copper.
 - b. High Pressure Line Contacts: Tin-to-tin.

2. Bolts: Steel, with Belleville washers for joints, splice plates, and connections.
3. Insulate bolted connections with preformed, molded, polyvinyl boots held in place with nylon hardware.

2.06 CABLE TERMINATION

- A. The power cables shall be fed in from the bottom of the switchgear.
- B. The design of the complete cable termination shall be suitable for the switchgear short-circuit current and BIL as specified.
- C. Cable termination system shall be plug-in outer cone type and touch-proof in accordance with IEEE 386.
- D. The cable connections of the three phases shall be arranged horizontally side-by-side at the same level and be easily accessible from the front.
- E. The number of cables, size, and type for each incoming and outgoing feeder shall be as shown on the Drawings and shall allow for additional surge arrestors per phase.
- F. All cable terminations shall be accessible through a cable compartment cover that is mechanically interlocked to allow access only with the three-position switch in GROUND position.
- G. A Mechanical interlocked shall prevent the three-position switch from being CLOSED when the cable compartment cover is open.
- H. A suitable shipping cover shall be provided and fitted securely at each cable termination point in the switchgear. These covers should only be removed just prior to field termination of cables. Shipping covers shall be replaced with dielectric-rated cable plugs or dielectric rated covers prior to energization.
- I. Cable Termination Access shall be padlockable, capable of up to three locks.
- J. Cable testing shall be possible directly at the termination plug without removing the power cables from the bushing. A separate test socket therefore should not be needed for cable testing.

2.07 OPERATOR COMPARTMENT

- A. The mechanism bay shall have a screw-fastened cover.
- B. The mechanism bay houses the operating mechanism for the circuit-breaker, the operating mechanism for the 3-position disconnect and grounding switch and the sensors for gas density monitoring and the non-return filling valve of the gas-filled panel module.
- C. The sockets for the capacitive indicator system shall be located in the cover of the mechanism bay. The controls and indicators of the operating mechanisms are accessible from the outside.
- D. Provide a mimic diagram of sufficient size. The mimic diagram shall be black in color to contrast with the switchgear finish and be plainly visible to an operator. Mimic diagrams shall show circuit breakers, disconnect switches, grounding switches, busbar connections, and VTs. The mimic diagram shall be on the front of each section in conjunction with the mechanical switch and circuit breaker position indicators.
- E. Each section shall include voltage detectors to indicate phases "ALIVE". The voltage detectors shall be connected to each phase on the cable side with indicators visible from the front.

2.08 LOW VOLTAGE CONTROLS COMPARTMENT

- A. Low voltage controls shall be rated for 120V, supplied from external source.

- B. The low voltage control panel shall be completely wired, tested, and installed on the front of each switchgear panel. The low voltage control panel and the circuit breaker operating compartment are two independent metal enclosures.
- C. The low voltage control panel has a door. The low voltage control panel accommodates the protection devices and further secondary equipment with wiring.
- D. Cables for external connection to remote control shall enter through the bottom and top of the panel. Supplier shall provide the necessary cut outs and space to allow cable access.
- E. Wiring shall conform to NEC requirements and shall be neatly arranged and secured to the panel or supported by suitable brackets as required. Splicing of wires shall not be acceptable.

2.09 CIRCUIT BREAKERS

- A. Interrupter:
 - 1. Type: Vacuum, Three-pole, single-throw, Interrupter equipped with contact erosion indicators.
 - 2. Rating: 15,000 volts, 60-Hz.
 - 3. Continuous Current Rating: As shown on Drawings.
 - 4. Interrupting Rating: As shown on Drawings and shall be designed to withstand impacts and vibrations under rated and short-circuit current conditions.
 - 5. The circuit breaker shall have a minimum operational life of 30,000 switching cycles.
 - 6. The vacuum circuit breaker should be fixed type inside the gas tight vessel.
 - 7. A suitable form of arc control shall be incorporated in the design and the contacts shall be self-cleaning and self-aligning to ensure full contact without undue maintenance and classified as maintenance-free.
 - 8. Mechanically operated indicating device, marked "OPEN" (GREEN), "CLOSED" (RED), and "TRIPPED" (WHITE). The indicating device shall be visible at all times, from the front of the panel.
 - 9. The rated operating sequence (Duty Cycle) shall be O-0.3 sec-CO-3 min-CO for the rated current. The overall switchgear short-time rating shall be 2 secs as per IEEE.
 - 10. Circuit breakers shall be designed to withstand the transient recovery voltage (TRV) that occurs during the interruption of load currents and short-circuit currents within its rating. The vacuum circuit breakers shall not produce excessive overvoltage as a result of current chopping. The design shall reduce the current chopping value to less than 4 A.
 - 11. Primary Contacts:
 - a. Breaker mounted stud.
 - b. Stationary sockets.
 - c. Silver-plated pressure line contacts.
 - d. Nonmagnetic, corrosion-resistant leaf springs.
 - 12. Secondary Contacts:
 - a. Breaker mounted multiple plug coupler.
 - b. Stationary receptacles.
 - c. Silver-to-silver contacts.
 - 13. Auxiliary Contacts:
 - a. Rated 5 amperes, 120 volts, ac.
 - b. One Type "a" contact to indicate CLOSED position.
 - c. Two Type "b" contacts to indicate OPEN position and trip operation.
 - d. Provide space for two additional Type a-b contacts.
 - 14. Contacts closing speed shall be independent of control voltage and operator.
 - 15. Mechanically interlock to prevent breaker movement to or from operating position when primary contacts are engaged.
 - 16. Interlocking Scheme Between Selected Breakers: Mechanical key.
- B. Operating Mechanism:
 - 1. Operating power source: 120 Vac
 - 2. Closing of the circuit breaker shall be by means of a motor-charged, spring-operated, stored-energy type mechanism with electrical release. The operating mechanism shall automatically recharge the

closing spring after the completion of a closing operation. It shall not be possible for the circuit breaker to close unless the closing spring is fully charged.

3. Opening of the circuit breaker shall be by means of a spring, that is automatically charged when the circuit breaker is closed.
4. Provide provisions for closing the circuit breaker by manually charging the spring without dismantling any parts or mechanism. It shall not be possible for the circuit breaker to close unless the closing spring is fully charged.
5. Each mechanism shall be provided with a shunt release and the necessary auxiliary switches.
6. Mechanisms shall have a minimum operational life of ten (10) years or 10,000 operations, be "trip free" type, and classified as Maintenance-free.
7. Each open/close mechanism located in a separate operating bay, located outside of the gas vessel, allowing access from the front of the switchgear with the primary equipment in service.
8. A visual, mechanical indicating device shall be provided to indicate the status of the stored-energy closing spring. The indicator shall show charged symbol when the mechanism is fully charged (ready-to-close the circuit breaker) and a discharged symbol when it is in any other condition.
9. Mechanical CLOSE and OPEN operation with push buttons, shrouded to prevent inadvertent operation
10. A non-reset operations counter shall be fitted to the mechanism, designed to total all "opening" operations of the interrupter.
11. Provisions for locking-out the manual tripping of the circuit breaker shall be made. It shall not be possible to defeat locking of the manual tripping unintentionally.

2.10 DISCONNECTING AND GROUNDING SWITCH

- A. Busbar disconnecting and circuit grounding shall be accomplished by means of a manually operated 3-position disconnect and grounding switch, located between the main bus and each circuit breaker. All three poles of the three-position switches shall be operated simultaneously.
- B. The ratings for the 3-position disconnect and grounding switches shall be coordinated with the system ratings as shown on Drawings.
- C. The three-position switch shall be a no load switch. Mechanical interlocks shall be provided to prevent switching if the circuit breaker is in a closed position.
- D. The three-position switch shall be located within the switchgear gas vessel, with the operating mechanism located outside and accessible from the front. All operations shall be performed without requiring the opening of any doors.
- E. Operation of the three-position switch should take place via two separate actuating openings, which enable a clear selection of the DISCONNECTED and GROUNDED functions and prevent operation directly from the CONNECTED to GROUNDED positions
- F. Means shall be provided to ground both the outgoing circuit and the busbars, but not both simultaneously.
- G. A mechanism operated position indicator shall be located on the front of the switchgear panel and indicate CONNECTED-DISCONNECTED-GROUNDED.
- H. The three-position switch operating mechanism shall be provided with auxiliary switches for remote indication.
- I. GROUNDED position shall be padlockable, capable of up to three locks.
- J. Interlocks shall prevent switching from being blocked in an intermediate or undefined position. The system shall operate effectively for either electrical switching commands or manual.

- K. Each disconnect shall be equipped with a fixed viewing and lighting system located on front of the three-position switch operator panel for means of a visual verification.

2.11 CURRENT TRANSFORMER (CT)

- A. Current Transformer: Section 26 09 11.
- B. Rating: 15 kV.
- C. CTs shall have a short-circuit ratings not less than that of the associated switchgear.
- D. All CTs shall be installed outside SF6 chamber and around the cable bushings so that the CT is free of dielectric and thermal stress. CTs shall be located on the cable termination side of the circuit breaker.
- E. CTs to be mounted on the bushings of the cable connection in order to keep the cable terminations within the protection area of the transformers.

2.12 POTENTIAL TRANSFORMER (PT)

- A. Potential Transformer: Section 26 09 11
- B. Rating: 60 kV BIL.
- C. Type: Single phase double epoxy insulated plug-in potential transformers (with 40 year maintenance-free design life)
- D. Potential Transformers shall have secondary protection by means of suitable high performance miniature circuit breakers. Primary fuses shall not be supplied.
- E. Shall be solid-insulated, metal-enclosed and mounted on the top of the appropriate busbar phase enclosure, house outside of gas chamber.
- F. All secondary leads shall be wired to terminal blocks, located in the low voltage control panel.

2.13 TERMINAL BLOCKS

- A. General Terminal Blocks: Section 26 05 00.
- B. Type:
 - 1. One-piece barrier with strap screws.
 - 2. Shorting type for current transformer leads.
 - 3. Pull-apart control wiring terminal boards on drawout units.
- C. Provide for:
 - 1. Conductors connecting to circuits external to switchgear.
 - 2. Internal circuits crossing shipping splits.
 - 3. Equipment parts requiring replacement and maintenance.
- D. Spares: Minimum 20 percent spare unused terminals.
- E. Grouped together terminal blocks for external circuit wiring leads.
- F. 6-inch minimum space between columns of terminal blocks.
- G. Permanently identify each terminal and columns of terminal blocks.

2.14 CONTROL WIRING

- A. The medium voltage gas-insulated switchgear manufacturer shall follow IEEE C37.20.9 for design, manufacture and testing of the switchgears' secondary control wiring.
- B. NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts for control, instrumentation, and power circuits.
- C. Individual seven-strand, copper conductors, twisted and covered with a 100 percent aluminum, polyester shield with tinned copper drain wire and overall outer jacket, rated 600 volts, 90 degrees C minimum for transducer output and analog circuits.
- D. Conductor Lugs: Pre-insulated, self-locking, spade type with reinforced sleeves.
- E. Wire Markers: Each wire individually identified with permanent markers at each end.
- F. Internal circuit wiring crossing shipping splits to have plug connectors.
- G. Splices: Not permitted.

2.15 METERS AND INSTRUMENTS

- A. General:
 - 1. Provide protective relays as shown on Drawings.
 - 2. As specified in Section 26 09 11.
 - 3. Multifunction protective relaying shall be microprocessor-based three-phase relays and shall be UL-Listed.
 - 4. Input Power: 120Vac
 - 5. Communication: Modbus TCP.
 - 6. Ethernet Switch:
 - a. Preconfigured per Drawings
 - b. 10/100Base tX RJ-45 Copper ports
 - c. Prewired to all ethernet devices with the Switchgear.
 - d. 20% spare ports
 - 7. Minimum I/O: 8 Digital Inputs, 8 Digital outputs, 1 Analog output
 - 8. Display:
 - a. The front panel shall be capable of displaying measured values, calculated values, I/O status, device status, and configuration parameters.
 - b. The display shall have a rotating capability to display custom messages and data. Thirty-two display messages shall be provided.
 - c. The front panel shall have a color touchscreen with a minimum of 6 user-programmable tricolor LEDs, a TARGET RESET pushbutton, and 4 user-programmable pushbutton controls with 8 programmable tricolor LEDs, respectively.
 - 9. Metering shall be integrated into the multifunction protective relay with the following features:
 - a. Load-profile monitoring. The relay shall provide a periodic snapshot (at a selectable rate from every 5 to 60 minutes) of as many as 17 selectable analog quantities.
 - b. Metering. The relay shall include metering capabilities for real-time current, voltage, power, energy qualities, and demand and peak demand current and power values and minimum/maximum metering.
 - c. Event summaries. Fault type and trip data, including time of tripping.
 - d. Event reports.
 - e. Sequential Events Recorder (SER). The relay shall have as many as 1,024 time-tagged, most recent input, output, and element transitions.
 - f. Data stored in nonvolatile, Flash memory.
 - g. Breaker wear monitoring.
- B. Main feeder Protection Relays:
 - 1. Manufacturer: SEL, type 751 Model 751501DBD1D0X85AF01, or approved equal.

2. Shall provide the basic protection for the following:
 - a. Phase, residual, and negative-sequence overcurrent elements (50P/50G/50Q).
 - b. Phase, residual, and negative-sequence inverse-time overcurrent elements (51P/51G/51Q).
 - c. Breaker/contact failure (BF).
 - d. Auto-reclosing control (79).
 - e. Arc-flash detection and arc-flash overcurrent (50PAF/50NAF).
 - f. Over- and undervoltage (59/59G/59Q/27).
 - g. Inverse-time over- and undervoltage elements (59I, 27I).
 - h. Power factor (55).
 - i. Over- and underfrequency (81).
 - j. Rate-of-change of frequency (81R).
 - k. Loss-of-potential (60).
 - l. Second- and fifth-harmonic blocking (HBL).
 - m. Incipient cable fault (50INC).
 - n. Phase discontinuity detection (PDD).
 - o. Broken conductor detection (BCD).
 - p. Cold-load pickup element (CLPU).
 3. The relay shall incorporate adaptive phase overcurrent elements that perform reliably in the presence of current transformer saturation, dc offset, and off-frequency harmonics.
- C. Transformer Protection Relays:
1. Manufacturer: SEL, Model 07872EE1DBA1A7985A201, or approved equal
 2. Shall provide the protection for the following:
 - a. Percentage Differential Protection. The relay shall incorporate restrained differential protection for two windings with fixed or variable percentage, using one or two settable slopes with adjustable intersection point and minimum pickup values.
 - b. CT Phase Angle Compensation. The relay shall incorporate full “round-the-clock” current compensation, in 30-degree increments, to accommodate virtually any type of transformer and CT winding connection.
 - c. Harmonic Elements. The relay shall incorporate second-, fourth-, and fifth-harmonic elements, with the choice of either harmonic blocking or harmonic restraint to prevent restrained differential element operation during inrush or overexcitation conditions; an independent fifth-harmonic alarm element shall be included to warn of an overexcitation condition.
 - d. Unrestrained Differential Protection. The relay shall include unrestrained differential protection to produce rapid tripping for severe internal faults.
 - e. Overcurrent Fault Protection. The relay shall incorporate two groups of three-phase current inputs that can be independently enabled for overcurrent protection. Overcurrent elements per group shall be included to provide phase, neutral, negative-sequence, and residual protection.
 - f. Overexcitation Volts/Hertz Protection. The relay shall incorporate volts/hertz protection as an ordering option to detect and provide an output when user-settable volts/hertz thresholds are exceeded.
 - g. Breaker Failure Protection(BF). The relay shall provide breaker failure detection for two breakers. Breaker failure detection shall provide subsidence current detection to minimize system coordination times.
 - h. Loss-of-Potential Detection. The relay shall provide loss-of-potential detection elements for detecting open voltage transformer fuses or other conditions that cause a loss of relay secondary voltage input.
 - i. Transformer RTD Protection. The relay shall accept 2 digital inputs from transformer relay, one for high temperature alarm and one for high temperature trip.

2.16 SURGE PROTECTION

- A. In accordance with IEEE C62.11.
- B. Connect to line side of main power circuit breakers and ground to switchgear ground bus.
- C. Class: Distribution.

2.17 ACCESSORIES

- A. One each, manual spring charging crank.
- B. One each, operating handle for disconnect and grounding switch
- C. One each, viewing and lighting system module.
- D. Silicone grease packs.
- E. One set, test plugs, cables, and jumper for relays, meters, and electrically operated circuit breakers.

2.18 KEY INTERLOCKS

- A. Mechanical lock cylinder within main and tie breaker compartments.
- B. Kirk type keys and lock cylinders.
- C. Keys to be captive when breakers are closed.
- D. Two main and one tie breaker arrangement.
- E. Two keys available for each group of three locks.

2.19 EQUIPMENT IDENTIFICATION

- A. As specified in Section 26 05 00.
- B. Master Nameplate:
 - 1. Deep etched aluminum with manufacturer's name and model number.
 - 2. Riveted to main vertical section.
- C. Section Identification:
 - 1. Engraved metallic, riveted to each vertical section.
 - 2. Serial number, bus rating, and section reference number.
 - 3. Size: Manufacturer's standard.
- D. Nameplate:
 - 1. For each circuit breaker cubicle and door mounted device.
- E. Cubicle Labels:
 - 1. Applied inside each cubicle compartment.
 - 2. Device serial number, rating, and description.
- F. Metering Instruments: Meter type identified on meter face below pointer or dial.
- G. Control Switches: Deep etched, aluminum escutcheon plate.
- H. Relays and Devices:
 - 1. Stamped metallic, riveted to instrument case.
 - 2. Manufacturer's name, model number, relay type, and rating data.
- I. Switchgear Signs:
 - 1. Two signs each on front of switchgear.
 - 2. Size: Manufacturer's standard: 8 inches by 4 inches, with three lines each.
 - 3. Engraved, phenolic.
 - 4. Color: Red with white.

5. Inscription: DANGER/HIGH VOLTAGE/KEEPOUT.
6. Characters: Gothic type, 2 inches high.
7. Attachment: Four rivets each sign.

2.20 SOURCE QUALITY CONTROL

- A. Factory Tests:
 1. Switchgear assembly production tested in accordance with IEEE C37.20.9.
 2. Circuit breakers production tested in accordance with IEEE C37.09.
 3. Witnessing provisions:
 - a. County may elect to witness factory performance testing.
 - b. Provide the project Representative with not less than 60 days advance written notice of the date and place of each factory performance test.
 - c. Payment and administration for County witnessing testing: Section 01 29 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions and recommendations.
- B. Secure equipment to floor with anchor bolts of sufficient size and number adequate for specified seismic conditions.
- C. Install equipment plumb and in longitudinal alignment with wall.
- D. Tighten current-carrying bolted bus connections and enclosure framing and panel bolts to manufacturer's recommendations.
- E. Coordinate terminal connections with installation of secondary feeders.
- F. Protective-relay settings: Set relays in accordance with Section 26 05 73.

3.03 FIELD QUALITY CONTROL

- A. Inspect.
- B. Field Testing: Section 01 75 20 and Section 26 08 00.

3.04 MANUFACTURER SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner for minimum person-days listed below, travel time excluded:
 1. 4 person-days for installation assistance and inspection.
 2. 4 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 3. 2 person-days for prestartup classroom or site training per training session.
- B. See Section 01 79 00.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies modifications to existing panelboards for lighting and power distribution.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
UL 50	Enclosures for Electrical Equipment
UL 67	Panelboards
UL 489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Technical Data:
1. Quantity and rating of circuit breakers for each panelboard.
 2. Time current curves for all protection devices.
 3. Applicable operation and maintenance information: Section 01 78 23.
- C. For all drawings prepared for the submittals, provide updated CAD drawings to reflect as-built conditions in *.dwg format per Section 01 78 39 upon completion of Operational Testing per Section 01 75 20.

1.04 PANELBOARDS

- A. As indicated on the Drawings.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.06 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.07 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 GENERAL

- A. Acceptable Manufacturer:
 - 1. All parts and accessories to existing equipment must be approved by the original equipment manufacturer for compatibility.

2.02 CIRCUIT BREAKERS

- A. Molded-case type provided for the current ratings and pole configurations indicated on the panelboard schedule.
- B. Rated 120/208 volt and 120/240 VAC: Minimum interrupting current rating of 22,000 amperes (symmetrical) at 240 VAC.
- C. Rated 480 VAC: Unless otherwise indicated on the panelboard schedule, a minimum interrupting current rating of 65,000 amperes (symmetrical) at 480 VAC.
- D. Bolt-on Type.
- E. Listed in accordance with UL 489 for the service indicated.
- F. Load Terminals: Solderless connectors.

PART 3 EXECUTION

3.01 GENERAL

- A. Field verify the existing loads of each modified panelboard in alignment with NEC 220.87.
- B. Provide proposal for alterations necessary to balance electrical loads between phases.
- C. Type in the circuit description on the circuit directory or panelboard schedule, after load balancing revisions have been approved.

3.02 TESTING

- A. Test for proper operation and function per Section 01 75 20 and Section 26 08 00.

END OF SECTION

SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies modifications to existing freestanding, factory assembled 600-volt motor control centers (MCC) with all appurtenances, and accessories.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/NEMA ICS 1	General Standards for Industrial Controls and Systems
ANSI/NEMA ICS 2	Industrial Control Devices, Controllers and Assemblies
NEMA 1	National Electrical Manufacturer Association Enclosure 1
NFPA 79	Electrical Standard for Industrial Machinery
UL 845	Motor Control Centers

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Elementary connection and interconnection diagrams as required in this Section, in accordance with NFPA 79 and/or NEMA ICS standards.
 2. Time current curves for all protection devices.
 3. List of starters and feeder tap compartments indicating the size and type of circuit protection.
 4. Interrupting, withstand and continuous current rating of:
 - a. Feeder tap units.
 - b. Starter units.
 5. Catalog and technical data indicating the equipment meets the specifications.
 6. Installation instruction, outline dimensions, front view drawing identifying control and monitoring devices, nameplate engravings, shipping section dimensions, weight, and foundation requirements assembly.
 7. External connection diagram showing function and identification of all terminals requiring field connections.
 8. Operations and Maintenance manuals as specified in Section 01 78 23.
 9. Schematics and wiring diagrams.
 10. Bill of Materials, including Form 01 78 45-A.
 11. Certified copies of all material test reports.
 12. Training schedule and materials.
- C. Completed test report form 26 05 00-D.
- D. For all drawings prepared for the submittals, provide updated CAD drawings to reflect as-built conditions in *.dwg format per Section 01 78 39 upon completion of Operational Testing per Section 01 75 20.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. All parts and accessories to existing equipment must be approved by original equipment manufacturer to be compatible.
- B. All protective devices shall be fully rated. Series rating of protective devices is not allowed.
- C. All parts and accessories to existing equipment must be approved by original equipment manufacturer to be compatible.

2.02 SERVICE

- A. Motor control centers shall be rated 600 volts, 60 hertz, 3 phase, 4-wire as specified, and suitable for operation at the specified voltages and short circuit capacities.

2.03 STRUCTURE AND CONSTRUCTION

- A. Structure:
 - 1. Motor control center (MCC) individual unit compartments shall be made of No. 14 gage steel minimum. The individual unit compartments shall be a minimum of 12 inches high. Compartments shall have pan-type doors with a minimum of two quarter-turn hold-down latches; and neoprene gaskets.
- B. Construction:
 - 1. Unit compartments shall maintain NEMA rating of the existing motor control center installed in.
 - 2. Starter units, size 5 and smaller, and feeder tap units less than 225 amperes shall be drawout plug-in construction with hardened, plated copper free-floating stabs and steel spring backups. The door shall have interference tabs which prevent door closure if unit is improperly installed. Units shall be latched in the position to assure proper bus contact. The unit disconnect device shall be interlocked to prevent removal or reinsertion of a unit when the disconnect is in the "ON" or "TRIPPED" positions.
 - 3. Fusible switch or circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "OPEN" position.

2.04 FINISH AND COLOR

- A. The finish and color shall match existing MCC structure that unit will be installed in.

2.05 WIRING

- A. General: All starter units shall be provided with Type B wiring, with terminal blocks for control wiring. Terminal blocks shall be provided for power wiring for starters size 2 and smaller. Provide elementary and connection diagrams for each starter unit. Attach polyester plastic protected connection diagram to inside of each unit door.
- B. Power Wire: Power wire shall be copper 90 degrees C "MTW" insulated, sized to suit load; minimum power wire size shall be No. 12 AWG copper stranded.
- C. Control Wire: Control wire shall be No. 16 AWG stranded copper wire, rated 90 degrees C and UL listed for panel wiring.
- D. Terminations and Cable Connections:
 - 1. Terminals: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.
 - 2. Cable Connectors: Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 MCM, shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors. Incoming line and outgoing feeder compartments shall be provided with crimp type lugs, 3M, Burndy, or approved equal.
- E. Conductor Markers: Markers used for identification shall meet the requirements of Section 26 05 00.

2.06 FEEDER BRANCH CIRCUIT PROTECTION

- A. General: Feeder tap units shall consist of circuit breakers, as specified.
- B. Circuit Breakers (Thermal Magnetic): Thermal-magnetic circuit breakers shall be molded case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 65,000 amperes RMS symmetrical.
- C. Circuit Breakers (Magnetic Only): To be used only in combination with motor starter overload device as a listed assembly. Magnetic circuit breakers shall be molded-case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 65,000 amps symmetrical.

2.07 MOTOR CONTROLLER UNITS

- A. General: Motor controller units shall be combination type with contactor and motor circuit protector as specified on the Drawings. The starter units shall have a minimum UL listing of 65,000 amps RMS, symmetrical or as specified on the Drawings.
- B. Motor Circuit Protectors: The molded case motor circuit protector shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection. The instantaneous trip setting shall be adjustable from 700 to 1300 percent of the motor full load amperes from the front of the breaker. The motor circuit protector shall be set at its lowest position at the factory.

C. Control Power Transformers (CPT):

1. Each control transformer shall be rated 480/240-120V, single phase, 2 wire, 60 Hz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

NEMA starter size	Volt-ampere rating
1	100
2	150
3	200
4	300
5	500

2. Each control transformer shall be provided with time-delay, slow-blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two UL Class CC time-delay primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all control transformers. Fuses shall be sized in accordance with NEC. Primary fuse shall have a time/current characteristic specifically designed for control circuit transformer protection.
3. Fuse holder for secondary fuse shall be drawout indicating type and mounted on the door of the compartment. Fuse holders for primary fuses shall be fuse clips with full barriers between fuses.

D. Contactors:

1. Full-Voltage Non-Reversing (FVNR): Unless otherwise specified, contactors shall be full voltage, 3-pole, 600-volt AC, NEMA size 1 minimum. Contacts shall be double break, silver-cadmium oxide, and weld resistant. Contacts shall be isolated to prevent arcing. Coils and magnets shall be capable of being removed or replaced without special tools.

E. Surge Protection: A surge protection device shall be provided in each starter. The device shall be encapsulated in a small module suitable for mounting directly to the starter coil. Additional panel space for the surge protection device shall not be required. Surge protection devices shall be rated 120V AC.

F. Auxiliary Contacts: Contactors shall be equipped with auxiliary contacts, rated 10 amperes at 120 volts AC. Each contactor shall be equipped with interlocks as shown on the Drawings, but not less than two normally open and two normally closed electrically isolated auxiliary contacts. Auxiliary contacts shall be wired out to terminal blocks.

G. Overload Relay: TeSys T Motor Management System with current module shall protect the power wiring and motor from excessive over currents. The relay shall be ambient compensated. The sensing element shall conform to ANSI/NEMA ICS 2-222.06, Class 20 tripping time. The management system shall incorporate Ethernet TCP/IP communications protocol. Each TeSys T Motor managements system shall integrate a Human Machine Interface (HMI) module on the front of the MCC. The Overload Relays shall include the LTM-E expansion unit and load metering.

H. Terminal Blocks: Terminal blocks shall be screw type rated 600 volts, 20 amperes for control wiring and 30 amperes power wiring (starters size 3 and larger shall terminate the power leads directly to the contactor). The number of terminal blocks shall be specified on the Drawings. Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number as specified on the Drawings. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.

2.08 MISCELLANEOUS

A. For motor starter units, the control devices such as pushbuttons, selector switches, indicating lights, and overload reset pushbuttons shall be mounted on the unit compartment door via the HMI module.

B. Elapsed time indicator shall be incorporated into the HMI module.

- C. Nameplates: Nameplates shall be provided in accordance with the requirements of Section 26 05 00. Nameplates shall be provided for all cubicles and compartments including existing compartments with load changes.
- D. Power Monitor: Power monitor shall be an Schneider Electric ION Analyzer and shall be provided in accordance with the requirements of Section 26 09 11.
- E. Provide phase fail relays which shall comply with the requirements of the control circuits.
- F. Surge Protection Device (SPD) shall be provided in accordance with the requirements of Section 26 43 00.

PART 3 EXECUTION

3.01 GENERAL

- A. The motor control centers shall be installed in accordance with the recommendations of the manufacturer and with the details specified herein.
- B. Field wiring shall meet the requirements of Section 26 05 19. Cables larger than No. 6 AWG which hang from their vertical connections shall be supported within 2 feet of the connection.
- C. The TeSys T overload unit shall be provided and sized based on the actual full load amperes of the motor.
- D. The motor circuit protectors shall be adjusted to the lowest setting not causing false tripping.

3.02 TRAINING

- A. Procedures: Section 01 79 00.
- B. Provide a minimum of 4 hours per training.

3.03 FIELD TESTS

- A. Motor control centers shall be tested in accordance with Section 26 08 00.
- B. Complete applicable sections of test report Form 26 05 00-D.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies wiring devices consisting of receptacles, plugs, switches, and appurtenances.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)
NEMA WD-1	General Purpose Wiring Devices
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts for all materials.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. UL-list wiring devices for the current, voltage, and frequency specified and complying with NEMA WD-1.
- B. Use devices containing provisions for back wiring and side wiring with captively held metallic binding screws.
- C. Devices are to be brown, except those located in finished areas are to be ivory.

- D. All to be supplied by a single manufacturer.
- E. Enclosures shall meet or exceed requirements of NEMA 250.

2.02 RECEPTACLES AND PLUGS

- A. General: Grounding type.
 - 1. Receptacles to be grounding type.
 - 2. Provide outdoor receptacles with weatherproof lift covers, while in use.
- B. 120V Receptacles:
 - 1. Indoor, clean areas:
 - a. Duplex 20 amp NEMA 5-20R that accept NEMA 5-15P or 5-20P plug caps.
 - b. Acceptable manufacturer:
 - 1) Hubbell 5362.
 - 2) Arrow Hart.
 - 3) Approved Equal.
 - 2. GFCI protected receptacles:
 - a. Indoor and outdoor areas:
 - b. Duplex 20 amp NEMA 5-20R that accept NEMA 5-15P or 5-20P plug caps.
 - c. Tamper and weather resistant.
 - d. Acceptable manufacturer:
 - 1) Hubbell GFR5362 series.
 - 2) Arrow Hart TWRVGF20 series.
 - 3) Approved Equal.
 - 3. Where the manufacturer of cord connected equipment requires an isolated ground, provide a receptacle with isolated ground.
 - 4. Isolated ground receptacles:
 - a. Acceptable manufacturers:
 - 1) Hubbell IG-5362.
 - 2) Arrow Hart 6766.
 - 3) Approved Equal.
 - 5. Classified Areas:
 - a. Rate receptacles for use in classified areas in accordance with NEC for the area in which they are to be located and factory seal.
 - b. Interlocked switch and cover preventing insertion or removal unless switch is in "OFF" position.
 - c. Provide receptacles with mounting box, sealing chamber and compatible plug.
 - d. Voltage and current ratings to be as specified.
 - e. Acceptable manufacturers:
 - 1) Crouse Hinds, FSQ 20 Amps 600 VAC.
 - 2) Appleton, FSQX Series.
 - 3) Approved Equal.
- C. Three Phase Receptacles and Plugs:
 - 1. Receptacles:
 - a. Suitable for 480V, 3-phase, 4-wire service, with ampere ratings as specified.
 - b. Provided complete with cast back box, angle adapter, gaskets, a gasketed screw-type, weathertight cap with chain fastener and interlocked with enclosed safety disconnect switch.
 - c. Provide each receptacle with one plug.
 - 2. Receptacles and plugs: Designed so that the grounding pole is permanently connected to the housing.
 - 3. Contacts:
 - a. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing.
 - b. The plug sleeve shall make contact with the receptacle housing before the line and load poles make contact.
 - 4. Safety Disconnect Switch:

- a. Shall meet requirements of Safety Disconnect switch per specification 26 09 16.
 - b. The switch blades shall be visible through a viewing window on the enclosure door.
- 5. Acceptable manufacturers:
 - a. Crouse-Hinds "Arktite WSRD".
 - b. Appleton "Powertite".
 - c. Approved Equal.
- D. Male plug caps for 120V and 250V receptacles:
 - 1. Cord grip armored type with heavy phenolic housing, of the same manufacture as the receptacle.
 - 2. Rate plug caps at 15 amps.
 - 3. Provide one plug cap for every 4 receptacles, with a minimum of 2 plug caps.

2.03 SWITCHES

- A. General Purpose (Indoor, Clean Areas):
 - 1. General purpose switches: Quiet AC type, specification grade, with rated capacities as required.
 - 2. Match receptacles in color.
 - 3. Acceptable manufacturers:
 - a. Arrow Hart.
 - b. Hubbell.
 - c. Approved Equal, as follows:

	15A, 120-277V		20A, 120-277V	
	Arrow Hart	Hubbell	Arrow Hart	Hubbell
Single:	1891	1201	1991	1221
Three-way	1893	1203	1993	1223
Four-way	1894	1204	1994	1224
SPST momentary	1895		1995	

- B. Switch, Motor Rated:
 - 1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
 - 2. UL 508 listed.
 - 3. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts.
 - 4. Minimum General Purpose Rating: 30 amperes, 600V ac.
 - 5. Minimum Motor Ratings:
 - a. 2 horsepower for 120V ac, single-phase, two-pole.
 - b. 3 horsepower for 240V ac, single-phase, two-pole.
 - c. 15 horsepower for 480V ac, three-phase, three-pole.
 - 6. Screw-type terminal.
 - 7. Acceptable manufacturers:
 - a. Arrow Hart.
 - b. Hubbell: HBL78 Series.
 - c. Approved Equal
- C. Wall Box Lighting Dimmers:
 - 1. Modular gangable design.
 - 2. Solid-state circuitry.
 - 3. Voltage: As required on Drawings.
 - 4. ON/OFF switch integral to the unit. ON/OFF switch shall be independent of dimming level function.
 - 5. Single-pole or three-way as indicated on Drawings.
 - 6. Operator:
 - a. Continuous adjustability throughout the dimming range.
 - b. Slider.
 - 7. Integral suppression for audible frequency and EMI/RFI.
 - 8. Comply with UL 1472.

9. LED System Dimmers: Certified by manufacturer to operate on dimming drivers provided with luminaires in this Project.
- D. Wall Box Lighting Occupancy Sensors:
1. General:
 - a. Capable of operating normally with any electronic driver, ballast and PL lamp systems.
 - b. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to cycling of air conditioner or heating fans.
 - c. Provide sensors with readily accessible, user adjustable controls for time delay and sensitivity.
 2. Sensor Technology:
 - a. General:
 - 1) Sensors use a dual technology of passive infrared and ultrasonic technologies to detect occupants in coverage area.
 - 2) Provide technology mode selection to allow installer to configure the operation mode between dual technology, passive infrared only, or ultrasonic only functionality.
 - 3) No audio dual technology units will be accepted.
 - b. Passive Infrared (PIR):
 - 1) Provide sensors that respond to human heat and movement to detect occupants in the coverage area.
 - 2) Temperature compensated pyroelectric sensor.
 - 3) High immunity to false triggering due to RFI and EMI noise.
 - 4) Provide passive infrared sensors with a multiple segmented lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue buildup.
 - c. Ultrasonic:
 - 1) Provide sensors which respond to ultrasonic disturbances within as well as outside the line of sight to detect occupants in the coverage area.
 - 2) Use advanced signal processing technology to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and airflow throughout the controlled space.
 3. Switch Box:
 - a. Directional Coverage: 180 degrees.
 - b. Coverage Area: At desk top level up to 300 square feet and gross motion up to 1,000 square feet.
- E. Switches for classified areas:
1. Switches for control of lighting and small single-phase power loads in classified areas: Factory assembled and sealed combination general purpose type switch in an explosion proof housing.
 2. Rate the switch in accordance with NEC for the area in which it is to be installed.
 3. External operating mechanism: wing-type handle having the "ON" and "OFF" positions visible from the front.
 4. Acceptable manufacturers:
 - a. Crouse Hinds Cat. No. EFS2129, 20 AMP. 277 VAC.
 - b. Appleton, EDS Series.
 - c. Approved Equal.
- F. Switches for outdoor and corrosive areas:
1. Maintained contact switches:
 - a. Press switch type with a weatherproof hypalon or neoprene cover.
 - b. Acceptable manufacturers:
 - 1) Arrow Hart.
 - 2) Hubbell.
 - 3) Approved Equal.
 2. Momentary contact switches: sealed contact pushbutton switches, rated NEMA 4X, mounted on a NEMA 4X control station.

2.04 DEVICE PLATES

- A. Provide with switches.

- B. Non-corrosive indoor areas:
 - 1. Type 302 stainless steel device plates on sheet metal boxes. Sheet steel, zinc electroplated with chrome finish in all other indoor areas.
 - 2. Acceptable Manufacturer:
 - a. Crouse-Hinds.
 - b. Appleton.
 - c. Approved Equal.
- C. Corrosive or outdoor areas: Impact resistant, marine grade fiberglass.
- D. Factory provided explosion-proof equipment.
- E. Provide device plates for small single-phase power loads and instrumentation power supply disconnect switches with a lockoff feature with provision for a single padlock.
- F. Nameplates:
 - 1. Provide with engraved laminated phenolic nameplates with 1/8-inch white characters on black background as specified in Section 26 05 00.
 - 2. Switches: Identify panel and circuit number and area served.
 - 3. Receptacles: Identify circuit and also voltage if other than 120V, single phase.
 - 4. Indoor nameplates may be secured by epoxy glue.
 - 5. Secure outdoor or corrosive area nameplates with Type 316 stainless steel screws.

2.05 DEVICE BOX

- A. Provide device box to complete assembly as specified in Section 26 05 33.

PART 3 EXECUTION

3.01 GENERAL

- A. Boxes:
 - 1. Independently support boxes by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate.
 - 2. Do not use wooden or plastic plugs inserted in masonry or concrete as a base to secure boxes. Do not use welding or brazing for attachment.
- B. Unless otherwise indicated, flush mount receptacles and switches installed in sheet steel boxes. Locate flush-mounted receptacles 18 inches above the finished floor.
- C. Mount switch boxes 48 inches above the floor. Locate receptacles installed in cast device boxes 48 inches above the finished floor.
- D. Wire all 480V receptacles to suit the plant's standard phase rotation.
- E. Test wiring devices for correct connections.
- F. Perform all work in accordance with NFPA 70 and these specifications.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies variable frequency drive (VFD) controllers. The controllers include converters, inverters, control functions, instrumentation, filters, harmonic analysis, protective equipment and accessories necessary to provide the specified functions and features. The County has preselected this equipment. Refer to Part 2 for the requirements.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP #1 VFD	704-VFD03DC011
RSP #2 VFD	704-VFD03DC021
RSP #3 VFD	704-VFD03DC031
RSP #4 VFD	704-VFD03DC041
Sampler Feed Pump VFD 1	704-VFD24AX011
Sampler Feed Pump VFD 2	704-VFD24AX021

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI C37.90	Relays and Relay Systems Associated with Electric Power Apparatus
NEMA ICS6	Enclosures for Industrial Control and Systems
NEMA ST20	Dry Type Transformers for General Applications
IEEE 519	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
UL Standard 508	Industrial Control Equipment
UL 61800-5-1 and -2	Standard for Adjustable Speed Electrical Power Drive Systems
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the submittals from this Section, related to the RSP VFDs, with the submittals for Section 43 23 04 and Section 40 05 94 to allow evaluation as a unit responsibility system. Provide unit responsibility as specified in Section 43 05 01 for the variable speed non-clog end suction centrifugal pump system with the required compatible components listed in Section 43 05 01 including the variable frequency drives specified in this Section.
- C. Provide the submittals from this Section, related to all other VFDs, with the submittals for Section 40 05 93 to allow evaluation as a unit responsibility system. Provide unit responsibility as specified in Section

43 05 01 for general requirements for all compatible components including the variable frequency drives specified in this Section.

D. Provide the following submittals:

1. Catalog and technical data indicating the equipment meets the specifications.
2. Installation instructions outline dimensions and weights including filters and/or isolation transformers, front view drawing identifying control and monitoring devices, nameplate engravings, and wall mounting requirements for all assemblies.
3. External connection diagram showing function and identification of all terminals requiring field connections.
4. Operations and Maintenance manuals as specified in Section 01 78 23.
5. Schematics and wiring diagrams.
6. Plan drawings showing conduit entry locations.
7. Current and voltage distortion calculations:
 - a. Point of Common Coupling (PCC) is the service entrance disconnect.
 - b. Include first 36 odd current and voltage harmonics: Voltage calculated on line to line basis.
 - c. Provide distortion figures for each harmonic and the total demand distortion.
 - d. Provide plots of voltage and current waves.
 - e. Perform calculations for the following criteria:
 - 1) Full load.
 - 2) Half load.
 - 3) Quarter load.
 - 4) Each load criteria shall be tested with UPS online and with UPS in bypass mode, as applicable.
8. Efficiency and power factor calculations:
 - a. Calculate efficiencies of the VFD controller including the transformer (where applicable), ventilation fans, control power and all VFD losses.
 - b. Calculate displacement and total power factor including filter.
 - c. Perform calculations at 100, 75, and 50 percent speed.
 - d. Include first 36 harmonics.
9. Calculations of cooling and ventilation requirements.
10. Quality Assurance letters of certification.
11. Certified final factory test procedure and results for each drive.
12. Location and description of service center.
13. Bill of Materials, including Form 01 78 45-A.
14. Test procedures as specified in this Section.
15. Certified copies of all material test reports.
16. VFD training instructor qualifications.
17. Training schedule and materials.
18. Manufacturer's certification that the controller can withstand fault conditions on the load side based on the assumption that an infinite bus and 5 percent impedance on a 1000kVA delta-to-wye service transformer exists on the supply side of the controller.
19. Provide written verification to the Project Representative that the factory installed wiring, busing, metering, relaying, and related equipment are properly connected, aligned, phased and identified.
20. Test instruments used to perform factory testing, including documentation of calibration.
21. Test documentation from post installation field testing.
22. Mounting base design requirements
23. For all drawings prepared for the submittals, provide updated CAD drawings to reflect as-built conditions in *.dwg format per Section 01 78 39 upon completion of Operational Testing per Section 01 75 20.
24. Provide written statement that manufacturer's equipment has been installed and properly adjusted and is ready for operation by Owner's personnel.
25. Provide final VFD configuration file in the native format.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. The VFD training instructor shall be factory-trained.
- B. Listed and labeled by Underwriter's Laboratories, Inc. (UL), ETL, or Canadian Standards Association.
- C. All upgrades to specified requirements per UL 508 or ETL.
- D. Compatibility: VFD controller's performance shall be compatible with and tolerant of disturbances produced by other VFD controllers and not interfere with each other.
- E. Provide letters of certification signed by officers of the motor manufacturer, VFD manufacturer and the UPS manufacturer (where applicable) that the specific application has been reviewed and that the motor, drive and UPS (where applicable) combination are compatible and will satisfy operating requirements under all conditions of operation without adverse impacts to any of the equipment. Coordinate the submittal of these letters through the Contractor's Unit Responsibility Engineer for equipment included in a unit responsibility system.
- F. Harmonics:
 1. All line side harmonic suppression devices used to eliminate or deal with harmonics in any way shall be contained within the VFD enclosure and shall be integral with the VFD controller.
 2. Use of input line filters external to the VFD shall not be permitted to meet the specified harmonic levels contained in this specification.
 3. Output filters, used to protect motors from high voltage reflections, may be installed external to the VFD.
 4. VFD controller's performance shall be in compliance with the latest version of IEEE 519.
- G. Equipment shall be in current production as a standard series. All material and parts in this unit shall be new and unused, of current manufacture, of the highest grade, and free from all defects affecting performance. The supplier shall have available 24-hour-per-day service by factory-trained technicians and shall have a manufacturer's authorized distributor's parts and service facility located within 50 miles of the job site.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.06 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.07 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 GENERAL

- A. The equipment in this Section has been pre-selected by the County for system standardization. Contractor shall procure the items required in this Section from a vendor authorized to supply products by the listed manufacturer.

2.02 ACCEPTABLE VFD MANUFACTURER IN ORDER OF PREFERENCE

- A. Rockwell Automation 755 18 pulse drive.
- B. Rockwell Automation 755TL 6 pulse drive with active harmonic filter.
- C. Rockwell Automation 755 6 pulse drive with passive harmonic filter, when installed with an external harmonic mitigating device.
- D. No substitution for the above manufacturers.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

- A. General:
 - 1. Minimum Continuous Current Ratings: 1.15 nameplate current of driven motor at full voltage, torque and speed.
 - 2. Minimum Overload Current Rating: 150 percent of continuous current rating for one minute.
 - 3. Torque Requirements: Variable.

2.04 FABRICATION REQUIREMENTS

- A. General Requirements:
 - 1. Pulse Width Modulated (PWM) drive design suitable for use with NEMA design B squirrel-cage induction motors rated for inverter duty at 480 volt, 3 phase, 60 hertz with 1.15 service factor.
 - 2. Converters:
 - a. For 6-pulse drives VFDs: 6-Pulse, multiple full wave, 3 phase, solid state rectifier bridge to convert incoming fixed voltage and frequency to a fixed DC voltage. All components for converters shall be integral to the VFD enclosure.
 - 3. Inverter:
 - a. Output voltage: Adjustable and controlled by the value of output frequency to maintain a constant ratio of Volts per Hertz throughout the operating range. The Volts per Hertz shall be internally field adjustable.
 - b. Capable of varying the speed of any standard NEMA B or NEMA E design, squirrel cage, induction motor with a 1.15 service factor.
 - c. A single unit, with no paralleling of smaller inverters.
 - d. Suppresses output dV/dT high voltage spikes and shall be compatible with driven machinery.
 - 4. Telephone Interference Requirements: Limit the I-T product at any harmonic as defined in IEEE 519 to 10,000 at the primary of the station supply transformer for 2 pumps running.
 - 5. General Features:
 - a. Inverter output shall be conditioned to prevent high voltage ringing on motor leads. Output filters are acceptable.
 - b. Microprocessor controlled pulse width modulation output voltage control strategy.
 - c. Utilize pulse width modulation control techniques such that the maximum root mean square motor line current at rated voltage, torque and speed is less than 1.05 times that motor nameplate current.
 - d. Power transistor output circuitry shall use insulated gate bipolar transistors (IGBT). An essential 18-pulse design combining three 6-pulse inverters to achieve a 18-pulse output will not be accepted. Input phase shifting transformer shall be specifically designed for equal current sharing in VFD applications.
 - e. Power devices to have peak reverse voltage ratings of 2.5 times line current.
 - f. Input power devices shall have peak reverse voltage ratings of 2.5 times line voltage.
 - g. Insensitive to incoming power phase sequence.
 - 6. Ratings:
 - a. Rated Input Power: 480 Volt, plus 10 percent or minus 10 percent, 3 phase, 48 - 62 Hertz, incoming voltage imbalance of plus or minus 0.5 percent.
 - b. Rated Output Power: 0-480 Volt, plus or minus 1 percent, 3 phase, 1-90 Hertz.
 - c. Frequency Drift: Plus or minus 0.5 percent.

- d. Voltage Regulation: Plus or minus 1 percent rated value no load to full load.
 - e. Speed Regulation: 3 percent.
 - f. VFD Efficiency: A minimum of 95 percent at 100-percent speed and torque at 40 degrees Celsius ambient based upon measurement of input power versus output power with all specified components in system.
 - g. Displacement Power Factor: The minimum displacement power factor the VFD controller shall present to the AC system shall be 95 percent at all speeds. The unit shall be designed to inherently provide this minimum power factor.
 - h. Speed Range: 40:1.
 - i. Input Speed Signal: A 4-20 mA DC from an external source and a remote pot. Circuitry shall be isolated. RSP VFDs shall be capable of a digital input speed reference with a +/- 0.01% accuracy.
 - j. Output Contacts: A minimum of three electrically isolated, programmable auxiliary status contacts, rated 5 amp at 120 VAC, for Ready, Run, and Fault.
7. Frequency control and regulation:
- a. Range: 4 mA DC at minimum equipment speed and 20 mA DC at maximum equipment speed.
 - b. Accuracy: 1.0 percent of span.
 - c. Deadband: 0.5 percent of span.
 - d. Repeatability: 0.5 percent of span.
 - e. Input signal impedance: 100 Ohms minimum, with isolated two-wire signal follower.
 - f. Adjustable minimum and maximum output frequency limits.
 - g. Independent timed linear acceleration and deceleration functions adjustable from 3 to 300 seconds.
8. Provide program to prevent operation of the VFD at a minimum of two critical speeds.
9. Disconnects:
- a. Provide input fused disconnects or circuit breaker and current limiter combinations.
 - b. Provide disconnects or circuit breakers with through-the-door or flange-mounted handle and include door interlocks with defeater mechanisms.
 - c. Provide these disconnect switch and circuit breakers as integral components of the factory built assemblies.
- B. Microprocessor Digital Control:
- 1. Drive operating parameters programmable.
 - 2. Sealed keypad with pushbuttons or sealed membrane type keypad with LED or LCD display, mounted on door.
 - 3. Operating parameters, fault, and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data for a minimum of the four most recent events, and is accessible via keypad and RS232/RS422 serial port.
 - 4. Utilize English messages and engineering units.
 - 5. Menu driven.
 - 6. Password security.
 - 7. Computer Interface via RS232/RS422 Serial Communication Port:
 - a. Adjust drive-operating parameter.
 - b. Fault and diagnostic data accessible.
 - c. Isolated from pump station ground so that no connection of a computer powered by the pump station power can cause damage to the computer or the VFD serial communication ports.
 - 8. Display fault and diagnostic data.
 - 9. Ethernet communication capability.
- C. Basic Drive Features and Functions:
- 1. Automatic Restart Feature:
 - a. Field selectable.
 - b. Faults:
 - 1) Overload.
 - 2) Overvoltage.
 - 3) Undervoltage.
 - 4) Voltage imbalance.

- c. Final fault, requiring manual reset, if restart is not successful after three attempts at 30-second intervals between restart attempts.
- d. Provide drive with the ability to start into a motor that is spinning in the forward direction and assume normal operation upon auto restart of the drive.
- 2. Upon restoration of AC power after a loss of utility or standby power, the VFD controller shall not attempt to restart until an external start signal is received. The drive shall not require any type of reset command after a power outage.
- 3. 30 percent voltage dip ride through capability for one cycle. RSP VFDs shall also be capable of riding through a 0 percent voltage dip for 2ms, to allow for UPS static bypass to switch.
- 4. Controllers shall be compatible and tolerant of disturbances produced by other VFD controllers and shall not interfere with each other.

D. Adjustments:

- 1. Maximum frequency: Adjustable 60-90 Hertz. RSP VFDs shall be capable of adjusting the maximum frequency to match the motor adjusted rated frequency.
- 2. Minimum frequency: Adjustable 2-40 Hertz.
- 3. Speed: Frequency maximum and frequency minimum.
- 4. Independent acceleration and deceleration rates: Field adjustable with minimum range of 3-300 seconds at full load. Acceleration and deceleration rates shall be constant at all speed set points, based on the full load time set point. Emergency stop shall bypass deceleration rate and shutoff immediately.
- 5. Voltage parameters: Minimum and maximum voltage and Volts/Hertz.
- 6. Current limit: 50 to 150 percent of drive limit for 1 minute.
- 7. Inverse time overload: NEMA Class 10.
- 8. Speed shedding: Automatic upon low voltage.
- 9. Speed profile: Starting ramp, stopping ramp, minimum speed, and maximum speed.
- 10. Starting boost: 4%.

E. Protective Features and Functions:

- 1. Current limiting fuses, regulators, or other techniques for both internal and external fault protection.
- 2. Overvoltage protection on the incoming AC line.
- 3. Ground fault protection.
- 4. Single-phase fault or 3-phase short-circuit on VFD output terminals without damage to any power component.
- 5. Over-speed (over-frequency).
- 6. Instantaneous overcurrent and overvoltage trip with inverse time overcurrent protection.
- 7. Single phase and undervoltage trip.
- 8. Power unit over-temperature.
- 9. Electronic motor overload protection.
- 10. De-saturation circuit protection for the following conditions:
 - a. VFD fault.
 - b. Motor protection interlock.
 - c. Emergency stop.
- 11. DC bus discharge circuit for protection of operator and service personnel with indicator lamp.
- 12. Transistor assembly overcurrent protection.
- 13. Provides safe drive shutdown on following faults:
 - a. Loss of input power.
 - b. Sustained input undervoltage (minus 15 percent).
 - c. Sustained gradual overload.
 - d. Instantaneous severe overload.
 - e. Power transistor over-temperature.
 - f. Blown fuse.
 - g. Logic power supply failure.
- 14. Voltage transients: Provide solid state line transient protection up to 6000 volts peak per IEEE C62.41-1991.
- 15. Overcurrent protection:

- a. The VFD system shall provide adjustable electronic current limit. Current shall be accurate to within 1.0 percent and shall smoothly limit motor speed at whatever value is necessary to limit motor current to that value.
 - b. The VFD shall provide motor running overcurrent protection in compliance with NFPA-70.
- 16. Short-circuit protection:
 - a. The VFD shall be fully protected against load faults.
 - b. Bolted, phase to phase, or phase to ground faults shall not damage the unit.
 - c. Fault protection shall be based on a power source short circuit capacity of 65,000 Amps RMS symmetrical at the VFD power input terminals. Any impedance or other current limiting necessary to meet this requirement shall be provided as part of the VFD system, and any losses caused by current limiting devices shall be included in efficiency calculations for the VFD system.
- 17. Internal faults: The VFD shall incorporate an internal fault monitoring system to detect malfunctions. This system shall be designed to protect the VFD from transient and sustained faults and to limit damage that may be caused by these faults.
- 18. Motor overtemperature:
 - a. The VFD shall include all components necessary to sense a contact opening and shutdown the affected motor if the motor winding temperature exceeds maximum rated operating temperature.
 - b. Drive shall be manually reset after a motor over-temperature trip.
- F. Special Features and Functions:
 - 1. Operator interface devices and Human Interface Module (HIM) on door of VFD enclosure:
 - a. Provide additional interface devices as indicated on Drawings.
 - b. Display shall have a rotating capability to display custom messages and data.
 - c. Event log shall display data recorded for up to ten event conditions. The initiation level of the declaration of an event condition shall be field programmable for all measured parameters.
 - d. Elapsed time meter (non re-settable) via individual meter.
 - e. Indication of output voltage in volts, via HIM.
 - f. Indication of input voltage in volts, via HIM.
 - g. Indication of output currents in amps, via HIM.
 - h. Indication of motor speed in RPM, via HIM.
 - i. Indication of enclosure temperature in Fahrenheit, via HIM.
 - j. Local/Off/Auto selector switch, via individual switch. When in Auto, the speed is controlled from an external 4 to 20 mA DC signal, via individual switch. In Local, the speed is controlled from a keypad module, via HIM.
 - k. Start, Stop pushbuttons (keypad) active in Local mode, via HIM.
 - l. VFD off but ready indication light (green), via individual light.
 - m. VFD running indication light (red), via individual light.
 - n. Power indication light (white), via individual light.
 - o. VFD failure indication light (amber), via individual light.
 - p. System stop mushroom head maintained contact pushbutton, via individual switch.
 - q. Reset pushbutton, via individual switch.
 - r. Control devices per Section 26 09 16.
 - s. EtherNet port for extracting drive data to station PLC or Plant SCADA System. Drive shall be setup to provide Machinery health and power meter information through this port per Section 26 09 11.
 - 2. Control power transformer:
 - a. 120 VAC secondary; 100 VA minimum.
 - b. Two primary fuses and one secondary fuse with non-fused secondary leg grounded.
 - c. Door mounted "Control Power On" pilot light.
 - d. Independent transformer utilized for internal VFD electronic controls.
 - 3. Remote local control interface requirements:
 - a. Remote run signal from PLC contact closure, two-wire control.
 - b. Remote: Isolated 4-20 mA DC speed reference input signal; preset speed input is active.
 - c. Local: 4-20 mA DC inactive; preset speed inactive; reference from interface module. May be keypad operated.

- d. Drive running: 1 form C isolated contacts, 120V, 5 amps (typical).
 - e. Drive off and ready to run: 1 form C isolated contacts.
 - f. Drive fault: 1 form C isolated contacts.
 - g. Drive in remote mode: 1 form C isolated contacts.
 - 4. Preset speed: The drives shall ramp to a pre-programmed speed upon a contact closure, ignoring the 4 to 20 mA DC normal speed reference signal.
- G. Noise Data: Free field noise generated by the VFD shall not exceed 85 dBA at 3 feet from any point of the VFD cabinet under any normal operating condition.
- H. Enclosures:
- 1. Mounting:
 - a. Less than 50HP: Wall-mounted
 - b. 50HP and larger: Free-standing
 - 2. Location:
 - a. Include fan and ventilation provisions that are necessary for equipment cooling and coordinated with the cooling ductwork provided by others in the pump station building.
 - b. Dry Location: NEMA 250 Type 1
 - c. Damp Location: NEMA 250 Type 12
 - d. Wet Location: NEMA 250 Type 4X
 - 3. For RSP VFDs, the full cabinet lineup shall fit within a space no larger than 35.5" deep by 142" wide by 126" tall completely installed.
 - 4. Painted parts:
 - a. To undergo phosphatizing, prepaint treatment for rust resistance and paint bond.
 - b. Paint and process color:
 - 1) Interior: Manufacturer's standard color
 - 2) Exterior: Sherwin Williams Hunt Club SW 6468.
 - c. Paint: Applied by electrostatic process and baked to a durable hard finish.
 - 5. Nameplates:
 - a. Provide laminate phenolic nameplates showing the controller designations as specified.
 - b. Design: Black, with minimum 3/16-inch high white letters. Nominal size shall be 1 inch high by 3 inches long.
 - c. Abbreviations: If required because of space limitations, abbreviations shall be submitted to the Project Representative for approval.
 - 6. Seismic bracing: The entire assembly, including electronics and controls, shall be braced for the site seismic criteria listed in Section 01 73 00.
 - 7. Audible noise requirements: See Section 44 05 10 and this Section.
 - 8. All components shall be accessible and removable from the front only.
 - 9. Doors:
 - a. Open at least 90 degrees and shall be provided with 4 point hinges.
 - b. Door handles: Capable of accepting a padlock with a 3/8-inch shackle to lock the VFD enclosure closed and the input breaker open.
 - 10. Drive enclosures:
 - a. Provided with external framework for housing the air filters.
 - b. Access to the filter media for purposes of replacement or cleaning shall be possible from the exterior of the drive without the need to open doors on the drive enclosure or otherwise gain interior access to the drive.
 - 11. Ventilation:
 - a. When required provide intake and exhaust ventilation in the door of the enclosure.
- I. Maintainability: VFD controller's parts shall be interchangeable and modular for all controllers.

2.05 SOURCE QUALITY CONTROL

- A. Perform stand-alone Factory Test
 - 1. The Project Representative will observe factory tests on the VFD controller at the Project Representative's option and expense.

2. Witnessing provisions:
 - a. County may elect to witness factory performance testing.
 - b. Provide the project Representative with not less than 60 days advance written notice of the date and place of each factory performance test.
 - c. Payment and administration for County witnessing testing: Section 01 29 00.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install equipment level and plumb and anchor in accordance with the equipment manufacturer's instructions and as indicated herein.
- C. Wall mounted VFDs shall maintain a minimum of ¼" separation between the VFD and wall.
- D. Provide earthquake resistant attachments and supports for equipment.
- E. Provide seismic anchorage and bracing per Section 01 73 00.

3.02 HARMONIC ANALYSIS CALCULATIONS

- A. Calculate total harmonic distortion at the common node Motor Control Center bus for the controller units based on the specified impedances and system configuration. Unless otherwise indicated, determine distortion in accordance with IEEE 519.

3.03 FIELD QUALITY CONTROL

- A. Employ and pay for services of the equipment manufacturer's field service representative to:
 1. Inspect equipment covered by these specifications.
 2. Supervise adjustments and installation checks.
 3. Conduct startup of equipment and perform operational checks; provide a checklist of all inspections.

3.04 TRAINING

- A. Procedures: Section 01 79 00.
- B. Provide a minimum of 2 hours per training to cover general VFD theory and operation.
- C. Provide a minimum of 6 hours per training on operation and maintenance.

3.05 FACTORY TEST

- A. Perform standard factory tests on each drive provided.
- B. Notify the Project Representative at least 4 weeks in advance of any test. Provide certified copies of the test reports.

3.06 TESTING AND STARTUP

- A. Test Procedure:
 1. Prepare test procedure and conduct tests in accordance with the procedure to demonstrate to the Project Representative the accuracy of the wiring, control, and proper functioning of the equipment.
 2. Submit proposed test procedure for approval at least two weeks prior to the demonstration.

3. All equipment and systems shall be demonstrated as operating properly prior to acceptance of the work. All protective devices shall be operative during the demonstration.
 4. If the demonstration indicates unsatisfactory operation as determined by the Project Representative or inspecting authorities, correct defects and repeat the demonstration.
- B. Phase Relationship Tests:
1. Check connection to all equipment for proper phase relationship.
 2. During such check, disconnect all devices that could be damaged by the application of voltage of reversed phase sequence.
- C. Insulation Resistance Tests:
1. Perform insulation resistance tests on conductors, cables, and equipment, signal circuits exempt.
 2. Make tests using 1,000-volt Biddle hand cranked megger insulation resistance tester.
 3. Disconnect all equipment that may be damaged by such tests before the tests are made.
 4. Tests shall measure insulation resistance from line to ground.
 5. Test conductors and cables after placement and the completion of the terminations, but before connection to equipment.
 6. Test 600-volt class circuits and equipment. Minimum acceptable values of insulation resistance of circuits and equipment shall be 100 megohms.
 7. Provide test reports listing test equipment used, person or persons performing the tests, the date tested, the circuits or equipment tested, and the results of all tests.
 8. These tests shall be witnessed by the Project Representative.
 9. The Contractor shall notify the Project Representative one week in advance of testing.
- D. High Voltage Ringing on Motor Leads:
1. The contract requires VFDs, or VFDs with output filters, which control the phenomenon of high voltage reflected voltage waves on motor cable, produced by the high speed switching of PWM drives.
 2. Use an oscilloscope with a 5,000-volt test probe at the motors with the longest length able to record the amplitude of the voltage at the motor.
 3. Voltage spikes plus base 480 volts: Not exceed 1488 Volts peak, per NEMA.
- E. Test Equipment: All test instrumentation equipment used during testing shall be NIST traceable and certified.

END OF SECTION

SECTION 26 31 00

GRID-TIED PHOTOVOLTAIC SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies grid-tied photovoltaic system.
- B. The general requirements for electrical equipment, as specified in Section 26 05 00, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-Photovoltaic System Inverter	704-INV30DC001
RSP-Photovoltaic Panel String 1	704- PVP30001 Thru 018
RSP-Photovoltaic Panel String 2	704- PVP30001 Thru 218

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
IEC 61215	Crystalline Silicon Terrestrial Photovoltaic (PV) Modules-- Design Qualification and Type Approval
NFPA 70	National Electrical Code (NEC)
UL 1699B	UL Standard for safety Photovoltaic (PV) DC Arc-Fault Circuit Protection
UL 1703	Standard for Flat-Plate Photovoltaic Modules and Panels
UL 1741	Standard for Safety for Inverters, Converters and Interconnection System Equipment for Use with Distributed Energy Resource

1.03 DEFINITIONS

- A. Array: A mechanically integrated assembly of modules and panels, together with support structure and foundation, tracking, thermal control, and other components, if used, to form a dc power-producing unit.
- B. Insolation: Sunlight, direct or diffuse (not to be confused with insulation). The integrated intensity of sunlight reaching a given area, usually expressed in watts per square meter per day. This measurement may be used to express the average amount of solar energy falling on different regions of the country.
- C. LEED: Leadership Energy and Environmental Design from USGBC.
- D. Module: A number of solar cells connected together electrically and sealed inside a weatherproof package with a clear face; sometimes called a "solar panel".

- E. Panel: A designation for a number of PV modules assembled in a single mechanical frame.
- F. PV: Photovoltaic, pertaining to the direct conversion of light into electricity.
- G. PV System: Photovoltaic energy system consisting of, but not limited to, photovoltaic modules, combiner boxes, dc disconnects, inverters, ac disconnects, equipment enclosures, wire, conduit, switches, fuses, meters, monitoring equipment, and appurtenances.
- H. PV USA Test Conditions (PTC): Test conditions applied to PV modules intended to represent wattage during operation; irradiance of 1,000 watts per square meter, 20 degrees C ambient temperature, 1 meter per second wind speed, and air mass of 1.5.
- I. Standard Test Conditions (STC): Test conditions applied to PV modules; irradiance of 1,000 watts per square meter, cell temperature of 25 degrees C, and air mass of 1.5.
- J. Tilt Angle: The angle of inclination of solar panel measured from the horizontal plane.

1.04 SYSTEM DESCRIPTION

- A. General:
 - 1. Design grid-tied photovoltaic electrical power system.
 - 2. Unless otherwise noted, references to PV dc kW ratings are based on STC values.
 - 3. Components, wiring methods, and work associated with system shall meet NFPA 70 requirements.
 - 4. PV modules shall not extend beyond areas designated in the Drawings, unless approved by Project Representative.
 - 5. Design shall prevent moisture from penetrating roof system and shall be coordinated with roof structure.
 - 6. Comply with roof system manufacturer's warranty design criteria when penetrating roof system.
 - 7. Attachment considerations shall take into account Site conditions, including expansion and contraction movements, so there is no possibility of loosening, weakening, or fracturing connection between PV system and building envelope components.

1.05 DESIGN REQUIREMENTS:

- A. System shall include, but not be limited to:
 - 1. Arrays of PV modules installed at locations shown in the Drawings.
 - 2. Mounting system for PV modules.
 - 3. dc to ac inverter(s).
 - 4. dc wiring and conduit from PV arrays to combiner boxes and inverter.
 - 5. Include ac wiring on output side of inverter(s), up to grid tie-in point(s):
 - a. Tie-in breaker(s) are not part of PV system design. PV system designer shall provide sizes, quantities, and configuration for required Contractor-supplied tie-in breaker(s) to be used when connecting electrical tie-in equipment.
 - 6. Other equipment required to provide a complete and functional PV system.
- B. Provide concealed fastening wherever possible.
- C. Panel Tilt and Azimuth: As required for optimum power generation at the installation site, but no more than 5 degrees to minimize added wind load to the building.
- D. DC Circuit Voltage Drop:
 - 1. Maximum 1 percent for individual circuit, as measured from PV panel to input of inverter, including losses through conductors, fuses, blocking diodes, and terminations.
 - 2. Provide larger wire, design smaller sub-array sizes, or make other adjustments as necessary to meet voltage drop requirement.

- E. Design shall minimize shading on PV module.
- F. Array layout shall be consistent with ordering and labeling of source circuits in array combiner boxes.
- G. Individual panels shall be interconnected using manufacturer's standard cable assemblies, specifically intended for use with PV modules.
- H. System shall include combiner boxes, containing fuses if more than three strings combined and bussing to combine outputs from groups of panels:
 - 1. Combiner boxes may be integral to inverters or be housed in separate enclosures.
 - 2. If combiner boxes are mounted outside building envelope or exposed to outside air, boxes shall be rated NEMA 4X.
- I. Provide grounding system for grid-tied photovoltaic system and necessary interconnections to other grounding systems, as required by NFPA 70.
- J. System shall meet or exceed applicable electric utility interconnection requirements:
 - 1. Provide meter base, disconnects, and other equipment as required by applicable electric utility.
- K. Provide array dc ground-fault protection devices as part of inverter or as external device in accordance with NFPA 70.
- L. Financial Incentives, Rebates, and Tax Credit Eligibility:
 - 1. Identify potential incentives, rebates, and tax incentives.
 - 2. PV system shall comply with eligibility requirements in order for County to receive incentives, rebates, and tax credits from available sources.
- M. Capacity/Size:
 - 1. Capacity as shown in the Drawings.
 - 2. PV panels shall, at a minimum, cover area shown in the Drawings.

1.06 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
 - 1. General:
 - a. PV module product description.
 - b. PV array layout drawings.
 - c. Support structure design.
 - d. Inverter product description and connection diagrams.
 - e. Wiring diagrams detailing distribution of dc conductors from modules to inverter, including combiner boxes and fuses if used. Also include ac wiring up to grid tie-in point(s).
 - f. Conduit and conductor information.
 - g. PV grounding interconnections to other grounding systems.
 - h. Electrical and structural penetration details of weathertight building envelope.
 - 2. Calculations: Solar access/shade report, performed with Solmetric SunEye or similar device.
 - 3. Provide Site-specific calculations showing expected monthly and annual output of each separate PV system in ac kWh/yr. Use PVWatts online calculator or approved equivalent:
 - a. Take into account known Site conditions, dust and dirt accumulation, module and wiring mismatches, conversion and other system losses, weather, and other environmental factors.
 - b. Include assumptions, such as environmental factors and expected insolation.
 - 4. Anchorage and bracing drawings and cut sheets, as required by Section 01 73 00.
 - 5. Information on financial incentives, rebates, and tax credit eligibility.
 - 6. Equipment and system warranties.
 - 7. Operations and Maintenance manuals: Section 01 78 23.
 - 8. Field test reports.

9. Anchorage and bracing calculations as required by Section 01 73 00.
10. Bill of Materials, including Form 01 78 45-A.

C. Qualifications.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications:
1. At least 5 years experience designing and installing grid-tied photovoltaic systems, and carry proper licensing.
 2. Certified by NABCEP, or approved equivalent grid-tied photovoltaic system design and installation training:
 - a. Identify at least three projects where installed capacity was at least 30 dc kW.
- B. UL Compliance:
1. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.
 2. If no UL compliance is available, provide the Work in accordance with NFPA 70. Where required by AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to AHJ.

1.08 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.09 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.10 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.
- B. Photovoltaic System: Provide extended guarantee or warranty, with County named as beneficiary, in writing, as special guarantee. Special guarantee shall provide correction, or at the option of County, removal and replacement of the Work specified in this Specification found defective during a period of 2 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.
- C. Photovoltaic Module: Manufacturer's standard limited power output warranty, 25 years minimum, guaranteeing:
1. No module shall generate less than 90 percent of its specified minimum power when purchased.
 2. No module shall generate less than 80 percent of its specified minimum power at the end of warranty period.
- D. Inverter Warranty: 10 years minimum.

PART 2 PRODUCTS

2.01 PHOTOVOLTAIC MODULE

- A. General:

1. UL 1703 listed.
 2. Manufactured in the USA, with product support in the USA.
 3. Comply with IEC 61215.
 4. System Voltage: 600V dc, maximum.
 5. Factory-installed bypass diode.
 6. Reduces voltage to touch-safe levels upon inverter initiation.
- B. Materials:
1. Monolithic structure, corrosion resistant, suitable for marine environment, resistant to damage from snow, wind, or hail.
 2. High-impact-resistant tempered glass face.
 3. Weatherproof.
 4. Anodized aluminum frame, rails, legs, and feet.
 5. Use stainless steel fastener hardware.
- C. Efficiency: 12 peak STC watts per square foot minimum. Determine square footage as the entire front side physical area of module, measured to outside perimeter of frame or mounting device.
- D. Acceptable manufacturer:
1. Silfab Solar.
 2. LG Solar.
 3. Mission Solar.
 4. Approved Equal.

2.02 INVERTER

- A. Features:
1. UL 1741 listed.
 2. dc to ac inverter, with pure sine wave output.
 3. Rating: Estimated number and size of inverters that are required are shown in the Drawings. If final calculations show a different number or size is required, provide equipment to meet requirements. Coordinate with project representative, number and size of inverters with physical space available and electrical system interface (tie-in points at motor control center) shown in the Drawings.
 4. ac Output: 480 volts, three-phase.
 5. Top and bottom cable entry.
 6. dc contactor for array isolation.
 7. "Nighttime" mode or other means to minimize standby losses.
 8. Integrated dc and ac disconnects, UL listed.
 9. Automatically initiates module-level rapid shutdown upon loss of AC power
 10. Arc Fault protection, UL 1699B listed.
 11. Isolation transformer.
 12. Fan forced cooling.
 13. Operating Temperature Range: 0 degree C to 50 degrees C.
 14. Total Current Harmonics: Less than 5 percent at inverter ac terminal.
 15. Efficiency: 95 percent minimum.
 16. Parallel or Stacked Operation: Capable of operating in parallel with other inverters (stacked) without loss of functionality or performance.
 17. Capable of interrupting line-to-line fault currents and line-to-ground fault currents. Available fault current from the AC side of the inverter will be provided by the design engineer, maximum fault current from the photovoltaic modules shall be calculated as part of the provided system. Inverter shall turn off before ac or dc contactors are opened, as applicable.
 18. Provide self-protective features to protect inverter from damage in event of component failure or from parameters beyond normal operating range due to internal or external causes:
 - a. Self-protective features shall not allow inverters to be operated in a manner which may be unsafe or damaging.
 - b. Faults due to malfunctions within inverter or solar conversion system equipment shall be cleared by inverter over-current protection device and not by Owner's protection devices.

19. Grounding system shall:
 - a. Provide personnel protection for step and touch potential in accordance with utility standards.
 - b. Facilitate detection and clearing of ground faults.

B. Monitoring:

1. Multifunction digital display mounted on front of inverter, with a minimum of the following features:
 - a. Input dc voltage, amps, and power in kW.
 - b. Output ac voltage, amps, power factor, power in kW and KVA, frequency.
 - c. Utility grid status; available or not available.
 - d. Common inverter fail indication.
 - e. Inverter status; off/operating.
 - f. Display historical power generated in kWh, with 1-day minimum resolution, with at least 2 years of memory.
2. If a feature is not available on digital display at inverter, provide separate digital power meter that has these features.

C. Controls:

1. Grid Synchronization Control:
 - a. Capable of parallel operation with ac power system.
 - b. Synchronize output waveform with that of utility power system.
 - c. Automatically disconnect from utility power system if that power is interrupted.
2. Wake up and sleep sequencing with isolation controls and grid restoration.

D. Communications/Monitoring: Modbus/TCP.

E. Enclosure:

1. Steel construction, rated NEMA 1.
2. Finish: Manufacturer's standard.

F. Acceptable manufacturer:

1. SolarEdge.
2. SMA.
3. Solectrica/Yaskawa.
4. Square D/Xantrex.
5. Eaton-Cutler Hammer.
6. Approved Equal.

2.03 SUPPORT STRUCTURES

- A. Structural design shall be performed by professional engineer registered in the state of Washington.
1. PV arrays, including modules, hardware, support structure, and attachments shall be structurally designed to withstand wind loads of 100 miles per hour, minimum, and comply with existing local and national codes.
 2. Mounting Hardware:
 - a. Compatible with Site considerations and environment.
 - b. Bolts: Antitheft heads to prevent removal of PV modules.
 - c. Minimize risk from exposed fasteners, sharp edges, and potential damage to modules or support structure.
 3. Mechanical Hardware:
 - a. Use stainless steel fasteners and aluminum support structure for corrosion resistance and durability.
 - b. Use of ferrous metals, wood, or plastic components is not allowed.
 - c. Avoid galvanic corrosion.
 4. Conceal mechanical hardware, conduit, junction boxes, and other equipment beneath or behind array.
 5. Provide access to back of array for module junction box servicing, and removal/replacement of individual source circuits and modules.

2.04 ELECTRICAL

- A. Conductors: In accordance with Section 26 05 19.
- B. Raceway and Boxes: In accordance with Section 26 05 33.

2.05 ACCESSORIES

- A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- B. Equipment Identification Plates: Provide identification plate, as specified in Section 26 05 00, securely mounted on each separate equipment component and control panel in a readily visible location.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00.

PART 3 EXECUTION

3.01 PREPARATION

- A. Visit Site and become familiar with Site layout and conditions which might affect system installation or performance.
- B. Coordinate installation with electric utility and provide required paperwork to electric utility on behalf of Owner.

3.02 INSTALLATION

- A. In accordance with manufacturer's instructions, recommendations and IEEE 1547.
- B. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
- C. Install equipment plumb and in longitudinal alignment with pad or wall.
- D. Retighten current-carrying bolted connections, and enclosure support framing and panels in accordance with manufacturer's recommendations.
- E. Install rapid shutdown and equipment disconnect placards.

3.03 FIELD QUALITY CONTROL

- A. General:
 - 1. Test completed system in presence of approved representatives from electric utility and Project Representative.
 - 2. Schedule test a minimum of 2 weeks in advance with representatives.
- B. Test shall include as a minimum:
 - 1. Inverter function test to ensure each individual and stacked inverter set performs as specified.
 - 2. Verify each inverter and stacked inverter set automatically operates in parallel with utility-supplied power.
 - 3. Test each inverter under typical and maximum load conditions.
 - 4. Total testing period shall be at least 24 hours.
 - 5. Retest entire system and associated equipment if initial test requires corrective action.
 - 6. Test Reports:

- a. Written summary of programmed values and setpoints for each inverter upon completion of final testing.
- b. Current and voltage readings at completion of test.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Project Representative for minimum person-days listed below, travel time excluded
 1. 1 person-days for installation assistance and inspection.
 2. 1 person-day for facility startup.
- B. Training:
 1. Procedures: Section 01 79 00.
 2. Provide a minimum of 8 hours per training.

3.05 CLEANING

- A. Clean areas affected by the Work, including surface of PV modules. Leave areas in such a condition that no cleaning will be required by County.

END OF SECTION

SECTION 26 33 53

UNINTERRUPTIBLE POWER SUPPLY

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies uninterruptible power supplies (UPS), including but not limited to:
1. UPS Module(s).
 2. Static Bypass Transfer Switch.
 3. System Control.
 4. DC Battery System.
 5. Battery Protective and Disconnect Device(s).
- B. The general requirements for electrical equipment, as specified in Section 26 05 00, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP-Pump 1 MTR UPS	704-UPS03DC011
RSP-Pump 1 MTR UPS Batt. Mod #1	704-BAT03DC011
RSP-Pump 1 MTR UPS Batt. Mod #2	704-BAT03DC012
RSP-Pump 1 MTR UPS Batt. Mod #3	704-BAT03DC013
RSP-Pump 1 MTR UPS Batt. Mod #4	704-BAT03DC014
RSP-Pump 1 MTR UPS Batt. Mod #5	704-BAT03DC015
RSP-Pump 1 MTR UPS Batt. Mod #6	704-BAT03DC016
RSP-Pump 2 MTR UPS	704-UPS03DC021
RSP-Pump 2 MTR UPS Batt. Mod #1	704-BAT03DC021
RSP-Pump 2 MTR UPS Batt. Mod #2	704-BAT03DC022
RSP-Pump 2 MTR UPS Batt. Mod #3	704-BAT03DC023
RSP-Pump 2 MTR UPS Batt. Mod #4	704-BAT03DC024
RSP-Pump 2 MTR UPS Batt. Mod #5	704-BAT03DC025
RSP-Pump 2 MTR UPS Batt. Mod #6	704-BAT03DC026
RSP-Pump 3 MTR UPS	704-UPS03DC031
RSP-Pump 3 MTR UPS Batt. Mod #1	704-BAT03DC031
RSP-Pump 3 MTR UPS Batt. Mod #2	704-BAT03DC032
RSP-Pump 3 MTR UPS Batt. Mod #3	704-BAT03DC033
RSP-Pump 3 MTR UPS Batt. Mod #4	704-BAT03DC034
RSP-Pump 3 MTR UPS Batt. Mod #5	704-BAT03DC035
RSP-Pump 3 MTR UPS Batt. Mod #6	704-BAT03DC036
RSP-Pump 4 MTR UPS	704-UPS03DC041
RSP-Pump 4 MTR UPS Batt. Mod #1	704-BAT03DC041
RSP-Pump 4 MTR UPS Batt. Mod #2	704-BAT03DC042
RSP-Pump 4 MTR UPS Batt. Mod #3	704-BAT03DC043
RSP-Pump 4 MTR UPS Batt. Mod #4	704-BAT03DC044
RSP-Pump 4 MTR UPS Batt. Mod #5	704-BAT03DC045
RSP-Pump 4 MTR UPS Batt. Mod #6	704-BAT03DC046

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
UL 1564	Standard for Safety Industrial Battery Chargers
UL 1778	Standard for Safety Uninterruptible Power Systems
UL 1973	Standard for Safety Batteries for Use in Stationary and Motive Auxiliary Power Applications
UL 9540A	Standard for Safety Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
ANSI C62.41	Guide for Surge Voltages in Low-voltage AC Power Circuits
NFPA.70	National Electrical Code (NEC)
NEMA PE-1	Uninterruptible Power Systems – Specification and Performance Verification

1.03 SYSTEM DESCRIPTION

- A. System Configuration: Multi-module Uninterruptible Power System.
- B. Components: System includes batteries to provide a continuous source of electrical power, rectifier/charger to maintain battery charge and to provide input to inverter when utility power is available, inverter to provide power to load during normal operation, static switch to transfer load automatically and without disturbance between inverter and utility power and filters to provide appropriate isolation and disturbance attenuation, and necessary monitors, sensors, and control circuits.
- C. Modes of Operation:
1. Normal: The inverter(s) continuously powers the critical load. The rectifier/charger(s) derives power from the utility alternating current (AC) source and supplies direct current (DC) power to the inverter(s), while simultaneously charging the battery(s).
 2. Emergency: Upon utility AC power failure, without any switching, the inverter(s) obtains power from the battery plant(s) and provides uninterrupted power to the critical AC load. Designed to have no interruption in power to the critical load upon failure or restoration of the utility ac source.
 3. Recharge: Upon restoration of the utility AC source, the rectifier/charger(s) automatically powers the inverter(s) and simultaneously recharges the battery(s) with no interruption to the critical AC load.
 4. Off-battery: For battery(s) maintenance, battery disconnect breaker(s), isolates the battery(s) from the rectifier/charger(s) and inverter(s). The UPS module(s) continues to function and meet all of the specified steady-state performance criteria, except for the power outage back-up time capability.
 5. Single Multi-module Unit (MMU) Failure: The failed UPS module is disconnected from the critical load and the remaining modules will carry the load without disturbance. When the MMU returns to acceptable operation, it is reconnected to the load without disturbance.
 6. Bypass: Upon overload, load fault or internal failure, the UPS automatically switches to the static bypass, providing AC power to the load directly from utility power. While in this mode the load is not protected from utility voltage or frequency fluctuations, or power outages.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.

- B. Provide the following submittals:
1. Itemized list of exceptions and deviations from these specifications.
 2. Performance characteristics. Capacities and ratings including noise. Data sheets, catalog cutsheets, other descriptive literature.
 3. Layout with dimensions and openings for major components including inverter, by-pass, charger, battery, battery rack, and battery enclosure.
 4. Single-line diagram including controls, control interface, metering, and external wiring requirements. (detail breaker and disconnect locations, frame size, trip ratings, and model numbers). Detailed layouts of metering, alarm, and mimic panels (show metering on single-line).
 5. Heat rejection and ventilation requirements under no load and full load conditions. (include battery and rack/enclosure).
 6. Mounting and detailed scaled installation drawings, including seismic per 01 73 00.
 7. Battery specification, installation, and maintenance requirements.
 8. Size and type of cable to interconnect batteries to UPS system.
 9. Bill of Materials, including Form 01 78 45-A.
 10. Onsite written test procedure.
 11. Software, files, databases.
 12. Factory testing results.
 13. Field test results.
 14. Operation and maintenance manuals.
 15. Training.

1.05 QUALITY ASSURANCE

- A. Qualifications:
1. Manufacturer: Company specializing in UPS equipment with 5 years documented experience.
- B. Factory Tests: Test complete system at factory and calibrate prior to shipment, include full-load test at rated power factor.
- C. Provide the Work in accordance with NFPA 70 (National Electric Code – NEC). Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the above listed agency.
- D. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.
- E. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.
- F. Material and equipment shall be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.
- G. Provide letters of certification signed by officers of the VFD manufacturer and the UPS manufacturer that the specific application has been reviewed and that the drive and UPS combination are compatible and will satisfy operating requirements under all conditions of operation without adverse impacts to any of the equipment. Coordinate the submittal of these letters through the Contractor's Unit Responsibility Engineer for equipment included in a unit responsibility system.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00 and 26 05 00.

1.07 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.
- C. Audible Noise: Limit noise generated by UPS under conditions of normal operation below sound pressure level of 75 db measured at 5 feet from the UPS cabinet.

1.08 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.
- B. Battery: Ten (10) year full warranty or manufacturer's standard warranty, whichever is longer.
- C. Warranty – End User: Pass warranties associated with buy-out items to the end user.

1.09 MAINTENANCE

- A. Preventive Maintenance and Maintenance contracts shall be available. Preventive Maintenance shall be performed by factory authorized service representatives.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Eaton.
 - 2. Toshiba.
 - 3. No or equal

2.02 SYSTEM RATINGS AND OPERATING CHARACTERISTICS

- A. System Continuous Rating: As shown in the Drawings. Maintain output voltage within specified limits at loads from full load to no load.
- B. Battery Capacity: Discharge time to end voltage: minimum 6.5 minutes at designed connected load, 77 degrees C, and sustained through end of warrantied life.
- C. Voltage Rating:
 - 1. Input:
 - a. Three-phase: 480 Volts.
 - 2. Output:
 - a. Three-phase: 480 Volts.
 - 3. Battery input:
 - a. 480Volts dc.
- D. Equipment Short-Circuit Rating: as shown in the Drawings.
- E. UPS, batteries and associated equipment shall be UL 9540 listed as a complete assembly.

2.03 UPS MODULE PERFORMANCE REQUIREMENTS

- A. Input:
 - 1. Voltage Range: Plus or minus 10 percent.
 - 2. Frequency Range: 60, plus or minus 3 Hz.
 - 3. Inrush Current Limiting: 30 percent of full load rated max.
 - 4. Current Walk-in: 0 to 100 percent in 15 seconds.
 - 5. Power Factor: Minimum 0.95 lagging at full load with nominal input voltage.
 - 6. Two-step Battery Charge Current Limit:
 - a. Step 1: Factory set at 10 percent (adjustable 1 to 25 percent) maximum discharge current.
 - b. Step 2: Factory set at 1 percent (adjustable 1 to 25 percent) maximum discharge current.
 - 7. Current Distortion: Less than 7 percent at full load input.
 - 8. Surge Protection: Sustains input surges without damage per criteria listed in ANSI C62.41.
- B. Output:
 - 1. Load Rating: 100 percent continuous load rating at 0 to 104 degrees F for any combination of linear and non-linear load.
 - 2. Voltage Regulation: Plus or minus 1 percent for steady state load.
 - 3. Voltage Adjustment: Plus or minus 5 percent.
 - 4. Free Running Frequency: 60 Hz, plus or minus 1.0 percent.
 - 5. Frequency Regulation: 0.1 percent.
 - 6. Measure UPS efficiency under the following conditions:
 - a. UPS, operating at full-rated load kVA, and kW.
 - b. Battery, fully charged.
 - c. Input voltage within specified range.
 - d. Efficiency: Defined as output kW divided by input kW.
 - e. Minimum Efficiency at Full Load: 97 percent.
 - 7. Phase Displacement:
 - a. 120, plus or minus 1 degree for balanced loads.
 - b. 120, plus or minus 4 degrees for 50 percent unbalanced loads.
 - 8. Unbalanced Voltage Regulation:
 - a. 100 percent balanced loads: Plus or minus 1 percent.
 - b. 100 percent unbalanced loads: Plus or minus 2 percent.
 - 9. Voltage Transients:
 - a. Compliant to IEC 62040-3 Class 1.
 - 10. Harmonic Distortion: Maximum 5 percent rms voltage total harmonic distortion (THD) and maximum 3 percent for any single harmonic, at rated frequency and voltage, from 10 percent load to full load and over battery voltage range, measured into a linear load.
 - 11. Three-phase Overload Ratings:
 - a. 150 percent for 10 seconds with voltage regulation.
 - b. 125 percent for 2 minutes with voltage regulation.
 - c. 100 percent continuously.
 - 12. Current Limit: 125 percent of rated output current.
 - 13. Fault Clearing: 500 percent of normal full load current for 1 cycle (with bypass available).
 - 14. Power Factor: 1.0.

2.04 DESIGN AND CONSTRUCTION

- A. UL 1778 listed.
- B. UPS Materials:
 - 1. Provide all new high-grade materials for UPS module(s) with solid-state electronic devices, sealed semi-conductors, and control logic and fuses that are physically isolated from power train components.
 - 2. The maximum working voltage, current, and di/dt of all solid-state power components and electronic devices shall not exceed 75 percent of the ratings established by their manufacturer.

3. The operating temperature of solid-state component sub-assemblies shall not be greater than 75 percent of their ratings.
4. Electrolytic capacitors shall be computer grade and operated at no more than 95 percent of their voltage rating at the maximum rectifier charging voltage.

C. Mechanical Design Features

1. Enclosure:
 - a. Construction: NEMA Type 1 enclosure designed for floor mounting.
 - b. Full cabinet lineup shall fit within a space no larger than 45" deep by 156" wide by 90" tall completely installed.
 - c. Mounting: Structurally adequate with provisions for hoisting, jacking, and forklift handling and in accordance with Specification 01 73 00 Bracing and Anchoring.
 - d. Allow installation, maintenance, and service of UPS without removal of or access to side or rear panels.
 - e. Provide adequate space and termination facilities for terminating input and output cables. Provide provisions for top access to input, output, and DC connections.
2. Ventilation:
 - a. Provide redundant forced air cooling to ensure that all components are operated well within temperature ratings.
 - b. Locate air intake at bottom front and air exhaust at top of unit.
 - c. Incorporate removable air filters that do not require shutting down UPS for cleaning or replacement, are readily accessible and located at air intakes.
 - d. Provide temperature sensors to monitor UPS internal temperature. Upon detection of temperatures in excess of manufacturer's recommendations, the sensors shall cause audible and visual alarms to be sounded on the UPS panel.
3. Lugs: Two-hole, long barrel copper only compression lugs.
4. Grounding: The UPS MMU chassis shall have an equipment ground terminal. A terminal for bonding the system to the facility service entrance ground (customer-supplied cable) shall be provided.

D. Vibration Isolation:

1. Application: Mount UPS on double neoprene pad (DNP) isolators.
2. DNP:
 - a. Utilize Neoprene pad isolators formed by two layers of 1/4-inch to 3/8-inch thick ribbed or waffled neoprene, separated by stainless steel or aluminum plate. Utilize layers permanently adhered together. Provide Neoprene of 40 to 50 durometer. Size pads so they will be loaded within manufacturer's recommended range. Provide a steel top plate equal to size of pad to transfer weight of support unit to pads and to distribute load evenly over surface of pads.
 - b. Acceptable manufacturers:
 - 1) VMC Group (Amber/Booth), Type NR.
 - 2) VMC Group (Korfund Dynamics), Type Korpad.
 - 3) Mason Industries, Type WSW.
 - 4) Peabody Noise Control, Type NPS.
 - 5) Approved Equal.

E. Protection:

1. Provide built-in self-protection for surges, sags, and overcurrent from the AC source, overvoltage and voltage surges from output terminals of paralleled sources, and load switching and circuit breaker operation in the distribution system.
2. Provide protection against sudden changes in output load and short circuits at the output terminals. Provide built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Use fast-acting current limiting devices to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off-line.

3. Provide control section for monitoring and control. Locate meters, controls, and mimic panel on control section door with alarm functions integral to UPS enclosure.

F. Rectifier/Charger Unit:

1. Solid-state, providing direct current to inverter unit and for battery charging.
2. Size rectifier/charger to supply power for load and recharging of batteries. Provide charging rate sufficient to restore battery from discharge to 90 percent full charge within ten times the discharge time. After battery is recharged, maintain battery at full charge until next emergency operation.
3. Fuse Protection: Fuse each AC phase individually with fast-acting fuses so that loss of any semi-conductor shall not cause cascading failure. Bolt fuses to bus bars at both ends to ensure mechanical and electrical integrity. The display panel on the front of the unit shall indicate a blown fuse occurring on any phase of the rectifier.
4. Limit initial magnetization inrush current to 30 to 40 percent of rectifier/battery charger full-load current. Provide minimum power factor of 0.95 lagging at nominal input voltage and frequency with inverter operating at full-rated load.
5. DC Filter: Provide the rectifier/charger with an output filter to minimize ripple current into the Battery. The AC ripple voltage of the rectifier DC output shall not exceed 0.5 percent root mean squared (RMS) of the nominal voltage. The filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter without the battery connected.
6. Battery Equalize Charge: Provide an automatic equalize charge timer feature to automatically apply an equalize voltage to the battery after a utility outage that generates a Battery Discharging Alarm. The duration of equalize charge time shall be adjustable from 0 to 72 hours. Manual override shall be provided for the automatic equalize circuit.
7. Over-voltage Protection: Provide DC over-voltage protection within each module so that if the DC voltage rises to the pre-set limit, that UPS module shall shut down automatically. In the Multi-module UPS System, should the connected critical load exceed the capacity of the available on-line modules, the system control cabinet will initiate an uninterrupted load transfer to bypass.

G. Inverter:

1. Inverter Unit: Inverter shall be a solid-state Pulse-width Modulation (PWM) controlled Insulated Gate Bipolar Transistor (IGBT) technology device. Inverter will be capable of accepting rectifier/charger or battery output and providing rated output within required specified limits.
2. Provide electronic controls for individual phase voltage compensation to obtain phase voltage balance of no more than 3 percent under operating conditions, including up to 50 percent current unbalance.
3. Provide fault sensing and static isolation.
4. Inverter: Shall be capable of providing specified rated volt-amperes (VA) within operating range of battery while connected to 1 to 0.8 leading or lagging power factor load. Provide current limit for loads in excess of 150 percent of full load rating. Provide maximum effective current at output of inverter, when bypass AC input not available, of 150 percent.
5. Static Voltage Regulation of Inverter Steady-State Output: Deviate plus or minus 2 percent maximum under the following conditions:
 - a. Ambient temperature variations.
 - b. Minimum to maximum DC bus voltage.
 - c. Maximum frequency excursions.
6. Provide manual adjustment control to regulate output voltage, plus or minus 3 percent from rated value.
7. Provide output frequency controlled within plus or minus 2 Hz. Limit frequency transients for system disturbances to plus or minus 0.1 percent maximum.
8. Load sharing of parallel modules: Plus or minus 5 percent of UPS module rated current.
9. Battery Protection:
 - a. Provide the inverter with monitoring and control circuits to protect the battery from damage due to excessive discharge. At a minimum the following shall be included:
 - 1) Inverter shall be capable of receiving three discrete inputs from the battery monitoring system: circuit breaker status, major fault, and minor fault.
 - 2) Inverter shall be capable of sending a shunt trip to the battery for controlled isolation.

- b. Initiate inverter shutdown when the battery voltage has fully discharged.
- c. Automatically calculate and adjust the battery end-of-discharge voltage for partial load conditions to allow extended operation without damaging the battery. Alarm when discharge capacity is not acceptable.

H. Static Bypass Transfer Switch

1. Description: Fully rated, solid state static bypass transfer switch which allows “make before break” or overlap type transfer of load from UPS to utility power source (and back again) without interruption of power to critical load. Provide control unit with an automatic transfer circuit which senses status of inverter logic signals and alarm conditions and initiates uninterrupted transfer of load in case of malfunction or external overload.
2. Continuous Duty Static Switch:
 - a. Rated to provide 500 percent of capacity for one cycle.
 - b. Capable of transferring the full rated load from UPS module output to static bypass.
 - c. Factory installed bus bar jumpers for single-feed configuration.
3. Manual Load Transfers: Initiated from the control panel.
4. Automatic Transfer Conditions:
 - a. Transfer static bypass switch from inverter to static bypass for the following conditions:
 - 1) Inverter Under voltage: Less than 90 percent of nominal.
 - 2) Inverter Over voltage: Greater than 110 percent of nominal.
 - 3) Inverter overload.
 - 4) Inverter shutdown for any reason.
 - 5) DC circuit under voltage or over voltage
 - b. Automatic Retransfer Conditions: Automatically retransfer load to inverter provided all of the following conditions are met:
 - 1) Inverter Conditions are stable for 32 seconds.
 - 2) Retransfer selector switch is in the automatic position.
 - 3) UPS output is not overloaded

2.05 CONTROLS AND INDICATORS

A. HMI – A touchscreen display shall be capable of providing a mimic display of the current UPS status, as well as monitoring and control of critical UPS parameters:

1. Mimic Panel - A one-line diagram of the system shall be displayed on the touch panel display panel to provide a visual status of contactors within UPS. The panel shall display the followings:
 - a. AC Input, DC Input.
 - b. Rectifier in Operation.
 - c. Inverter in Operation.
 - d. UPS/Bypass supply.
 - e. Battery Operating Condition (charge/discharge).
 - f. Fault, Warning.
 - g. Operator Guidance: Menu-driven operator instructions detailing the operation of the UPS system. The UPS logic microprocessor shall monitor each step, thus prompting itself to the next step of the instructions. The following instructions shall be available as a minimum:
 - 1) UPS Startup.
 - 2) UPS Shutdown.
 - 3) Inverter Stop.
 - 4) Inverter Start.
 - 5) Transfer of Load to Static Bypass.
 - 6) Equalize Charge to System Battery.
 - h. Fault Guidance: Menu-driven instructions detailing fault conditions and troubleshooting procedures.
2. Controls:
 - a. Inverter operation – Start/Stop.
 - b. Static switch transfer – Manual Transfer/Retransfer.
 - c. Static switch lockout – Inhibit automatic retransfer of load to inverter.

- d. Audio alarm reset.
 - 3. Quantitative Indications:
 - a. Input voltage, each phase, line to line.
 - b. Input current, each phase, line to line.
 - c. System output voltage, each phase, line to line.
 - d. System output current, each phase.
 - e. System output frequency.
 - f. DC bus voltage.
 - g. Battery current and direction (charge/discharge).
 - h. Elapsed time discharging battery.
 - i. Battery capacity remaining during battery operation.
 - j. Number of transfers to battery source.
 - k. Percent load.
 - 4. Alarm Indications, adjustable for audible and/or visual display:
 - a. Input Fail.
 - b. Control Power Fail.
 - c. Output Over/Under Frequency.
 - d. Output Under-voltage.
 - e. Output Over-voltage.
 - f. Overload.
 - g. Overload Transfer.
 - h. Overload Shutdown.
 - i. DC Ground Fault.
 - j. DC Capacitor Fuse Blown.
 - k. Battery CB Open.
 - l. Battery Discharging.
 - m. Low Battery Warning.
 - n. Low Battery Shutdown.
 - o. DC Over-voltage Shutdown.
 - p. Load on Static Switch
 - q. Auto Retransfer Primed
 - r. Manual Reset/Retransfer
 - s. Static Switch Unable
 - t. Reverse Power.
 - u. Rectifier Fuse Blown.
 - v. Inverter Fault.
 - w. Shutdown initiated.
 - x. Emergency Off.
 - y. Ambient Over-temperature.
 - z. Blower Failed.
 - aa. Equipment Over-temperature.
- B. Provide logic microprocessors, sensors, transducers, terminals, relays, and wiring required to support listed items.
- C. EPO (Emergency Power Off) button: The Front Panel shall have an Emergency Power Off button (EPO) that when pressed, will shut down the UPS.
- D. Programmable I/O Board Inputs: The Programmable I/O Board shall provide eight (8) configurable inputs. The configurable inputs shall be programmed with any combination of the below functions:
- 1. Remote Inverter Start.
 - 2. Remote Inverter Stop.
 - 3. Power Demand 1 (Limit Input Current to 10-150% of rated value; Set point 1).
 - 4. Power Demand 2 (Limit Input Current to 10-150% of rated value; Set point 2).
 - 5. Battery Liquid Low.
 - 6. Battery Temp Abnormal.

7. Asynchronous.
 8. Use Battery Charge Rate 2.
 9. Charger Stop.
 10. External Alarm.
 11. Rectifier Operation Inhibit.
 12. None.
- E. Programmable I/O Board Outputs: The Programmable I/O Board shall provide eight (8) configurable relay outputs. The configurable outputs shall be programmed with any combination of the below functions:
1. Total Alarm – activated when any fault or alarm occurs.
 2. Minor Fault.
 3. Major Fault.
 4. Alarm.
 5. AC Input Abnormal.
 6. Bypass Abnormal.
 7. Battery Abnormal.
 8. Battery Low Voltage 1.
 9. Battery Low Voltage 2 (2 Setpoints Available).
 10. Battery Depletion.
 11. Overload.
 12. Overload Prealarm.
 13. Fault Group 1 (Activated when preset group of alarms all occur).
 14. Fault Group 2 (Activated when preset group of alarms all occur).
 15. Bypass Synchronous.
 16. Bypass Asynchronous.
 17. Remote Operation Enable.
 18. Load On Inverter.
 19. Load On Bypass.
 20. Load on AC.
 21. Battery Operation.
 22. Rectifier Operation.
 23. Inverter Operation.
 24. Static switch Closed.
 25. Power Demand On.
 26. Equalizing Charge.
 27. Another Bus Sync OK.
 28. None.
- F. Communications Interface: Modbus/TCP Communication port to enable the UPS to interface with a computer to provide power status and diagnostic information.

2.06 STORAGE BATTERIES

- A. Acceptable manufacturers:
1. Samsung.
 2. Approved Equal.
- B. UL 1973 listed and 9540A tested.
- C. Furnish modular storage batteries for UPS with sufficient capacity to maintain UPS output at required load for minimum specified time. Battery to provide 100 percent of specified capacity at initial startup. Provide heavy-duty industrial type battery designed for stationary power service.

- D. Provide lithium-ion batteries. Provide impact-resistant plastic container of a design proven by field experience.
- E. Battery to have sufficient capacity to supply load as listed in Operating Characteristics section, while limiting peak capacity to 299kWH per system, restricting each fire area to less than 600kWH.
- F. Supply battery with the following:
 - 1. Cabinets, protected with electrolyte-resistant paint. Full cabinet lineup shall fit within a space no larger than 22" deep by 144" wide by 90" tall, completely installed.
 - 2. Intercell and interior connectors for racks, end to end and/or back to back. Maximum connection voltage drop of 30 mV between adjacent units.
 - 3. Special tools and fittings required to assemble battery.
 - 4. Individual Cell tags.
 - 5. DC disconnect breaker.
 - 6. Barrier around battery terminals to prevent accidental contact
 - 7. Integrated battery monitoring system and status display for battery safety. The battery system alarms, warnings and status to be available through an Ethernet port with TCP/IP/Modbus. The system shall monitor the following battery parameters:
 - a. Individual cell voltage.
 - b. Individual cell pack temperature.
 - c. Cabinet voltage.
 - d. Cabinet current.
 - e. Cabinet state of charge.
 - f. Cabinet disconnect position.
 - g. Cabinet overcharge warning.
 - h. Cabinet over discharge warning.
 - i. Cabinet over current warning.
 - j. Cabinet summary alarm and warning.
 - 8. Enclosure LED indicators for annunciation of Battery Ready (Green), Discharging (Amber), and Fault (Red).

2.07 SOURCE QUALITY CONTROL

- A. Factory Tests:
 - 1. Test UPS and battery system as defined here as a minimum requirement for compliance with this Specification. Perform tests described in this Section at UPS manufacturer's facility.
 - 2. Witnessing provisions:
 - a. County may elect to witness factory performance testing.
 - b. Provide the project Representative with not less than 60 days advance written notice of the date and place of each factory performance test.
 - c. Payment and administration for County witnessing testing: Section 01 29 00.
 - 3. Provide equipment, instruments, load banks, and apparatus for testing. Assure instruments are of sufficient accuracy to verify specified performance parameters.
 - 4. Perform testing at normal ambient conditions within test facility.
 - 5. System Tests: Conduct control and power tests simultaneously if appropriate.
 - a. Control Tests: Test operation of the following items/functions:
 - 1) Instrumentation:
 - a) Accuracy on display.
 - b) Operation upon command.
 - 2) Annunciation:
 - a) Sensor operation.
 - b) Distinction between manual override and normal status alarm.
 - c) Status command.
 - d) Display operation, normal alarms.
 - 3) Logic:
 - a) Protective functions.

- b) Normal operation functions.
 - 4) Operator controls.
 - 5) Troubleshooting controls.
- b. Module Power Tests: For tests in this paragraph, measure and continuously record phase voltages, three-phase currents, frequency, and power factor or kilowatts, at module input and output terminations.
 - 1) No load.
 - 2) 50 percent of rated power module kW load, balanced.
 - 3) 100 percent of rated power module kW load, balanced for 24 hours.
 - 4) Output harmonic voltages at 100 percent rated kW load.
- c. System Power Tests, Steady State: For tests in this paragraph, measure and continuously record three-phase voltages, three-line currents, frequency, and power factor or kilowatts, at system input and output terminations.
 - 1) No load.
 - 2) 50 percent of rated system kW load, balanced.
 - 3) 100 percent rated system kW load, balanced.
- d. System Power Tests, Transient: For tests in this paragraph, measure voltages with continuous recording instruments at output termination of system output module.
 - 1) 0 to 50 percent load addition.
 - 2) 50 to 100 percent load rejection.
 - 3) Manually initiated transfer
 - 4) Manually initiated retransfer
 - 5) 125 percent of rated system load, balanced.
 - 6) 150 percent of rated system load, balanced.
 - 7) Automatic transfer.
 - 8) Automatic retransfer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure enclosures and racks to floor.
- C. Include services of technician to supervise adjustments, final connection, and system energization.

3.03 FIELD QUALITY CONTROL

- A. On-site Tests: Provide on-site factory-trained technician to supervise installation and testing in accordance with Specification Sections 01 75 20 and 26 08 00.
- B. Field UPS Start-up Inspection and Testing:
 - 1. Visual Inspection:
 - a. Inspect equipment for signs of damage.
 - b. Verify installation per drawings.
 - c. Inspect cabinets for foreign objects.
 - d. Verify ground conductors are properly sized and configured per vendor requirements as noted in vendor drawings supplied with installation manuals or submittal package.
 - e. Inspect all battery cell cases.
 - f. Inspect each cell for proper polarity.
 - g. Verify all printed circuit boards are configured properly.

2. Mechanical Inspection:
 - a. Check all control wiring connections for tightness.
 - b. Check all power wiring connections for tightness.
 - c. Check all terminal screws, nuts, and/or spade lugs for tightness.
 3. Electrical Inspection:
 - a. Check all fuses for continuity.
 - b. Verify control transformer connections are correct for voltages being used.
 - c. Assure connections and voltage of the battery string(s).
 - d. Battery inspection and certification according to IEEE standards.
 4. Unit Start-Up:
 - a. Energize control power.
 - b. Perform control/logic checks and adjust to meet manufacturer specification.
 - c. Verify DC equalize voltage levels.
 - d. Verify DC voltage clamp and over-voltage shutdown levels.
 - e. Verify battery discharge, low battery warning, and low battery shutdown levels.
 - f. Verify fuse monitor alarms and system shutdown.
 - g. Verify inverter voltages and regulation circuits.
 - h. Perform manual transfers and returns
 - i. Simulate utility outage at no load.
 - j. Verify proper recharge.
- C. Training:
1. Procedures: Section 01 79 00.
 2. Provide minimum of 2 days per training.
- D. Provide test instruments to record elapsed time between transfers, voltage, current, frequency, waveform, and transients.
1. Include services of an experienced technician to make final adjustments, final connections, and perform final testing.
 2. Evidence of transients or phase shifts in graphs will be cause for rejection of system.

END OF SECTION

SINGLE PHASE UNINTERRUPTIBLE POWER SUPPLY**PART 1 GENERAL****1.01 SUMMARY**

- A. This Section specifies on-line single-phase PWM-type uninterruptible power supply (UPS) equipment, 1.0 through 10 kVA output. UPS equipment shall include rectifier/charger, pulse-width-modulation inverter, static transfer switch, maintenance bypass switch, meters, controls, indicators, battery, battery disconnect switch, battery rack, and appurtenances.

B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
704-SWGR02 Control Power UPS	704-UPS2601

C.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
IEEE 485	Recommended Practice for Sizing Lead- Acid Batteries for Stationary Applications
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NFPA 70	National Electrical Code (NEC)
UL1778	Uninterruptible Power Supply Equipment

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Catalog cuts showing general features of the UPS and batteries.
- C. Battery discharge/recharge calculations.
- D. Dimensions and weights of components including working clearances.
- E. Block diagram depicting functional operation of UPS.
- F. Installation information
- G. Wiring Diagrams, internal and external.

1.04 QUALITY ASSURANCE

- A. Label: UPS equipment shall bear a UL or other label acceptable to the inspection authority having jurisdiction for the specific application and be UL1778 listed.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00 and 26 05 00.

1.06 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.07 PERFORMANCE REQUIREMENTS

- A. Equipment output characteristics:
 - 1. Power factor: 1.0 to 0.8 lagging.
 - 2. Wave form: Sinusoidal, 5% maximum total harmonic distortion.
 - 3. Voltage regulation: $\pm 5\%$ nominal for no load to full load, 1.0 to 0.8 lagging power factor, minimum to maximum DC voltage, or 0 to 40 degrees C ambient.
 - 4. Transient response: $\pm 10\%$ maximum upon application or removal of 50 to 100% load step; recovery to $\pm 5\%$ within 50mS.
 - 5. Overload capability: 115% for 3 seconds.
 - 6. Frequency: Synchronized to power source. Automatic disconnect at $\pm 0.5\text{Hz}$; free running $\pm 0.1\%$.
 - 7. Battery charger float voltage: 2.25V/cell; recharge time less than 8 hours.
 - 8. Solid-state transfer switch: Maximum disturbance time, 1/4 cycle; capacity, 11,000A i sq. t.
- B. Equipment input characteristics:
 - 1. Normal source: Split 208/120 VAC, 1 phase.
 - 2. Input Power Factor: 95% lagging, minimum.
 - 3. Operating voltage range: $+10\%$ to -15% , (-20% without battery discharge).
 - 4. Frequency range: $\pm 5\%$.
 - 5. Battery voltage: 48 VDC-120VDC nominal; discharge cut-off at 1.75V/cell.
- C. Environmental:
 - 1. Operating temperature: 0 - 40 C.
 - 2. Humidity: 5% - 95% RH, non-condensing.
 - 3. Altitude: 0 - 5000 ft.
 - 4. Audible Noise @ 1m: 55 dB maximum, A-weighted

PART 2 PRODUCTS

2.01 GENERAL

- A. UPS and battery shall be housed in a free standing NEMA 250, Type 1, locking caster base enclosure for installation, service, and ventilation.
- B. UPS shall be arranged for rear or top entry of all conduits.
- C. UPS and batteries as a system shall be capable of carrying 125% of the rated load for 10 minutes, and 50% of rated load for 30 minutes. Efficiency at full load under normal operation shall not be less than 72%.
- D. UPS and batteries shall be comprised of modules with hot-swappable functionality.
- E. Acceptable Manufacturer:
 - 1. Eaton 9PXM
 - 2. Liebert APS UPS
 - 3. Approved Equal.

2.02 BATTERY CHARGER / RECTIFIER

- A. Constant-voltage type, capable of supplying the UPS direct current bus with no battery attached.

- B. Input Connection: Hardwired

2.03 INVERTER

- A. Solid-state pulse-width-modulation type.
- B. Output Protection: Microprocessor-sensed overvoltage and overcurrent, with fuse backup
- C. Output Connection: Hardwired

2.04 BATTERY

- A. Sealed maintenance-free type with 7-year life expectancy.
- B. Specific gravity: 1.215 at 25 degrees C.
- C. Size in accordance with IEEE 485.

2.05 MAINTENANCE BYPASS SWITCH

- A. Fully rated for the UPS capacity and make before break contacts.
- B. Mounted external to the UPS cabinet to permit completely de-energizing all components within the cabinet during maintenance.

2.06 INSTRUMENTATION AND CONTROLS

- A. Monitoring Instruments: Provide display panel indicator with the following parameters:
 - 1. Percent load.
 - 2. Battery reserve.
 - 3. Input power.
 - 4. Rectifier/charger.
 - 5. Output normal status.
- B. Alarm Indication:
 - 1. AC input failure.
 - 2. Battery low.
 - 3. Output under voltage.
 - 4. Output over voltage.
 - 5. DC bus over voltage.
 - 6. Bypass on.
- C. Alarm Signal Output: Provide normally closed common alarm contact.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's recommendations and per NFPA 70.

3.02 TESTING

- A. General: Test prior to operational use.
- B. Load Test:
 - 1. Use 0.8 power factor load bank.
 - 2. Disconnect AC input and operate UPS at rated load.
 - 3. Record operating time and battery voltage.

4. Continue operation at rated load battery cut-off.
 5. Monitor battery voltage and record value just prior to cut-off.
- C. Battery Re-charge Test: Connect AC power and record battery specific gravity at end of specified recharge duration.

END OF SECTION

SECTION 26 41 00

FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies lightning protection systems.
- B. The general requirements for electrical equipment, as specified in Section 26 05 00, are applicable to the equipment specified in this Section.

1.02 REFERENCES

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
LPI 175	Standard of Practice for the Design – Installation – Inspection of Lightning Protection Systems
NFPA 70	National Electrical Code (NEC)
NFPA 780	Standard for the Installation of Lightning Protection Systems
UL 96	Standard for Lightning Protection Components
UL 96A	Standard for Installation Requirements for Lightning Protection Systems

1.03 DESIGN REQUIREMENTS

- A. Provide lightning protection system design for the following structures:
 - 1. 704 - Raw Sewage Pump Building
 - 2. 705 – Grit/Screenings Handling Building
 - 3. Conduit support crossing between the 704 building to the 705 building.
- B. Design lightning protection system to comply with applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Lightning protection system layout.
 - 2. Component locations.
 - 3. Detailed plans.
 - 4. Down conductor.
 - 5. Connecting conductor.
 - 6. Bond strap.
 - 7. Air terminals.
 - 8. Fittings.
 - 9. Connectors.

10. Ground rods.
11. Field test report.
12. Ground Witness Certification-Form LPI-175A.
13. Post-Installation Certification-Form LPI-175B.
14. UL 96 Master Label "C" Certification.

1.05 QUALITY ASSURANCE

- A. Lightning protection system design shall be prepared by an LPI-certified master designer. Shop drawings shall be stamped by the designer.
- B. System components shall be the product of a manufacturer regularly engaged in the manufacturing of lightning protection components in accordance with UL 96.
- C. Lightning protection system shall be installed under direct supervision of an LPI 175 Certified Master Installer.
- D. Inspection of final installation and grounding connection shall be performed by an LPI-certified inspector.
- E. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
- F. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
 1. Thompson Lightning.
 2. Independent Protection Co. (IPC).
 3. Erico Eritech Lightning Protection Systems.
 4. VFC, Inc.
 5. Approved Equal.

2.02 GENERAL

- A. Complete system shall bear UL 96 Master Label C.
- B. System Material: Copper or high copper content, heavy-duty bronze castings.
- C. Material shall comply in weight, size, and composition for the class of structure to be protected as established by NFPA 780.

2.03 COMPONENTS

- A. Air Terminal:
 1. Material: Solid copper rods with tapered or blunt points as required for application.
 2. Length: Sufficient to extend minimum 10 inches above object being protected.
 3. UL 96 Label B applied to each terminal.
- B. Conductors:
 1. Lightning System Conductors: Bare medium hard-drawn stranded copper.

2. Main Down Conductor: Smooth twist stranding , Class I.
 3. Connecting Conductor: Concentric stranding, Class I.
 4. Bonding Conductor: Flexible strap, minimum 3/4-inch wide by 1/8-inch thick.
 5. Main down and connecting conductors shall bear the UL 96 Label A, applied every 10 feet.
 6. Grounding Conductors: Stranded bare copper.
- C. Cable Fastener and Accessories: Capable of withstanding minimum pull of 100 pounds.
- D. Fittings:
1. Heavy-duty.
 2. Bolts, Screws, and Related Hardware: Stainless steel.
- E. Ground Rods:
1. Material: Copper-clad.
 2. Diameter: 3/4inch.
 3. Length: 10 feet.
- F. Grounding Connections:
1. Welds: Exothermic process.
 2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
 3. Hardware: Silicone bronze.
- G. Cable Connections and Splicers:
1. Welds: Exothermic process.
 2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
 3. Through-Roof Connectors: Straight or right angle with bronze and lead seal flashing washer.
- H. Conduit: As specified in Section 26 05 33, Raceway and Boxes.

PART 3 EXECUTION

3.01 GENERAL

- A. Workmanship to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.
- B. Aluminum materials shall be used where required to meet the galvanic corrosion requirements of UL 96A.
- C. Provide pitchpockets or method compatible with roofing to waterproof roof penetrations.
- D. Install system in inconspicuous manner so components blend with building aesthetics.

3.02 EXAMINATION

- A. Verify conditions prior to installation. Actual conditions may require adjustments in air terminal and ground rod locations.

3.03 INSTALLATION

- A. Air Terminals:
 1. Supports: Brackets or braces.
 2. Parapet Bracket Attachment: Lag or expansion bolts.
 3. Secure base to roof surface with adhesive or pitch compatible with roofing bond.
 4. Provide terminal flashing at roof penetrations.
 5. Perimeter Terminals:
 - a. Maximum Spacing: 20 feet.

- b. Maximum Distance From Outside Edge of Building: 2 feet.
- 6. Roof Ridge Terminals: Maximum spacing 20 feet.
- 7. Mid-Roof Terminals: Maximum spacing 50 feet.
- 8. Provide blunt point air terminals for applications exposed to personnel.
- B. Conductors:
 - 1. Conceal whenever practical.
 - 2. Provide 1-inch conduit in building walls or columns for main downleads and roof risers.
 - 3. Support: Maximum spacing for exposed conductors.
 - a. Vertical: 3 foot.
 - b. Horizontal: 4 foot.
 - 4. Maintain horizontal and vertical conductor courses free from dips or pockets.
 - 5. Bends: Maximum 90 degrees, with minimum 8-inch radius.
 - 6. Install air terminal conductors on the structural roof surface before roofing composition is applied.
- C. Bonding:
 - 1. Bond to Main Conductor System:
 - a. Roof-mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
 - b. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
 - 2. Bond each steel column or major framing members to grounding system.
 - 3. Bond each main down conductor to grounding system.
 - 4. Bond the lightning protection grounding system to the electrical grounding system.
- D. Grounding System:
 - 1. Install dedicated grounding electrode system independent of the electrical grounding electrode system.
 - 2. Interconnect ground rods by direct-buried copper cables.
 - 3. Maximum Resistance: 2 ohms when connected to ground rods.
 - 4. Connections:
 - a. Install ground cables continuous between connections.
 - b. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
 - c. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
 - d. Use bolted offset parapet bases or through-roof concealed base assemblies for air terminal connections.
 - e. Provide interconnections with electrical and telephone systems and all underground metal pipes.
 - f. Provide electric service arrestor ground wire to building water main.

3.04 FIELD QUALITY CONTROL

- A. Field Testing:
 - 1. Isolate lightning protection system from other ground conditions while performing tests.
 - 2. Resistance: Test ground resistance of grounding system by the fall-of-potential method.
 - a. Test Resistance to Ground: Maximum 2 ohms.
 - b. Install additional ground rods as required to obtain maximum allowable resistance.
 - 3. Test Report:
 - a. Description of equipment tested.
 - b. Description of test.
 - c. Test results.
 - d. Conclusions and recommendations.
 - e. Appendix, including appropriate test forms.
 - f. Identification of test equipment used.
 - g. Signature of responsible test organization authority.

END OF SECTION

SECTION 26 43 00

SURGE PROTECTION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies surge protection system(s).

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/IEEE C62.41	Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
MIL STD 220A	Method of Insertion Loss Measurement
NFPA 70	National Electrical Code (NEC)
NFPA 780	Safety Code for the Protection of Life and Property against Lightning
UL 1449	Surge Protective Devices

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 TVSS SYSTEM

- A. Provided by the distribution equipment supplier as specified in specific Sections and as shown on Drawings.

- B. An integrally mounted surge protection system shall be included for the protection of all AC circuits from the effects of lightning induced currents, substation switching transients, and internally generated transients resulting from inductive and capacitive load switching.
- C. Modular with the following features:
 - 1. Suppression element: Each to be metal oxide varistor (MOV) based and have each phase fused with 200 kAIC surge rated fuses.
 - 2. Surge current diversion paths:
 - a. Provided between each phase conductor and neutral, between each phase conductor and ground and between the neutral conductor and ground.
 - b. For delta configured systems: Having components connected between each phase conductor and between each phase conductor and ground. Copper bus bars incorporated for the surge current path.
 - c. Do not use plug in connections and round wire in the surge current path.
 - 3. Provide UL-approved disconnect switch as a means of disconnect.
 - 4. Event surge counter:
 - a. Mounted on the dead front of the panel.
 - b. Containing battery to retain memory during power outages.
 - c. Equipped with a manual reset push button.
 - 5. Equip with visual and audible diagnostic monitoring:
 - a. Indicating lights: To provide full-time monitoring of each phase of the surge current diversion module.
 - b. Alarm: Activates upon a fault condition and has acknowledge, test, and reset push buttons.
 - c. C-Form dry contacts: One set which change state during an alarm condition to be provided.
 - d. Alarm contacts: Remain in alarm condition until the fault has cleared and the alarm has been manually reset.
- D. Meets or exceeds the following criteria:
 - 1. Maximum surge current capability of 250k AIC per phase.
 - 2. Capable of surviving 5,000 ANSI/IEEE C62.41 Category C3 transients without failure or degradation of UL 1449 Suppression Voltage Rating by more than 10 percent.
 - 3. Designed to withstand a continuous operating voltage of not less than 115 percent of nominal RMS voltage.
 - 4. Has a minimum EMI/RFI filtering of -50dB at 100kHz with an insertion ratio of 50:1 using MIL STD 220A methodology.
 - 5. Has a response time no greater than 1/2 nanosecond for any of the individual protection modes.
 - 6. Recognized Component Suppression Voltage Ratings: Not to exceeding the requirements of UL 1449.
 - 7. Category C3 Let Through Voltages: Not exceeding the requirements of ANSI/IEEE C62.41.
- E. Acceptable Manufacturer:
 - 1. Siemens Energy and Automation, Inc: TPS Series.
 - 2. Cutler Hammer: CPS Series.
 - 3. Square D: Surgebreaker Series.
 - 4. Approved Equal.

PART 3 EXECUTION [NOT USED]

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies lighting fixtures.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI/IEEE C62.11	Metal-Oxide Surge Arresters for Alternating Current Power Circuits
ANSI/IEEE C62.41	Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
IES LM-79-08	Electrical and Photometric Measurements of Solid State Lighting Products
NFPA 70	National Electrical Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Shop drawings and equipment data: Section 26 05 00.
- C. Large scale photometric charts for each fixture type.
- D. Catalog information describing fixture make, materials, and dimensions.
- E. Ballast/Driver data.
- F. Lamp/LED data.
- G. Product Data:
1. Polar plots on 8-1/2 by 11 inch paper providing candlepower vs. angle and foot-lamberts (brightness) vs. angle for longitudinal and transverse axes.
 2. Table of utilization factors for calculation of illumination levels by the zonal cavity method.
- H. Operation and maintenance information: Section 01 78 23.

1.04 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.05 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.06 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Unless otherwise indicated, lighting materials, including fixtures, accessories, and hardware conform with LIGHTING FIXTURE SPECIFICATION SHEETS (LIGHTSPECS) in this Section and as shown on the Drawings.
- B. Ballast/Driver:
 - 1. LED:
 - a. LED Driver shall be installed in an electrical enclosure integral to the luminaire.
 - b. Maximum case temperature: 75 degrees C.
 - c. Minimum ambient operating temperature: -40 degrees C.
 - d. Typical output current: 350mA, 525mA or 700mA.
 - e. Total harmonic distortion: less than Approved Equal to 20 percent.
 - f. Minimum power factor: 0.90.
 - g. Minimum surge protection: 2.5kV.
 - h. Sound rating: Class A or quieter.
 - i. Reduces output power to LEDs if max allowable case temperature is exceeded.
 - j. Minimum life expectancy of 50,000 hours at temperature case ≤ 70 degrees C.
 - k. Maximum failure rate of $\leq 0.01\%$ per 1,000 hours at case temperature ≤ 70 degrees C.
 - l. Standard: Complies with UL standard UL1012.
 - m. Regulation: Complies with the Federal Communications Commission (FCC), Title 47 CFR part 15 Non-Consumer (Class A).
 - n. Acceptable Manufacturers:
 - 1) Philips "Xitanium".
 - 2) Acuity Brands: Holophane, Lithonia.
 - 3) Approved Equal.
- C. Lamps:
 - 1. General:
 - a. Lamps: Per LIGHTSPECS.
 - 2. Acceptable Manufacturers:
 - a. General Electric.
 - b. North American Philips (Norelco).
 - c. Osram Sylvania.
 - d. Venture Lighting International.
 - e. Approved Equal.
- D. Photoelectric Cell Units:
 - 1. Cadmium sulfide cell housed in a plug receptacle assembly.
 - 2. Plug receptacle assembly: Three-prong polarized locking type, suitable for outdoor mounting and rated for 1800 VA at 120V maximum capacity.
- E. Emergency Power Supply:
 - 1. Sealed battery, inverter, and automatic transfer switch: Rated to start one lamp/driver immediately and maintain a lamp/led output of at least 600 lumens for 90 minutes following power failure.
 - 2. Install at the factory and internally mount inside the fixture ballast/driver compartment.
 - 3. External status pilot light and manual test button.
 - 4. Acceptable Manufacturers if different from luminaire manufacturer:
 - a. Bodine.
 - b. Daybrite.
 - c. Guth.

- d. Lithonia.
- e. Siltron.
- f. Holophane
- g. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. The location, type, and number of fixtures and receptacles are shown on the Drawings. Unless specifically detailed, the information is diagrammatic.
- B. Plan and layout work to avoid interferences with other Contract work. If unavoidable conflict, notify the Project Representative.
- C. Raceways and wire from the fixtures, switches, and receptacles to the lighting panel per the NEC.
- D. Raceways: Per Section 26 05 33.
- E. Wire: Per Section 26 05 19.
- F. Splice circuit conductors in a separately mounted junction box for fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C.
- G. Connect fixture to junction box using flexible conduit with a temperature rating equal to that of the fixture.
- H. Photoelectric cells: Orient toward the north.
- I. Remove labels and marks, except the UL label, from exposed parts of the fixtures.
- J. Clean fixtures per Section 01 74 23.
- K. Provide a concealed latch and hinge mechanism to permit access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture from ceiling panels.
- L. Provide a protective coating of bituminous paint for fixtures recessed in concrete.
- M. Align and direct fixture to illuminate an area as specified.
- N. Directly and rigidly mount on supporting structures.
- O. Unless otherwise indicated, do not use fixtures to support conduit system.
- P. Treat weld area with rust-resistant primer and finish paint where brackets or supports for lighting fixtures are welded to steel members.
- Q. Underground and outdoor wire splices per Section 26 05 19.

3.02 FIELD QUALITY CONTROL

- A. Provide a lighting system test plan.
- B. Test lighting system including operation and controls in accordance with Section 26 08 00.

3.03 FIXTURE SCHEDULE

A. General:

1. Manufacturer's catalog numbers listed are examples of the basic model, or series, and the overall quality required.
2. While the referenced catalog numbers attempt to be as definitive as available literature permits, such items as voltage, mounting style, modifications, and other special features may not be included.
3. Verify and provide all of the specified requirements.

B. LIGHTSPEC

1. Do not use catalog numbers given on the LIGHTSPECS for selection of mounting hardware, but only as a reference to the type of fixture required.
2. Contains the following Family groups of fixtures:
 - a. ET – Exit sign.
 - b. L – LED.
 - c. LR – LED, recessed-mounted.
 - d. LS – LED, surface/pendant mounted.

Family group:	ET – Exit sign.
Group description:	LED exit sign with battery-powered emergency lighting sign, 90-minute minimum light from integral batteries.
Family member:	X1 : Single face, maintenance-free nickel-cadmium battery and reliable, solid-state charging system.
Fabrication:	
Housing:	Die-cast aluminum signage.
Lighting:	
Distribution:	N/A
Reflector:	N/A
Lamps:	LED.
Electrical:	
Input voltage:	multi-Volt
Mounting:	Surface, wall or ceiling mount. Mount at 7'-6" above finish floor when wall mounted.
Acceptable manufacturers:	Lithonia LE, Approved Equal.
Family member:	X2 : Single face, maintenance-free nickel-cadmium battery and reliable, solid-state charging system. Protection against water entry NEMA 4.
Fabrication:	
Housing:	Fiberglass reinforced polyester with clear polycarbonate lens cover.
Lighting:	
Distribution:	N/A
Reflector:	N/A
Lamps:	LED.
Electrical:	
Input voltage:	multi-Volt
Mounting:	Surface, or wall mount. Mount at 7'-6" above finish floor when wall mounted.
Acceptable manufacturers:	Holophane DeLeon NM, Approved Equal.

Family group:	EX – Emergency, stand- alone.
Group description:	Battery- powered emergency lighting unit, corrosion- resistant, 90-minute minimum light from integral batteries.
Family member:	EX1: General purpose LED Emergency Light
Fabrication:	
Housing:	Die-formed steel
Finish:	Corrosion- resistant enamel
Lighting:	
Distribution:	adjustable light heads.
Reflector:	N/A
Lamps:	LED.
Electrical:	
Input voltage:	multi-Volt
Mounting:	Wall mount. Mount at 7'- 6" above finish floor unless otherwise indicated.
Acceptable manufacturers:	Lithonia TCU, or Approved Equal.

Family group: L – LED.

Group description: Array of LED's with thermal management system.

Family member: **F1:** General purpose LED Strip light

Fabrication:

Housing: Cold rolled steel.

Finish: Polyester powder paint.

Lighting:

Distribution: Symmetric.

Reflector: Clear tempered glass.

Lamps: LED light engine.

Electrical:

Input voltage: multi-Volt.

LED Driver: Electronic 4000 Lumens.

With battery backup, where indicated as **F1E**

Mounting: Surface mount.

Acceptable manufacturers: Lithonia WL4, Approved Equal.

Family member: **F2:** Silicone type gasket to withstand harsh environments. Type 4X enclosure with IP66 ingress protection.

Fabrication:

Housing: Low copper aluminum alloy.

Finish: Polyester powder paint.

Lighting:

Distribution: Symmetric.

Reflector: Clear tempered glass.

Lamps: LED light engine.

Electrical:

Input voltage: multi-Volt.

LED Driver: Electronic 4000 Lumens.

With 10 Watt battery backup, where indicated as **F2E**

Mounting: Surface/pendant mount.

Acceptable manufacturers: Lithonia FEX, Approved Equal.

Family group:	L – LED.
Family member:	F3: Silicone type gasket to withstand harsh environments. Type 4X enclosure with IP66 ingress protection.
Fabrication:	
Housing:	Low copper aluminum alloy.
Finish:	Polyester powder paint.
Lighting:	
Distribution:	Symmetric.
Reflector:	Clear tempered glass.
Lamps:	LED light engine.
Electrical:	
Input voltage:	multi-Volt.
LED Driver:	Electronic, 8000 Lumens.
	With 10 Watt battery backup, where indicated as F3E
Mounting:	Surface/pendant mount.
Acceptable Manufacturers:	Lithonia FEX, Approved Equal.
Family member:	F7: General purpose LED strip light.
Fabrication:	
Housing:	Cold rolled steel.
Finish:	Polyester powder paint.
Lighting:	
Distribution:	Symmetric.
Reflector:	Snap on/off lens.
Lamps:	
Electrical:	LED light engine, 1500 Lumens.
Input voltage:	
LED Driver:	multi-Volt.
	Electronic.
Mounting:	Surface mount.
Acceptable Manufacturer:	Lithonia HZL1D, Approved Equal.

Family group:	L – LED.
Family member:	F9: General purpose LED strip light.
Fabrication:	
Housing:	Cold rolled steel.
Finish:	Polyester powder paint.
Lighting:	
Distribution:	Symmetric.
Reflector:	Snap on/off lens.
Lamps:	
Electrical:	LED light engine, 3500 Lumens.
Input voltage:	
LED Driver:	multi-Volt. Electronic.
Mounting:	
Acceptable Manufacturer:	Surface mount. Lithonia HZL1D, Approved Equal.
Family member:	F12: Silicone type gasket to withstand harsh environments. Wet location enclosure with IP65 ingress protection.
Fabrication:	
Housing:	Low copper aluminum alloy.
Finish:	Polyester powder paint.
Lighting:	
Distribution:	Symmetric.
Reflector:	Clear tempered glass.
Lamps:	LED light engine.
Electrical:	
Input voltage:	multi-Volt.
LED Driver:	Electronic, 18000 Lumens. With 15 Watt battery backup, where indicated as F12E
Mounting:	Surface/pendant mount.
Acceptable manufacturer:	Lithonia XIB, Approved Equal.

Family group: L – LED.

Family member: **F13:** Silicone type gasket to withstand harsh environments. Wet location enclosure with IP65 ingress protection.

Fabrication:

Housing: Low copper aluminum alloy.

Finish: Polyester powder paint.

Lighting:

Distribution: Narrow.

Reflector: Clear tempered glass.

Lamps: LED light engine.

Electrical:

Input voltage: multi-Volt.

LED Driver: Electronic, 12000 Lumens,
With 15 Watt battery backup, where indicated as **F13E**

Mounting: Surface/pendant mount.

Acceptable Manufacturer: Lithonia XIB, Approved Equal.

Family member: **F14:** LED recessed light sealed to withstand dust and bugs with IP5X ingress protection.

Fabrication:

Housing: Steel.

Finish: Polyester powder paint.

Lighting:

Distribution: Symmetric.

Reflector: Clear acrylic lens.

Lamps: LED light engine.

Electrical:

Input voltage: multi-Volt.

LED Driver: Electronic, 4000 Lumens,
With 7 Watt battery backup, where indicated as **F14E**

Mounting: Recessed into ceiling.

Acceptable Manufacturer: Lithonia ENVEX, Approved Equal.

Family group:	L – LED.
Family member:	TT: Outdoor LED with full cut-off. Flow through thermal management. IP66 rated. Sealed against moisture and environmental contaminants.
Fabrication:	
Housing:	Low-copper aluminum, single piece die cast.
Finish:	Zinc-infused super durable TGIC thermoset powder coat. Resistance to corrosion and weathering.
Lighting:	
Distribution:	Type III.
Reflector:	N/A
Lamps:	2 LED light engines. 4000K, 90 CRI.
Electrical:	
Input voltage:	multi-Volt.
LED Driver:	Electronic driver.
Mounting:	Wall mount.
Acceptable manufacturers:	Lithonia WEDGE1 LED, Approved Equal.

END OF SECTION

SECTION 27 13 13

COMMUNICATIONS COPPER CABLING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements to procure and install the copper cabling systems for communications.

1.02 REFERENCES

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
BICSI	Building Industry Consulting Service International
FCC 68.5	Establishment of Telephone Premises Wiring Attestation List
NFPA 70	National Electrical Code (NEC)
EIA 310 D	Cabinets, Racks, Panels, and Associated Equipment
EIA TSB 67	Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems
ANSI/TIA 568.2-D	Balanced Twisted-Pair Telecommunications Cabling and Components Standard
TIA TR 42.9	Industrial Telecommunications Infrastructure
UL 444	Standard for Safety Communications Cables
UL 467	Standard for Safety Grounding and Bonding Equipment
UL 497	Standard for Safety Protectors for Paired-Conductors Communication Circuits
UL 508A	Standard for Industrial Control Panels
UL 514C	Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 910	Standard for Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
UL 969	Standard for Safety Marking and Labeling Systems
UL 1286	Standard for Safety Office Furnishings
UL 1581	Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 1863	Standard for Safety Communications-Circuit Accessories

1.03 DEFINITIONS

- A. CMG: Communications general-purpose cable.
- B. CMP: Communications plenum cable.
- C. CMR: Communications riser cable.

- D. IDC: Insulation displacement connection.
- E. LAN: Local area network.
- F. PBX: Private branch exchange.
- G. UTP: Unshielded twisted pair.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Shop Drawings:
 - a. Distribution Frames: Show layout of equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks and equipment spaces and racks.
 - b. Product Data:
 - 1) Telecommunication cabling (backbone and horizontal).
 - 2) Patch panels.
 - 3) Telecommunication outlet/connector assemblies.
 - 4) Equipment support frame.
 - 5) Building protector assemblies.
 - 6) Station Protectors.
 - 7) Connector blocks.
 - 8) Protector modules.
 - 2. Installer's Experience and Qualifications:
 - a. Names and locations of two projects successfully completed using copper communications cabling systems.
 - b. Specific experience installing and testing structured telecommunications distribution systems using Category 5e cabling systems.
 - c. Distribution frame installer's experience.
 - 3. Test Plan:
 - a. List of test equipment for components and accessories.
 - b. Procedures for certification, validation, and testing.
 - c. Sample of test form to be used to record test results.
 - 4. Telecommunications system test report consisting of printed out test reports from testing equipment.
 - 5. Operation and maintenance data in accordance with Section 01 78 23.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Communication Cable Installer:
 - a. Building Industry Consulting Service International (BICSI) Registered Cabling Installation Technician or equal certification.
 - b. Three years' experience on projects of similar complexity.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Ship cable on reels.
 - 1. Reels shall be substantial and constructed as to prevent damage during shipment and handling.
 - 2. Diameter of drum shall be at least 13 times diameter of cable.
 - 3. Outer end of cable shall be securely fastened to reel head so as to prevent cable from becoming loose in transit.
 - 4. Inner end of cable shall project into a slot in the side of the reel, or into a housing on inner slot of drum, in such a manner and with sufficient length to make it available for testing.
 - 5. Inner end shall be fastened so as to prevent cable from becoming loose during installation.
 - 6. Apply end seals to each cable to prevent moisture from entering cable.

7. Reels with cable shall be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent.
- B. Provide protection from weather, moisture, dirt, dust, and other contaminants for telecommunications cabling and pathway equipment placed in storage.

PART 2 PRODUCTS

2.01 PATHWAYS (BACKBONE AND HORIZONTAL)

- A. Pathway as specified in Section 26 05 33.

2.02 DATA CABLING

- A. Type NC1, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:
1. Category 6 UL listed, and third party verified to comply with ANSI/TIA-568.2-D requirements.
 2. Suitable for Premise Horizontal Cable, Gigabit Ethernet, 100BaseTX, 100BaseVG ANYLAN, 155ATM, 622ATM.
 3. Provide four each individually bonded twisted pair, 23 AWG solid bare copper conductors.
 4. Insulation: FEP – Fluorinated Ethylene Propylene
 5. Outer Jacket: PVC – Polyvinyl Chloride, Plenum-CMP
 6. Cable shall withstand a bend radius of 1 inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
 7. Manufacturer and Product: Belden; 2433.

2.03 DISTRIBUTION FRAMES/PANELS

- A. Equipment Support Frame:
1. Existing racks and housings will be utilized for this project.
- B. Patch Panels:
1. General:
 - a. Ports for number of horizontal and backbone cables terminated on panel, plus 25 percent spare.
 - b. ANSI/TIA-568.2-D for Category 5e and for Category 6.
 2. 19 Inch Rack Mount Patch Panel:
 - a. Port Count: As needed in groups of 24.
 - 1) 1U Space Factor: 24 port.
 - 2) 2U Space Factor: 48 port.
 - b. Mount with hinge on one side for access to rear of terminations.
 - c. Terminate building cabling on 110 style insulation displacement connectors and utilize printed circuit board interface.
 - d. Rear of panel shall have incoming cable strain-relief and routing guides.
 - e. Factory number and equip with laminated plastic nameplates above each port.
 3. Control Panel Mount Patch Panel:
 - a. For 1 through 4 Ports:
 - 1) Surface mount RJ-45 Jack housing acceptable.
 - 2) Adhesive mounting acceptable to side of enclosure.
 - b. For 1 through greater than 4 Ports:
 - 1) DIN Rail Mounted housing.
 - a) Manufacture/Part
 - (1) DINSpace: SNAP-Cu-12
 - (2) Or Approved Equal
 - 2) Wall Mount Bracket Mounting Panel
 - a) Manufacture/Part
 - (1) Panduit: S89D with NK5EPPG12WY
 - (2) Or Approved Equal

- C. Modular Jacks

1. Outlets shall meet or exceed all requirements of ANSI/TIA/EIA-568.2-D, ISO/IEC 11801 and CENELEC EN 50173 for performance level specified.
2. The outlets shall terminate 4-pair 24 to 22 AWG 100 ohm solid unshielded twisted pair cable.
3. The outlets shall consist of 8-position, 8 wire modular RJ-45 jacks.
4. All outlets shall be produced by the same manufacturer and shall be designed to flush mount in the faceplate, adapter plate, or mounting strap.
5. The outlets shall support TIA/EIA 568A and 568B wiring schemes for terminating the horizontal cables.
6. Include strain relief device to control bend radius and help secure cable terminations.
7. Ovation systems shall utilize BLUE Category 5e/6 jacks.

2.04 IDENTIFICATION

- A. Cables are labeled at each end with the cable ID per Cable Schedule on Drawings and Section 26 05 00.
- B. Each patch panel to be labeled with a nameplate with ID indicated on Drawings.
 1. Each Port on a patch panel labeled with number from 1 to max of ports on the patch panel.
- C. Nameplates: See Section 26 05 00.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation and termination of copper cabling shall be by the manufacturer requirements and per Contract Documents.

3.02 TESTING

- A. Provide testing per EIA/TIA-568.

END OF SECTION

SECTION 28 46 00

FIRE ALARM SYSTEM - PERFORMANCE

PART 1 GENERAL

1.01 SUMMARY

- A. The Fire Alarm System work for the Raw Sewage Pump Station (RSPS) is a delegated design with performance specifications.
- B. This Section establishes minimum standards and guidelines for providing a complete and operable and tested fire alarm system including final design, permitting, supervision, and installation by a qualified firm specializing in fire alarm design and installation. Work includes the design and installation of cable and raceway systems to support the fire alarm system which shall monitor all heat detectors, smoke detectors, alarm devices, relay modules, monitoring modules, pull stations, and other fire alarm devices and appurtenances.
- C. Equipment List:

Equipment	Equipment No.
Existing FACU	Fire Alarm Panel 704-FACP2710
Fire Alarm Releasing Panel	Fire Alarm Releasing Panel 704-FAPNL2711

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NFPA 70	National Electrical Code, 2020 Edition
NFPA 72	National Fire Alarm and Signaling Code, 2016 Edition
NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems, 2015 Edition
NFPA 820	Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2020 Edition
NFPA 855	Standard for the Installation of Stationary Energy Storage Systems, 2020 Edition
FM	Factory Mutual Research Corporation Standards
FM 2-0	Installation Guidelines for Automatic Sprinklers
FM 5-24	Miscellaneous Electrical Equipment
FM 5-33	Electrical Energy Storage Systems
FM 5-40	Fire Alarm Systems
FM 5-48	Automatic Fire Detection
FM 7-11	Conveyors
NEC Article 760	Fire Alarm Systems
NICET	National Institute for Certification in Engineering Technologies
UL 268	Smoke Detectors for Fire Protective Signaling Systems
UL 268A	Smoke Detectors for Duct Applications
UL 521	Heat Detection for Fire Protective Signaling Systems
28 CFR Part 36,	ADA Accessibility Guidelines for Buildings and Facilities

Reference	Title
Appendix A	
UL 38	Manual Signaling Boxes for Fire Alarm Systems
UL 497B	Protectors for Data Communications and Fire Alarm Circuits
UL 864	Standard for Control Units and Accessories for Fire Alarm Systems.
SBC	2018 Seattle Building Code (International Building Code with local amendments)
SFC	2018 Seattle Fire Code (International Fire Code with local amendments)
SMC	2018 Seattle Mechanical Code (International Mechanical Code with local amendments)

1.03 GENERAL REQUIREMENTS

- A. Provide fire alarm systems under the supervision of a single specialty contractor (fire alarm system contractor), which is regularly engaged in the design and installation of such systems of similar scope and complexity. Be responsible for performance of all systems as specified and as approved by the Authority Having Jurisdiction (AHJ).
- B. All conduits and wiring among fire alarm sensors, boxes, and panels shall be supplied, installed, and tested by the fire alarm system contractor.
- C. Perform a thorough examination of Contract Documents and fully coordinate with other disciplines and trades, e.g., verifying hazardous area locations requiring equipment rated for that type of environment.
- D. All fire alarm system wiring, and cable shall be installed in conduit.

1.04 DESIGN REQUIREMENTS

- A. Provide all components and features required by the applicable national and local codes, FM Global, as well as the AHJ and Fire Department for a complete and code compliant system.
- B. The scope of work shall include the expansion and upgrading of the existing fire alarm system as described herein as well as the provision of a new Fire Alarm Control Unit (FACU) to provide releasing services for the three single interlocked auxiliary pre-action systems that shall serve the electrical room 411, north battery room 409, and south battery room 408 on the uppermost level of the RSPS. See the Drawings for the location of these rooms and the pre-action systems:
 - 1. The existing fire alarm system serving the RSPS is a Notifier model NFS-320SYS.
 - 2. The new releasing FACU shall also be a Notifier model NFS-320SYS, matching the existing FACU.
 - 3. The existing FACU and the new releasing FACU shall be networked together so that they function as single system with all signals from both FACUs being reported to the supervising monitoring station.
 - 4. The FACUs shall also have the ability to function in a fully independent manner should network communications between the FACUs fail.
 - 5. Contractor shall furnish all labor, materials, tools, equipment, and services required for the complete upgrade of the existing fire alarm system.
 - 6. Where system requirements described in the Contract Documents exceed those of the AHJ and/or NFPA, meet the requirements of both.
 - 7. All penetrations through a fire rated assembly shall be provided with firestopping per Section 07 84 00.
- C. Upgrade the existing FACU to provide the following fire alarm system functions for the RSPS:
 - 1. Fire alarm notification throughout the entirety of the RSPS including the 3-story Atrium and all other spaces that can be entered into by personnel.
 - 2. Automatic smoke detection for the Atrium, in accordance with SBC §907.2.13 and as directed by the Building Official with the Seattle Department of Codes and Inspections (SDCI):
 - a. The Atrium areas include the following:

- 1) The pump room on the lowest level of the RSPS.
 - 2) The engine room on the intermediate level of the RSPS.
 - 3) The crane hall area on the uppermost level of the RSPS.
 - b. The automatic smoke detection for the crane hall on the uppermost level of the RSPS shall be Open-area Smoke Imaging Detection (OSID):
 - c. The automatic smoke detection for the pump room on the lowest level of the RSPS shall be photoelectric smoke detectors (i.e., spot type smoke detectors).
 - d. The automatic smoke detection for the engine room on the intermediate level of the RSPS shall be photoelectric smoke detectors (i.e., spot type smoke detectors).
 - e. Provide a photoelectric smoke detector (i.e., spot type smoke detector) above the existing FACU and above the new releasing FACU.
 3. The conveyor belts in the screen room shall shut down upon activation of a waterflow alarm signal in the RSPS:
 - a. Shut down shall be coordinated with the Project Representative and shall be accomplished in a manner compliant with FM 7-11 and NFPA 72.
 - b. The existing Fire Alarm Panel 704-FACP2710 within the RSPS to be provided with a relay output to the existing Fire Alarm Panel FACU 2712, which is a Notifier NFS-320, within the Influent Screening Building 716 for conveyor belt shut down.
 - c. The existing Fire Alarm Panel FACU 2712, within the Influent Screening Building 716, to be reprogrammed to shut down conveyors with a relay output of a waterflow alarm from the existing Fire Alarm Panel 704-FACP2710 within the RSPS.
 4. The existing fire alarm system shall serve as a manual fire alarm system throughout the RSPS, which shall require the following:
 - a. Manual pull stations in accordance with NFPA 72:
 - 1) Provide a manual pull station within 5 feet of each exit from the RSPS:
 - a) Note that this includes multiple horizontal exits leading from the RSPS into the pedestrian tunnels (pipe gallery).
 - b) Additional manual pull stations shall be provided so that the travel distance to the nearest manual pull station does not exceed 200 ft, measured horizontally on the same floor.
 - b. Provide audible and visual notification appliances (i.e., horns and strobes) throughout the RSPS:
 - 1) Notification appliance spacing shall comply with NFPA 72 public mode requirements.
 - 2) Provide notification appliance booster panels as determined by fire alarm system designer (based upon power distribution requirements, NAC voltage drop calculations, etc.).
 5. Duct smoke detectors shall be provided for any Air Handling Units (AHUs) exceeding 2,000 CFM, installed in accordance with both NFPA 90A and the Seattle Mechanical Code. Coordinate and monitor any duct detectors provided as part of the AHU packages.
 - a. Remote alarm indicator for concealed smoke sensors (either spot or ductwork mounted) shall be provided.
 - b. Remote test switches shall be provided for concealed smoke (either spot or ductwork mounted) shall be provided.
 - c. Fan control relays shall be provided for shutdown of Air Handling Units (AHUs) upon alarm from ductwork smoke sensor associated with that AHU.
 6. Monitor the wet pipe sprinkler system that serves most of the RSPS, including the following:
 - a. Main post indicator valve and indicating sprinkler valve tamper switches.
 - b. Sprinkler system pressure switches.
 7. Provide a non-silenceable 24 VDC notification appliance circuit serving a dedicated, exterior alarm device activated upon a waterflow alarm:
 - a. Exterior water flow alarm device shall be a weatherproof audible/visible notification device provided on the exterior of the building located as near to the Fire Department Connection (FDC) as possible, in a location approved by the Seattle Fire Department.
- D. Provide a new releasing FACU that provides functionality as follows:
1. Smoke detection for the electrical room, north battery room, and south battery room on the uppermost level of the RSPS in a manner compliant with the requirements of FM 2-0, FM 5-24, FM 5-33, FM 5-40, FM 5-48, SFC §1206, and NFPA 855:

- a. The automatic smoke detection for the electrical room, north battery room, and south battery room on the uppermost level of the RSPS shall be photoelectric smoke detectors (i.e., spot type smoke detectors).
 - b. Provide a photoelectric smoke detector (i.e., spot type smoke detector) above the new releasing FACU.
 2. Provide releasing services for the three single interlocked auxiliary pre-action systems serving the electrical room, north battery room, and south battery room on the uppermost level of the RSPS:
 - a. The three pre-action systems shall be single interlocked so that when the FACU receives an alarm from a smoke detector in the space served by the pre-action system the control panel shall send a signal to open the solenoid valve of that preaction system, which shall release pressure on the preaction valve's diaphragm and allow water to flow into the sprinkler system.
 - b. The new releasing FACU and provides releasing services for the three single interlocked auxiliary pre-action systems shall be designed and installed in accordance with FM 5-24, FM 5-33, FM 5-48, NFPA 13, NFPA 72, the SBC, and the SFC.
 3. FM 2-0 allows a single fire alarm control panel to be used to activate more than one sprinkler system if the fire alarm control panel is capable of the following, all of which shall be provided for the new releasing FACU:
 - a. Initiating each sprinkler system from its own dedicated automatic releasing module for preaction sprinkler systems compatible with the fire alarm control panel.
 - b. Each automatic releasing module can be independently isolated and supervised, and
 - c. The battery back-up is sized to provide 90 minutes of power for each sprinkler system that is connected to the panel.
 4. Monitor the three pre-action systems, including the following:
 - a. Main isolation valves and indicating sprinkler valve tamper switches.
 - b. Sprinkler system pressure switches.
- E. Provide a fire alarm system complete and operable in accordance with the following:
1. AHJ fire department standards.
 2. NFPA 70.
 3. NFPA 72.
 4. NFPA 820.
 5. SBC.
 6. SFC.
 7. Applicable provisions of 28 CFR Part 36, Appendix A.
- F. The design shall be prepared, stamped, dated, and signed by a Professional Engineer licensed in the state of Washington.
- G. The fire alarm system shall include:
1. Alarm initiating devices, including:
 - a. Smoke detectors:
 - 1) Spot type photoelectric smoke detectors.
 - 2) Open-area Smoke Imaging Detection (OSID) projected beam smoke detectors
 - 3) Duct Smoke Detectors.
 - b. Heat detectors.
 - c. Manual fire alarm pull boxes.
 - d. Notification appliances, including:
 - 1) Strobes.
 - 2) Horns.
 2. Fire Alarm Control Units (FACUs).
 3. Wire, conduit, and cable.
 4. Miscellaneous devices required for the proper functioning of the fire alarm system.
 5. Appurtenances as required by the AHJ Fire Marshal, or local fire code.
- H. Provide independent self-contained fire alarm control units (FACUs) in each area as specified and shown on the Drawings. The FACUs in the RSP shall be networked and fully integrated through programming and hardware so that they function seamlessly as a single system.

- I. Fire alarm panels shall monitor sensors, actuate alarm, and signal devices, and retransmit alarm, supervisory, and trouble signals to the monitoring system.
- J. Contacts for transmission of data to the monitoring system shall be normally closed and open on alarm or malfunction. Contacts shall be rated not less than 2.0 amperes at 120 VAC.
- K. Fire alarm panel shall interface with the West Point Control Room supervising station fire alarm system for alarm, trouble, and supervisory signal transition and should be integrated into the system for graphics and alarming.
- L. The fire alarm panel shall provide automatic fire detection, retransmit alarm, supervisory and trouble signals by zone to the West Point Control Room supervising station fire alarm system, retransmit alarm, monitor critical HVAC systems, and other functions normally attributed to fire alarm systems.
- M. Fire alarm system shall be an addressable micro-processor based system with smart sensors.
- N. Fire alarm system including automatic fire detection shall be provided as a complete and operable turn-key system in all areas protected by the zones assigned in this Section.
- O. Basic Performance:
 - 1. Signal Line circuits (SLC) shall be Class A (NFPA Style 6).
 - 2. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z).
 - 3. Each SLC shall be limited to only 80 percent of its total capacity at the time of initial installation.

1.05 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Shop drawings and equipment data per Section 26 05 00 requirements:
 - 1. Shop drawings submittal shall include minimum required documentation as prescribed in NFPA 72.
 - 2. Written narrative providing design intent and system description shall be provided.
 - 3. Product technical data:
 - a. Battery calculations.
 - b. Voltage drop calculations.
 - c. Product data sheet with complete descriptive data indicating UL listing or FM approval for all system components.
 - d. Sequence of operations of the system; description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs.
 - e. Provide a comprehensive list of all input and output points in system with label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
 - f. Service organization qualifications.
 - g. Copy of point-to-point electrical schematic and wiring drawings submitted to the AHJ and the approved drawings stamped by the AHJ.
 - h. Operating instructions for FACU.
 - i. Completed NFPA 72 record of inspection and testing.
 - j. Copy of site specific software.
 - k. Documentation of AHJ approval for system submittal.
 - 4. Fabrication and/or layout drawings:
 - a. Provide drawings in AutoCAD 2014, full size at 22 inches x 34 inches.
 - b. Plan drawings showing type and locations of all fire alarm devices. Indicate salient features of each device (e.g., weatherproof, strobe candela rating).
 - c. Complete system wiring diagrams for components capable of being connected to the system and interfaces to associated equipment.
 - 5. Contract Closeout Information:
 - a. Operation and Maintenance Manuals:

- 1) Include data for each type product, including all features and operating sequences, both automatic and manual.
 - b. Field test reports.
 - c. Owner instruction report.
 - d. Pro-rated warranty for batteries.
- C. Qualifications of the fire alarm system designer, fire alarm system installer, fire protection engineer, and service organization.
- D. Catalog cuts showing general features of all products.
- E. Schematic diagrams showing the wiring of all modified systems.
- F. Plan drawings showing the locations of detectors and other related devices in each area.
- G. Acceptance test records and test certificates signed and approved by the AHJ.
- H. Operating and maintenance information per Section 01 78 23.
- I. System access keys.
- J. Project "as-built" record documents.
- K. For all drawings prepared for the submittals, provide updated CAD drawings to reflect as-built conditions in *.dwg format per Section 01 78 39 upon completion of Operational Testing per Section 01 75 20.
- L. A copy of the final software configuration shall be provided to the owner in its native format.

1.06 QUALITY ASSURANCE

- A. Fire alarm system designer:
 - 1. Shop Drawings shall be stamped by a Licensed Professional Fire Protection Engineer licensed in the state of Washington.
 - 2. Minimum of five years of experience with design of systems of similar scope.
 - 3. The fire alarm system designer will provide detailed layout shop drawings. This system shall be designed by a NICET Fire Alarm Systems Level IV engineering technician or Licensed Professional Fire Protection Engineer licensed in the state of Washington.
- B. Fire alarm system installer:
 - 1. Fire Alarm System installer licensed in the state of Washington and subcontractor working on the fire alarm system.
 - 2. Minimum of five years of experience installing systems of similar scope.
- C. Fire Protection Engineer:
 - 1. The engineer of record for the fire alarm system and shall be licensed in the state of Washington.
- D. UL Listing or FM approval.
- E. Authority Having Jurisdiction (AHJ) review:
 - 1. Concurrent to or subsequent with submission to Project Representative, submit shop drawing and product data to Authority Having Jurisdiction (AHJ).
 - 2. Upon receipt of comments from AHJ, make resubmissions, if required, to make clarifications or revisions to obtain approval.
 - 3. The AHJ shall witness final testing and inspection in order to obtain final approval for system.
 - 4. The AHJ for the fire alarm system is the Seattle Fire Department.

- F. Service Organization Qualifications:
1. Offer an annual maintenance contract including complete service and equipment costs for maintenance of complete system.
 2. Ten (10) years' experience minimum serving fire alarm systems.
 3. Provide for 24 hour emergency service. Response time to site shall be 24 hours or less and service office shall be within 250 miles of site.

1.07 CONTRACTOR RESPONSIBILITY

- A. This Section specifies the areas required to have a fire alarm system as well as the requirements for the fire alarm system functionality. Contractor shall be responsible for the design of the system including evaluation of existing conditions prior to laying out the system design.
- B. Using the Specification requirements and the general arrangement Drawing for the fire alarm system, be responsible for obtaining AHJ permits, approval, inspection, and certification of the entire fire alarm system and for meeting the requirements of this Section.
- C. Furnish and install the Fire Alarm System.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fire Alarm Control Unit (FACU):
1. Notifier model NFS-320SYS (Existing FACU).
 2. New releasing FACU shall be listed as a releasing panel and be listed as a compatible network option for the existing FACU.
 - a. Notifier.
 - b. Siemens.
 - c. Simplex.
 - d. Approved Equal
 3. The fire alarm equipment shall comply with the requirements of NFPA 72.

2.02 FIRE ALARM CONTROL UNIT (FACU)

- A. Automatic and manual, addressable, general alarm and non-coded evacuation alarm, supervised, closed-circuit, 24 VDC microprocessor based fire detection and alarm system:
1. Construction shall be modular with solid-state, microprocessor-based electronics.
 2. Provide necessary switches, relays, indicator lamps, wiring terminals, etc., to provide complete operation supervising, control, and testing facilities for entire system.
 3. System shall have provisions for disabling and enabling all circuits individually for maintenance and testing purposes.
- B. Power Supply:
1. Power limited operation per NFPA 70, Article 760.
 2. 120 VAC dedicated circuit from panel board to integral 24 VDC regulated power supply in FACU and battery charger.
 3. The power supply shall provide all panel and peripheral device power needs:
 - a. If the FACU cannot provide power for the required number of notification appliances, additional notification appliance booster panels with additional power supplies shall be provided.
 4. An additional 120 VAC dedicated circuit from a panel board shall be used to power the power extenders power supply and battery charger.
 5. Provide transient voltage surge suppression for Main FACU for power supply and communication channel(s).
 6. Label the branch circuits serving the FACUs as "FIRE ALARM CONTROL UNIT" with red marking and make them accessible to only authorized personnel in accordance with NFPA 72.

- C. Listed under UL 864 Standard.
- D. Each FACU shall have an integral battery charger and sealed lead-calcium battery with sufficient capacity for the following:
 - 1. Existing FACU: 90 hours operation followed by 10 minutes sounding of audible alarms.
 - 2. New Releasing FACU: 90 hours operation followed by 10 minutes of alarm operation, which includes sounding of audible alarms, initiating device operations, and providing power for fire alarm components serving each sprinkler system that is connected to the panel.
- E. Alarm Signal to UL Listed FAMSP or King County Security Division, as specified:
 - 1. For consistency throughout the system, King County's FAMSP is *Guardian Security*.
 - 2. Provide a Subscriber Terminal Unit (STU), telephone autodial type as the means of connecting the Building to the monitoring facility operated by the FAMSP.
- F. Signals to Telemetry System (Off-Site Facilities):
 - 1. Contractor shall update the existing fire alarm reporting to include all new devices and coordinate all of the new off-site signaling with King County.
 - 2. Alarm, supervisory, and trouble signal shall be by a dry contact rated 1A at 120 VAC. The contact shall be closed for normal condition and open for alarm condition.
 - 3. See Division 33 and 40 for retransmission of the alarm signal from the Fire Alarm Panel to the West Point Control Room supervising station fire alarm system.
- G. Area Classifications:
 - 1. See Electrical Drawings for NEC Hazardous Location Classification designations.
 - 2. Designation of an area shall determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
 - a. Outdoor areas: Wet. Also, corrosive and/or classified when specifically designated in the Drawings or in the Specifications.
 - b. Indoor areas: Dry. Also, wet corrosive and/or classified when specifically designated in the Drawings or in the Specifications.
 - 3. Except for in the control room, break room, washroom (bathroom), server room, telephone equipment room, north battery room, south battery room, and electrical rooms, all of the fire alarm devices and conduit shall be rated for a wet and corrosive environment; Contractor shall provide weatherproof rated fire alarm devices, PVC coated rigid steel conduit (PGRS) with proper seals, corrosion resistant fittings, etc. for the wet and corrosive environment.
 - a. See Section 26 05 03 for electrical conduit and fitting requirements.
- H. System Description:
 - 1. Automatic and manual, analog addressable, general alarm and non-coded evacuation alarm, supervised, closed-circuit, 24 VDC microprocessor based fire detection and alarm system.
 - 2. Provide components including but not limited to the following:
 - a. Fire Alarm Control Units.
 - b. Analog addressable heat sensors.
 - c. Analog addressable smoke detectors.
 - d. Open-area Smoke Imaging Detection (OSID).
 - e. Analog addressable duct smoke sensors with auxiliary relays.
 - f. Addressable manual pull station.
 - g. HVAC System Interface:
 - 1) Duct detectors and circuits included in HVAC System work.
 - h. Fan control relay associated with the HVAC control system.
 - i. Combination fire alarm horns with strobe.
 - j. Stand-alone strobes and horns, where only one or the other is required.
 - k. Auto Dialer for remote alarm to Alarm Monitoring Agency:
 - 1) King County currently uses Guardian Security for alarm monitoring. Verify with Project Representative.
 - l. Fire alarm system wire, with all wiring in conduit:

- 1) Conduit and wiring between Duct Detectors and HVAC System Controller and HVAC System Controller and FAP included in HVAC work.
- m. Interconnection with HVAC System Controller for duct detector alarms.

2.03 AUTOMATIC FIRE DETECTORS

- A. Photoelectric Smoke Detectors per NFPA 72 with the following features:
 1. Sensitivity: Better than 3% per foot.
 2. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 3. Alarm indicator lamp.
 4. Capable of having sensitivity tested and adjusted as installed.
 5. Nominal 24 VDC operation. Range: 17-26 VDC, standby current <1 mA, alarm current > 30 mA.
 6. Terminal base connection.
 7. Anti-tampering features.
 8. Solid-state amplifier-switching circuitry.
 9. UL 268 listed for 30-foot nominal spacing for rooms with little to no forced air flow in the room:
 - a. Quantity and spacing based upon manufacturer's UL listed spacing and the following:
 - 1) Provide detectors in accordance with NFPA 72 and the requirements of the AHJ.
 - 2) Devices shall be suitable for environment in which they are installed.
 - 3) Spacing shall be reduced for increased air changes as required by NFPA 72.
 10. FM approval.
 11. Plug-in base with 2-wire terminal connection, compatible with other specified space detectors.
 12. Notifier FSP-851(A) FlashScan Series or equal.
- B. Open-area Smoke Imaging Detection (OSID) projected beam smoke detectors:
 1. Dual wavelength type LED-based projected beam smoke detection using optical imaging technology for early warning smoke detection.
 2. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 3. Optical imaging with CMOS imaging chip.
 4. On-board event log for fault and alarm diagnostics.
 5. High tolerance to false alarm due to building movement.
 6. High tolerance to transient dust, steam, and intrusion of solid objects.
 7. Easy alignment with large adjustment and viewing angles, no need for precise alignment, and tolerant of alignment drift.
 8. Automatic commissioning in under ten minutes.
 9. Simple DIP switch configuration.
 10. Three selectable alarm thresholds.
 11. Status LEDs for Fire, Trouble and Power.
 12. Conventional alarm interface for straightforward fire system integration (OSID projected beam smoke detectors Alarm and Trouble relay outputs shall be monitored by FACU).
 13. Powered with externally provided 24 VDC power from FACU or nearby fire alarm power booster panel.
 14. Provide factory environmental housing with NEMA 4X and IP66 ratings that is appropriate for use in harsh environments.
 15. Xtralis OSID or equal.
 16. OSID receiver shall be powered by a UL listed and FM approved 24VDC power supply, such as the FACU power supply.
 17. If reflectors are used to redirect a beam around corners so that one beam can monitor an area in several directions, reduce the FM Approved maximum beam length per manufacturer's instructions ($\frac{2}{3} L$ for two sides and $\frac{4}{9} L$ for three sides).
- C. Heat Detectors per NFPA 72 with the following features:
 1. Rate of Rise and rate compensated 135 DegF fixed temperature operation shall be used for ordinary areas where normal ceiling temperatures do not exceed 100 DegF:

- a. Rate compensated 190 DegF fixed temperature operation shall be used for areas with up to 150 DegF ceiling temperatures.
 2. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 3. Dual thermistor or pneumatic chamber rate of rise operating principle.
 4. Alarm indicator lamp.
 5. UL 521 listed for 50 feet nominal spacing (typical based upon a 10 foot ceiling):
 - a. Quantity and spacing based upon manufacturer's UL listed spacing and the following:
 - 1) Provide detectors in accordance with NFPA 72 and the requirements of the AHJ.
 - 2) Devices shall be suitable for environment in which they are installed.
 - 3) For ceilings higher than the base UL listing, reduce spacing as required by manufacturer and NFPA 72.
 - 4) Do not exceed the FM Approved spacing between detectors. The spacing guide for FM Approved heat detectors on smooth ceilings is dependent on Response Time Index (RTI) of the detector.
 6. The detector's electronics shall be immune from false alarms caused by EMI and RFI.
 7. Solid state electronics.
 8. Nominal 24 VDC operation. Range: 17-26 VDC, standby current <1 mA, alarm current > 30 mA.
 9. Plug in base with 2-wire terminal connection, compatible with other specified space.
 10. Notifier FST-851R(A) FlashScan Series or approved equal.
- D. Duct Smoke Detectors per NFPA 72 with the following features:
1. Duct smoke detectors shall utilize addressable photoelectric type detector as specified herein.
 2. UL 268A listed.
 3. Duct housing mounted directly to outside of duct with a sampling tube extended across duct to sample air movement.
 4. Duct housing couplings slotted to insure proper alignment of sampling and exhaust tubes:
 - a. Tube lengths as required per duct width.
 5. Duct smoke detectors shall be of the low voltage type rated for use on a 24 VDC system.
 6. Detector housing shall have an alarm LED visible through front cover.
 7. Remote red LED alarm indicators shall be provided on the wall or ceiling adjacent to detectors above the ceiling or that are not visible from the ground:
 - a. Duct detectors in non-accessible locations shall be provided with a remotely located test switch to provide for ease of testing.
 8. Accessories required for monitoring air flow in duct work.
 9. See HVAC temperature control diagrams in the mechanical drawings for locations of duct detectors.
 10. Two Form C contacts for shutdown of associated air handling units. Rated 2A at 24VDC or 120 VAC.
 11. Remote reset and test.
 12. Notifier FSP-851R(A) detector with DNR(A) housing or equal.

2.04 MANUAL PULL STATIONS

- A. Addressable manual stations per NFPA 72 with the following features:
1. Meets UL 38 Standard.
 2. Meets ADA Pull force requirements.
 3. Surface Mount indoor manual station.
 4. Single-action type not requiring part replacement to accomplish reset.
 5. Pull down lever locks in position, actuating alarm switch until manually reset.
 6. Switch contact: SPST N.O. rated 0.25A at 30V AC or DC.
 7. Pull stations shall be weatherproof where required by this Specification.

2.05 NOTIFICATION APPLIANCES

- A. Interior Horn/Strobes:
1. Solid state components.

2. Audible signal: Field selected continuous or pulsed output. Field selected standard and high dbA sound output levels. Minimum output 75 dbA at 10 ft. (anechoic).
 3. Visible signal: Xenon LED flashtube, flashing at one flash per second with minimum 75 candela rating.
 4. Operating voltage: 21 to 30 VDC. Maximum current at nominal 24 VDC = 160 mA.
 5. Fully compliant with ADA 1990 requirements. Listed to UL 464 and UL 1971 and approved for fire protective service.
 6. Housing: Red with white "FIRE" lettering.
 7. Quantity and location of interior horn/strobes shall be as required by code and/or the AHJ.
 8. Notifier MASS12/24ADA or equal.
 9. Except for in the control room, break room, washroom (bathroom), server room, telephone equipment room, north battery room, south battery room, and electrical rooms, all of the notification appliances shall be weatherproof.
 10. Strobes shall be synchronized when there are more than two strobes within the field of view per NFPA 72 requirements.
 11. Horns audible signals shall be synchronized within the zone to preserve the temporal alarm patterns.
- B. Exterior Horn/Strobes:
1. Solid state components.
 2. Audible signal: Field selected continuous or pulsed output. Field selected standard and high dbA sound output levels. Minimum output 75 dbA at 10 ft. (anechoic).
 3. Visible signal: Xenon LED flashtube, flashing at one flash per second with minimum 75 candela rating.
 4. Operating voltage: 21 to 30 VDC. Maximum current at nominal 24 VDC = 160 mA.
 5. Fully compliant with ADA 1990 requirements. Listed to UL 464 and UL 1971 and approved for fire protective service.
 6. Housing: Red with white "FIRE" lettering.
 7. Quantity and location of interior horn/strobes shall be as required by code and/or the AHJ.
 8. Weatherproof.
- C. Combination Audio/Visual Devices:
1. Mount in an integral unit and have the same features as the individual units specified herein.

2.06 MISCELLANEOUS DEVICES

- A. Isolated Loop Circuit Protector (Transient Suppressions):
1. Hybrid solid state high performance suppression system. Do not use gas tubes, spark gaps or other suppression system components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
 2. Line-to-line response time of less than 1 nanosecond capable of accepting a 2000 amperes (8 x 20 μ sec pulse) at 28 volts.
 3. Line-to-ground response time of less than 1 nanosecond capable of accepting a 2000 amperes (8 x 20 μ sec pulse) to earth.
 4. Shield-to-ground shall be capable of accepting a 5000 amperes (10 x 50 μ sec pulse) to earth.
 5. Standard: UL 497B.
- B. Fault Isolation Module:
1. Bi-directional short circuit protection for SLC communication lines. Isolators optimize communication integrity by creating device groups, any group with short circuited wiring can be isolated, allowing communications to continue to the other groups.
 2. FAP mounted or individually mounted.
- C. Releasing Control Module:
1. Redundant protocol releasing module for fire suppression releasing applications.
 2. Capable of releasing 12 and/or 24 VDC solenoids.
 3. Compatible for Notifier FlashScan Systems.

4. Standard: UL S635.
5. Notifier FCM-1 REL or approved equal.

D. Addressable Monitor Modules:

1. Provides addressability and supervision to a conventional initiating device (e.g., tamper switches, pressure switches, etc).
2. The conventional initiating device shall be wired Class A.
3. Integral or remote LED shall be provided that shall flash each time it is scanned by the FACU.
4. When the FACU determines that a monitor module is in an alarm or a trouble condition, the FACU shall command the LED on that module to turn on steady, change color, or otherwise indicate that an abnormal condition exists.

E. Control Relay Modules (fan control, and other control functions):

1. Compatible with unit being controlled.
2. Industrial grade relays shall be furnished.
3. Provide enclosures suitable for environment.
4. Provide engraved phenolic nameplate on enclosure identifying fan, air handling unit, or other equipment being controlled.

F. Automatic Telephone Dialer:

1. 120 Volt AC.
2. Remote Alarm Notification with telephone dial up.
 - a. Activate upon dry contact alarm/trip inputs.
 - b. Four channels for pre-defined inputs monitoring building conditions.
 - c. Four channels for custom configuration.
 - d. 8 pre-programmable telephone numbers.
3. Data parameters:
 - a. Receive calls from computer/modem and transfer to station SCADA.
 - b. Communications – RS-485 interface.
4. Dial unit to monitor status and retrieve information on operating modes and status.
5. Battery backup.

2.07 CABLE AND CONDUIT

A. Conduit:

1. $\frac{3}{4}$ inch rigid minimum.
2. All fire alarm wiring and cable shall be in conduit.
3. Fire alarm conduit shall be dedicated to fire alarm wiring and cable only.
 - a. Free-run wiring or cable is not permitted.
4. Except for in the control room, break room, washroom (bathroom), server room, telephone equipment room, north battery room, south battery room, and electrical rooms, which shall have Galvanized rigid steel conduit (GRS), all conduit shall be PVC coated rigid steel conduit (PGRS) with proper seals, corrosion resistant fittings, etc.
5. See Section 26 05 33.

B. Conductors:

1. Insulation type per NEC 760.
2. 120 VAC and power supply connections: 12 AWG, minimum.
3. Low-voltage general alarm circuits: 14 AWG, minimum.
4. Low-voltage signaling circuits: 18 AWG, minimum.
5. Data communication circuits: As required by manufacturer, UL listed.
6. Use larger wire sizes when recommended by equipment manufacturer and per voltage drop calculations.
7. See Section 26 05 19

C. Cable to interconnect the various components of the fire alarm system per NFPA 70.

- D. Locate the new releasing FACU as shown on the Contract Drawings. Route network cables and any other wiring interconnecting the new releasing FACU to the existing FACU in a dedicated conduit.

2.08 SYSTEM OPERATION

- A. Activation of any alarm-causing Initiating device shall cause the following:
 - 1. General evacuation notification via activation of audible and visual notification appliances.
 - 2. Automatic control devices to operate as defined by the operating sequences.
 - 3. Alarm information shall be displayed at the FACU.
 - 4. The conveyor belts in the screen room shall shut down upon activation of a waterflow alarm signal in the RSPS.
 - 5. All signals shall be reported to a constantly attended location in a manner compliant with the code and AHJ requirements.
- B. All fire alarm signals are automatically locked on the display of the FACU and remote FACU's until originating device is returned to normal and FACU is manually reset:
 - 1. Audible alarm signals shall be silenceable from FACU allowing for re-initiation following a subsequent alarm:
 - a. Silencing of alarm signals shall not impair ability of system to continue to perform as specified.
- C. Air Handling Equipment Fan Control:
 - 1. De-energize indicated air-handling equipment and interlocked exhaust fans upon alarm and close all associated smoke dampers.
 - 2. See Specification Section 23 09 00 for mechanical equipment sequence of operation and coordinate all fan controls.
 - 3. Fans shall not restart until FACU is manually reset.
- D. Activation of any system trouble shall initiate the following:
 - 1. Common audible trouble signal shall sound and common trouble light shall illuminate at the FACU and any remote FACU's.
 - 2. Specific device in trouble shall be indicated.
 - 3. All signals shall be reported to a constantly attended location in a manner compliant with the code and AHJ requirements
- E. Activation of any supervisory signal shall initiate the following:
 - 1. Common audible supervisory signal shall sound and common trouble light shall illuminate at the FACU and any remote FACU's.
 - 2. Specific device in supervisory shall be indicated.
 - 3. All signals shall be reported to a constantly attended location in a manner compliant with the code and AHJ requirements
- F. Audible trouble signal shall be silenceable by FACU.
 - 1. Visual trouble indication remains until trouble condition is corrected.
 - a. A subsequent trouble condition received after manually silencing shall cause audible trouble signal to resound.
 - b. Restoration of system to normal causes audible trouble signal until silencing switch is returned to normal position.
 - 2. Trouble signal(s) shall be initiated under following conditions:
 - a. Open on an initiation or alarm indicating circuit.
 - b. Open in wiring to any remote FACU's.
 - c. Ground fault condition.
 - d. Auxiliary manual control switch out of normal position.
 - e. Loss of 120 VAC operating power to the Main FACU or any Remote FACU's.
 - f. Low or no battery voltage condition.
 - 3. Supervisory signal(s) shall be initiated under the following conditions:
 - a. Main sprinkler valve is closed.
 - b. Post indicator valve is closed.

- c. Any sprinkler indicating valve is closed.

PART 3 EXECUTION

3.01 GENERAL

- A. Be responsible to request any record drawings available for the existing fire alarm system from Project Representative. Perform field verification of existing conditions prior to bid submittal.
 - 1. Be responsible for protecting existing conditions such as: structures, ceilings, walls, equipment, utilities, etc. Damage to existing conditions shall be repaired.
 - 2. Be responsible for patching and repairing floors, ceilings, and walls to match existing conditions in areas impacted by the demolition of the existing fire alarm system and installation of the new fire alarm system.
 - 3. Include removal and replacement of the existing fire alarm system components where necessary, such as the removal and replacement of modules monitoring the sprinkler system that serves the RSP (located adjacent to the fire sprinkler riser, in the pipe gallery).
 - 4. Inspection:
 - a. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
 - b. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
- B. Install per NFPA 72, NEC Article 760, ADA 1990 requirements, and all applicable codes and manufacturer's recommendations.
- C. Install all wiring in raceways:
 - 1. Provide raceways (conduits) per Section 26 05 33 for all interconnecting wiring between the Fire Alarm Panel and remote components.
- D. Make all fire alarm wiring continuous from terminal to terminal or from terminal to device pigtail lead:
 - 1. Circuit splices not permitted.
 - 2. Color code all wiring by type of device.
 - 3. Coordinate color with County.
 - 4. Wiring joints, only when required at device pigtail leads shall utilize Scotchlok insulated conical spring connector.
- E. Provide sensors with electronics immune from false alarms caused by EMI and RFI.
- F. Installation of equipment and devices that pertain to other work in Contract shall be closely coordinated with appropriate subcontractors:
 - 1. Duct detector devices, conduit and wiring not included in the fire alarm system work to be brought to the Fire Alarm Panel.
 - 2. Connect conduit and wiring for the duct detectors, and alarms at the Fire Alarm Panel.
 - 3. Telephone dialer for Alarm Monitoring Agency.
- G. Mount fire alarm panel and devices located on architecturally finished surfaces flush or semi-flush.
- H. Surface mount alarm panel and devices located on wall surfaces.
- I. Supply manufacturer's authorized representative as on-site supervision, who is factory trained by manufacturer and is certified as a minimum of NICET Level II in Fire Alarm Systems
- J. Clean all dirt and debris from inside and outside of equipment after completion of installation.
- K. Connect duct smoke detectors to the specified fire alarm panel for power supply, supervision, and alarm annunciation.

- L. Cover all smoke detectors with plastic bags immediately after installation to maintain cleanliness.
- M. Mark all duct sensor locations in red with "smoke/fire sensor location".
- N. Device Mounting Schedule:
 - 1. Dimensions are to center of item unless otherwise indicated.
 - 2. Mounting heights as indicated below unless otherwise required by code:
 - a. Manual pull stations: 48 inches.
 - b. Notification appliances: 80 inches.
 - c. Control panels: 72 inches to top.
 - d. Standalone duct detector annunciator: 54 inches.

3.02 TESTING

- A. Obtain services of factory trained representative of system manufacturer to supervise field installation and its progress, supervise final connections to equipment, provide testing to assure that system is in proper operating condition, and is in compliance with all applicable regulations.
- B. Pre-testing: Determine, through pre-testing, conformance of system to requirements of Drawings and Specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved. Pre-testing shall be completed before engagement with the Project Representative and state and local fire authorities.
- C. Entire system shall test free from opens, grounds, and short circuits.
 - 1. Existing fire alarm system shall be fully tested prior to beginning any new work. This benchmark quality test shall identify any problems or issues with the existing fire alarm system. The contractor shall be responsible for documenting all problems and issues, provide these in a written report to the Project Representative prior to beginning any new work.
- D. Test system to satisfaction of Project Representative and state and local fire authorities in accordance with NFPA 72, state and local codes and manufacturer's requirements.
- E. Acceptance Operational Tests:
 - 1. Perform operational system tests to verify conformance with Specifications:
 - a. Each alarm initiating device installed shall be operationally tested.
 - b. Each device shall be tested for alarm and trouble conditions.
 - c. Fire Alarm Contractor shall submit written certification that Fire Alarm System installation is complete including all punch-list items.
 - d. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified.
 - e. Test supervising station signal transmitter. Coordinate testing with supervising station monitoring firm/entity.
 - f. Test each notification appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
 - g. Test FACU.
- F. Test the completed system per NFPA 72 in the presence of the Project Representative and the AHJ. Coordinate test scheduling with the AHJ. Provide a minimum of 1 week notice to Project Representative prior to testing.
- G. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by system test that total system meets Specifications and complies with applicable standards.
- H. Report of Tests and Inspections: Provide written record of inspections, tests, and detailed test results in form of test log. Use NFPA 72 Forms for documentation.

- I. Final Test, Record of Completion, and Certificate of Occupancy:
- J. Test system as required by Authority Having Jurisdiction in order to obtain certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Project Representative and AHJ.
- K. Upon successful testing, certify system in writing. Provide system certification and description in accordance with NFPA 72.

3.03 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris from all devices and equipment panels. Clean panel internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of substantial completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to site for this purpose.

3.04 TRAINING

- A. Procedures: Section 01 79 00.
- B. Provide a minimum of 8 hours per training.

3.05 COMPLETION

- A. Prior to Final Acceptance:
 - 1. Turn all access keys over to the Project Representative.
 - 2. Turn in As-Built records.

END OF SECTION