THERMAL DESORPTION WORK PLAN
WOODS INDUSTRIES SITE
YAKIMA, WASHINGTON

PREPARED FOR:

Burlington Northern Railroad
2000 First Interstate Center
999 Third Avenue
Seattle, Washington 98104-1105
VOL. II

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Burlington Northern Railroad
2000 First Interstate Center
999 Third Avenue
Seattle, Washington 98104-1105

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WILLIAMS PROJECT NO: 0365-001-110

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F

APPENDIX F

BAGHOUSE FILTER MATERIAL INFORMATION

Summit
FILTER CORPORATION
879 RAHWAY AVENUE • UNION, NJ 07083

MAILING ADDRESS
PO Box 427 • Union, N.J. 07083
TEL: (908) 687-3500
FAX: (908) 687-4202

P-84 HIGH TEMPERATURE POLYIMIDE

Fiber Content	:	100% P-84
Construction	:	Needle Punched Felt
Surface Finish	:	Singed
Overall Weight	:	14 oz./sq. yard
Thickness	:	0.100" Nominal
Breaking Strength	:	175 lbs/2" Warp Direction 200 lbs/2" Fil Direction
Mullen Burst	:	350 lbs/sq. inch Minimum
Air Permeability	:	25-45 CFM/sq. foot

When Second Best Won't Do

12.22.92 10:37 AM P03

FROM SUMMIT FILTER

When Nomex® was introduced in 1969, it opened up a new area to filtration. Nomex® made it possible to filter high-temperature gas and liquid streams economically and efficiently. Now a brand new fiber is available that offers performance capabilities previously unattainable with other high temperature fibers.

P-84 is a new non-flammable fiber developed by the Lenzing Company in Austria. It can withstand 500°F continuously and resists exposure to acids and oxidizing agents, two frequent causes of filter bag failure. It also has a unique fiber cross section that makes P-84 exceptionally efficient at filtering out fine particles at high flow rates.

Compared to other high temperature fabrics:

- P-84 outperforms Ryton® on operating temperature (500°F vs. 375°F), filtration of fine particles and resistance to oxidation.
- P-84 outperforms Nomex® on operating temperature (500°F vs. 400°F) and resistance to acid attack.
- P-84 offers equal or better performance than felted glass, at roughly half the cost.

Filter bags made of P-84 have been in service for several years and have shown remarkable performance and durability filtering out exhaust gases from incinerators, coal fired boilers, rotary kilns, etc. P-84 filter bags are available from Summit Filter in a variety of styles for new and retrofit applications. We also offer specially designed cages and accessories to enhance the efficiency of your filtration equipment.

We would like to tell you more about the benefits of using P-84 or our other advanced filter media in your operation. Please call us at (201) 687-3500 and let us help you get the maximum performance out of your filtration equipment.

Felted P-84
14 ounces per square yard
25-40 CFM

Sample in singed finish

Composites of P-84 with Nomex®, Ryton® and polyester are available for special applications.

®Registered Trade Marks: Nomex, Dupont; Ryton, Phillips Fibers.

Summit
FILTER CORPORATION
879 RAHWAY AVENUE • UNION, NJ 07083

(201) 687-3500

OUR NEW AREA CODE IS 908
Please change your records.

** TOTAL PAGE.003 **
12.22.92 10:37 AM [illegible]
12.22.92 10:37 AM [illegible]

OVERALL EFFICIENCY

Collection efficiencies and equivalent emission levels of the filter fabrics are shown below. Collection efficiencies of both Huyglas fabrics and Goretex/Glass were in excess of 99.95% after two hours of testing. Efficiencies of Huyglas 1701, Huyglas 1607-S, and Goretex/Glass were in excess of 99.99% after 100 hours of testing. Long-term equivalent emissions stabilized at 0.00020 gr/dscf or less for the Huyglas and Goretex filter fabrics.

EFFICIENCY TEST RESULTS

FABRIC	PARTICLE CAPTURE EFFICIENCY (%) 2-Hour	100-Hour	EQUIVALENT EMISSION LEVEL (gr/dscf after 100 hrs)
Goretex/Glass	99.989	99.997	0.00010
Huyglas 1607-S	99.958	99.996	0.00020
Huyglas 1701	99.951	99.996	0.00020
P-84	99.183	99.980	0.00032
Nomex	99.421	99.971	0.00066
Ryton/Rastex	99.378	99.960	0.00123
22-oz. woven fiberglass	93.921	99.898	0.00311
16-oz. woven fiberglass	92.521	99.882	0.00358

PRESSURE DROP

The table below shows the pressure-drop characteristics of each of the filter fabrics after 100 hours of testing. Huyglas 1701, Huyglas 1607-S, and Goretex/Glass stabilized at under 3.0 inches W.G. The other felts (P-84, Nomex, and Ryton) stabilized at under 4.0 inches W.G., while the woven fiberglass fabrics were operating at about 5 inches W.G.

PRESSURE-DROP TEST RESULTS

FABRIC	OPERATING PRESSURE-DROP (Inches WG)
Goretex/Glass	2.39
Huyglas 1607-S	2.80
Huyglas 1701	2.76
P-84	3.09
Nomex	3.37
Ryton/Rastex	3.38
22-oz. woven fiberglass	5.04
16-oz. woven fiberglass	4.95

G

APPENDIX G

CONTINUOUS EMISSIONS MONITORING SYSTEM DESCRIPTION

CEM SYSTEM SPECIFICATIONS

The Columbia Scientific Industries (CSI) series CM6000 Continuous Emissions Monitoring (CEM) system is designed to the following specific requirements. The general description of the CM6000 system follows:

(1) Sample Probe
The material and length of each probe is determined by the application. A mounting hub with locking feature is provided for easy installation to the desired depth.

(2) Heat Traced Umbilical
Provides the pneumatic interface between the sample probe and sample conditioner. This umbilical is heated to insure no condensation occurs in the sample stream prior to conditioning.

(3) Sample Conditioner
Performs the following functions at the stack or duct: (a) creates the vacuum level necessary for sample extraction through the probe and heat traced umbilical; (b) provides secondary sample filtration to 0.5 micron; (c) provides blowback of clean air through the heat traced umbilical and probe for instack filter clean out; (d) maintains the sample temperature at 185 to 215°F, well above dewpoint, until dried: (e) achieved permeation drying of the sample to be analyzed by a process utilizing a special ion exchange membrane, thus lowering the sample dewpoint well below ambient to allow unheated transport to the analyzers; and (f) allows for the introduction of calibration gas through the conditioning and transport interface per EPA guidelines.

(4) Umbilical
Provides the pneumatic interconnect between the sample conditioner and sample control module contained in the instrument enclosure. The umbilical contains at least four tubes providing the following: (a) eductor clean air; (b) permeation dryer, clean, dry purge air; (c) sample gas transport; (d) calibration gas delivery. The length, material and size of each tube is determined by the application.

(5) Clean Air Supply
Provides the clean, dry air necessary for continuous system operation. Air from the user's supply is delivered to the instrument enclosure. This air then passes through the Clean Air Supply package which includes the HD10 regulation and control panel. Clean, dry air is sent to the eductor and permeation dryer in the Sample Conditioner. Zero air is also supplied to the Sample Control Module to provide analyzer "zero" samples.

(6) Sample Control Module
Provides controls necessary for remote operation of the sample conditioner. This unit maintains blowback through the probe whenever the sample conditioner is not within its specified operating temperature range. Calibration, or sample distribution to the analyzers is controlled by valves contained in the control module.

(7) Analysis System
Provides analysis for the component gases of the emission source specified by the customer. Typical gases analyzed include sulfur dioxide, nitrogen oxides, ammonia, total sulfur, reduced sulfur compounds, oxygen, carbon dioxide, carbon monoxide, methane, total hydrocarbons, and non-methane, organic compounds. Various types of detectors are used, including ultraviolet, flame photometric (FPD), chemiluminescent, non-dispersive infrared (NDIR), paramagnetic resonance and flame ionization (FID). One advantage of this system concept allows use of EPA designated ambient air monitors that have been established as stable and reliable.

(8) Data Acquisition and Control
To be provided by the customer.

(9) Accessories
A complete package is provided, specific to the customer's needs. Items included are: (a) electrical: constant voltage systems, circuit breakers, interfacing cables, digital display, etc.; (b) pneumatic: air purification and drying systems, pressure regulation, pumps, exhaust manifolds, interface lines etc.; (c) enclosures; NEMA 12, NEMA 4, rack-mount enclosures, shelters and temperature controlled environments.

The major components used in the CM6000 system are given in the next section. System description, operation, maintenance, warranty and spare parts are given in the following sections. Specific information about the analyzer(s), controller, conditioner and major accessories is given in their respective manuals included herein.

SPECIFICATIONS AND DESCRIPTION

This section contains specifications and detailed descriptions of the CM600-32 Continuous Emissions Monitoring (CEM).

Specifications

(1) Site Requirements

Electrical Requirements:	115 ± 10 Vac, 30 amps (suggested breaker size) 60 Hz, single phases.
Air Supply Requirements:	90 ± 10 psig, 3 SCFM Maximum; Free from particulates, oil and water (dewpoint) -40°F).
Environmental Requirements:	Temperature 20-30°C (68-86°F) Minimal dust; Relative humidity 5 to 955.
Special Requirements:	(a) Exhaust line of 1.25 in. diameter and 24 ft (max) length, to exhaust all gases from enclosure to provide sufficient air flow for ventilation intake and exhaust. (b) Heatless dryer is inside enclosure.

System Specifications (enclosure only):

(a)	RITTAL Model EL;	(PS4608-2700)
	Style:	Upright cabinet with rear door and Plexiglass front door.
	Size:	Height - 84.75" (215 cm.) Depth - 31.89" (81 cm.) Width - 23.88" (61 cm.)
	Type:	NEMA 12
	Weight:	375 lbs. (170Kg) (enclosure without analyzer) 525 lbs. (238Kg) (with analyzers and controller)

System Response Time:	Approximately 2 to 4 minutes maximum (depends on umbilical lengths).
Electrical Power:	Maximum 1000 VA (see site requirements)
Air Requirement:	3 SCFM regulated to 60 psig. oil and dirt free; dewpoint -40°C (-40°F).
System Protection:	30 amp circuit breaker to miscellaneous outlet power strip and 20 amp circuit breaker to instrument power strips via the 1000 VA supply. (Note: Both sides of each service line are breakered). Additional circuit protection is provided by an AC arrester installed at the breaker box. This device limits surge voltages caused by lightning or other unwanted transients.

(b) Sample Conditioner:

Manufacturer:	CSI
Model:	SC-10D
Options/Features	Single probe. All excess sample gas collected for safe exhaust.

(c) Total Hydrocarbon Analyzer:

Manufacturer:	CSI
Model:	HC500-2D
Options/Features:	Utilizes flame ionization (FID)

(d) Oxygen Gas Analyzer:

Manufacturer:	Servomex

Model: 1420B

Options/Features: Output range 0-25%. Utilizes paramagnetic susceptibility technique. Has internal 4-20mA output signal.

(e) Carbon Monoxide Gas Analyzer

Manufacturer: Milton Roy (formerly ACS)

Model: 3300 (CO_2)

Options/Features: Utilizes nondispersive infrared (NDIR) technique. Ranges 10 and 20%.

(f) Heatless Dryer and CO_2 Extractor

Manufacturer: General Cable

Model: P-100-303-1

(g) Methane Reactor:

Manufacturer: Aadco

Model: 737-41

Options/Features: CO to CO_2 conversion

(3) Miscellaneous:

(a) Enclosure Fan:

Manufacturer: RITTAL

Model: SK3168

Options/Features: 260 CFM, particulate filter at inlet, low noise

Specifications: 0.2 Amps, 18 W

Dimensions (filter): Length 12.72" (32.3 cm)
Width 12.72" (32.3 cm)

Replacement Filter Mat:	SK3173 (inlet and outlet filters)
Replacement Gasket:	SK3193

(b) Outlet Filer (Enclosure)

Manufacturer:	RITTAL
Model:	SK3163
Dimensions:	Length 12.72" (32.3 cm) Width 12.72" (32.3 cm)

(c) Instrument Power strip (six outlet with on/off switch and 15 amp circuit breaker

(d) Power Strip (six outlet) - miscellaneous supply

(e) Exhaust port(91.25 in. OD x 24 ft.) long to vent all system gases

(f) Lock on each door of enclosure

(g) System Probe Assembly:

Manufacturer:	CSI
Model:	D-TP (high temperature)
Specifications:	Length 36"
Material:	RA446

(h) Umbilical:

Manufacturer:	Technical Heaters
Length:	To be determined
Diameter:	1.125 in.

The CM6000-32 CEM System provides total hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO_2) and oxygen (O_2) emission concentration levels. This system consists of one high temperature D-TP Sample Probe, one SC-10D Sample Conditioner, CM10-1D Sample Control Module, Model HC500-2D HC Analyzer, Model 3300 CO Analyzer, Model 3300 CO_2 Analyzer, and Model 1420B Analyzer.

Control and analysis hardware is assembled in a NEMA 12, 19 inch rack mount enclosure, while the probe and conditioner are installed at the sample extraction site. The system may be operated manually at the enclosure front panels or remotely via the customer supplied equipment. Zero to full scales readings of the selected analyzer output range are available as isolated 4-20 mA DC signals at the auxiliary panel.

The following is a brief description of the above mentioned equipment.

(1) D-TP High Temperature Sample Probe and Heat Traced Umbilical.

One RE446 Alloy D-TP Sample Probe is provided. A 2.5 inch NPT mounting hub, with locking screw, assures accurate and repeatable probe installation. A 3/8" diameter heat traced, single line umbilical connects the probe outlet to sample conditioner inlet. This prevents condensation of the sample gas flow prior to conditioning.

(2) SC-10D Sample Conditioner

Sample gas extraction is achieved by a vacuum created in the SC-10D Sample Conditioner. Air flows through a venturi air eductor creating sufficient vacuum (approximately 15 in Hg) to allow sample gas flow into the heated conditioner enclosure. Temperature within this enclosure is maintained between 185 and 215°F. This assures no condensation prior to drying. The sample to be analyzed is drawn through a 0.5 micron bypass filter, while unused sample is blended with the eductor air and exhausted from the enclosure. A pump, located in the CM10-1D Sample Control Module, draws the sample to be analyzed through the filter, into a permeation dryer for conditioning prior to transport. In the permeation dryer, clean, dry air counter-flows over the outside of hygroscopic ion exchange membranes. Water vapor is removed from the sample gas flowing inside the membrane. Sample gas exiting the dryer is, therefore, conditioned and is suitable for transport to the instrument enclosure for analysis.

(3) Umbilical

The umbilical provides a pneumatic interconnect between the sample conditioner and control module.

(4) Instrument Enclosure

Contained in the Instrument Enclosure are the following major components. Where possible, each unit is slide mounted allowing easy access for maintenance and trouble shooting.

(a) CM10-1D Control Module

The CM10-1D Control Module provides control necessary for remoted operation of the SC-10D Sample Conditioner. This unit controls the sample pump and provides associated valving for sample gas. An air operated venturi pump draws sample gas through a 100 ml/min critical orifice. Zero air is also drawn into the mixing chamber at a controlled flow rate. Zero air is also drawn into the mixing chamber at a controlled flow rate. The resultant moisture is diluted in a precise and stable fashion by approximately 50:1. Both diluted and undiluted sample outputs are available.

The CM10-1D also controls the introduction and distribution of calibration gases to the system, either directly to the analyzer (INSIDE) or through the umbilical and SC0-10 per EPA guidelines (OUTSIDE). Operations of the control module may be accomplished using front panel selector switches. Alternatively, a remote control source may be employed for automatic operation. A further detailed description of operation and maintenance procedures is given in the unit manual appended.

(b) HD10-1 Clean Air Supply

Efficient and reliable system operation is dependent on the air supply quality. The HD10-1 Clean Air Supply provides clean, dry and contaminant free air for each system requirement. Supply air enters the system through a shut off valve and is regulated to approximately 60 psig at the auxiliary panel. This air then flows through a gas reactor that effectively converts any carbon monoxide (CO) to carbon dioxide (CO_2), which in turn is then removed by passing through alternating columns of the heatless dryer. Final drying in a silica gel filled canister, and filtration in an activated charcoal filled canister, provides air suitable for analyzer zero or span checks. A pressure regulator set to 40 psig and flow meter adjusted for approximately 20 liters per minute provide clean air for the eductor supply. Similarly, a regulator set to 40 psig and flow meter adjusted for 20 to 20 liters per minute (depending on site requirements) provides clean, dry air for permeation dryer purge.

(c) HC500-2D Total Hydrocarbon Analyzer

The CSI Model HC500-2D Total Hydrocarbon Analyzer performs continuous dry analysis for total hydrocarbon content in gas mixtures. FID, the well established technique of flame ionization, is used as the detection method. Hydrocarbons, contained in the sample gas, pass through a hydrogen rich flame and are converted to ions. An electrostatic field in the burner causes these ions to migrate and collect on an electrode. This results in an electric current which is proportional to the concentration of ions collected. An electrometer amplifier converts the current to voltage which is fed to the amplifier output jacks. Standard outputs are 0-100m V and 0-1V. A further detailed description of operation and maintenance procedures is given in the unit manual appended.

(d) Model 3300 CO_2 Analyzer

The Milton Roy (formerly ACS) Model 3300 Carbon Dioxide Analyzer performs specific, real time and continuous dry analysis for carbon dioxide in gas mixtures. The Model 3300 is a highly selective, nondispersive infrared (NDIR) gas analyzer. It utilizes a beam of infrared energy which passes first through a Sample Cell and then through both cells of a Dual Cell Detector system.

Two output signals are available from the Model 3300. Output I is a standard 0-1V signal. Output II is internally selectable from 4-20mA (standard), 0-10mV, 0-100mV or 0-1V. A further detailed description of operation and maintenance procedures is given in the unit manual appended.

(e) Model 3300 CO Analyzer

The Milton Roy (formerly ACS) Model 3300 Carbon Monoxide Analyzer performs specific, real time and continuous dry analysis for carbon monoxide in gas mixtures. The Model 3300 is a highly selective, nondispersive infrared (NDIR) gas analyzer. It utilizes a beam of infrared energy which passes first through a Sample Cell and then through both cells of a Dual cell Detector system. The Detector cells are filled with pure carbon monoxide. An externally mounted vacuum pump is used to draw sample gas through the detection system.

Two output signals are available from Model 3300. Output I is a standard 0-1V signal. Output II is internally selectable from 4-20mA (standard), 0-10mV, 0-100mV, or 0-1V. A further detailed description of operation and maintenance procedures is given in the unit manual appended.

(f) Model 1420B Oxygen Analyzer

To monitor the oxygen (O_2) content of the sample gas, CSI has selected a Servomex Model 1420B Oxygen analyzer. The model 1420B uses the paramagnetic response of oxygen for detection. A magnetodynamic sample cell measures the paramagnetic susceptibility of the sample gas. The oxygen concentration is detected by means of a "dumb-bell" mounted on a torque suspension in a strong, nonlinear magnetic field. The higher the concentration of oxygen, the greater the "dumb-bell" is deflected from its rest position. This deflection is monitored by an optical system connected to an amplifier circuit. A further detailed description of operation and maintenance procedures is given in the appended manual.

(g) Auxiliary Panel

The Auxiliary Panel is located in the back of the instrument enclosure and may be accessed through the rear door. As previously described, the air supply control and regulator valves are located on this panel and are labelled for easy identification and operation.

Signal distribution and output terminal strips are attached to the panel. TB1 furnished connection points for the analyzer analog output signals. TB2 and TB3 provide connection points for the external computer or data logger to CM10-1D interface. This provides easy access for electrical testing of the system control response.

(h) Span Source Isolator

Located between the calibration gas bottles and the sample controller (CM10-1D), the Span Source Isolator contains solenoid valves which are manually controlled by a toggle switch on the front panel.

This switching function allows the user to connect more than one calibration gas bottle to the sample controller.

COLUMBIA SCIENTIFIC INDUSTRIES CORPORATION

11950 JOLLYVILLE ROAD
AUSTIN, TEXAS 78759

TECHNICAL DESCRIPTION
FOR

CM6000 CONTINUOUS EMISSIONS MONITORING SYSTEM

Proposal No. 0-04-013 Rev. 1
April 30, 1991

SUBMITTED TO:

Williams Environmental
1550 Pumphrey Avenue
Auburn, AL 36830

1.0 INTRODUCTION

The Columbia Scientific Industries (CSI) Model CM6000 Continuous Emission Monitoring System (CEMS) has been designed around reliable, field-tested components and equipment. The Model CM-6000 is a standard system employing standard modules and components...but since monitoring requirements and plant conditions vary with each customer application, CSI has designed the CM-6000 to be both versatile and flexible. A CM-6000 system will be configured to meet the specific requirements of the customer. The Model CM-6000 system has been designed as a general-purpose combustion monitoring system to meet the performance requirements for Continuous Emission Monitoring Systems (CEMS's) as outlined in 40 CFR Part 60, Appendix B. The system is designed to monitor Carbon Monoxide (CO), Total Hydrocarbon (THC), Sulfur Dioxide (SO_2), Carbon Dioxide (CO_2), Oxygen (O_2) and optionally Oxides of Nitrogen (NO_x).

Sample probes will be installed in the stacks through which sample gas is extracted. This sample, after initial filtration, is conditioned to remove water vapor and transported via the tube umbilical to the analyzer cabinet. Since the water vapor is removed by the sample conditioner(s) near the probe(s), the tube umbilical to the analyzer cabinet does not have to be heated. In the analyzer cabinet control unit(s) (CM10) control the operation of the probe and sample conditioner and feed the stack gases to the analyzers sequentially from each stack. Analog outputs from the analyzers are fed to the auxiliary panel.

2.0 LIST OF EQUIPMENT

PRIMARY SYSTEM

QUANTITY	MODEL #	DESCRIPTION
1	D-TR	High Temperature, chemical resistant probe, 3-foot, without pre-filter, with 2¼" NPT male hub and positioning lock unit. For temperatures to 2450°F (1350°C).
1	SC-10D	Sample Conditioner
1	HD-10	Air Clean-Up System for SC-10 dry purge air and eductor air. -40°C. dewpoint, 75 liters/minute up to 40 psig
1	CM10-1D	Dilution Control Unit
1	SA700	Sulfur Dioxide Analyzer
1	HC500-2D	Total Hydrocarbon Analyzer
1	3300	Milton Roy
1	3300	Milton Roy CO_2 Analyzer
1	1400A	Servomex Oxygen Analyzer
1	1600	Oxides of Nitrogen Analyzer (Optional)
1	HD10-1	Dry Air System with CO_2 Extractor
1	SD-33	SD-33 Nema 12 enclosure including the following: Heatless Dryer with CO_2 Sola Line Regulator. Lightning Arrestor. Exhaust Manifold. Power Circuit Breakers. Outlet Strips Wilkerson Drier Wilkerson Charcoal Scrubber 4 each Eye-bolt Lifting Rings. Cooling Fan and Filter Hydrocarbon and CO converter.
1	Auxiliary Panel	

3.0 DESCRIPTION OF SYSTEM

3.1 Model CM6000 Emission Monitoring System

The configuration of the CM6000 monitoring system is shown in Figures 1 through 5. These figures show the pneumatic diagram, block diagram and enclosure assembly.

The gas extracted through the sampling probe is delivered to the SC-10D sample conditioner via the 10 ft. heat traced line. This line prohibits condensation in the sample stream, prior to passing through the permeation dryers. After filtration, to 5 microns absolute, the sample gas flows directly into a permeation dryer. The permeation dryer removes most of the water contained in the sample. The dewpoint is effectively reduced to -20°C or less. This dried sample is transported via the unheated tube umbilicals to the instrument enclosure for analysis. The output of each analyzer is connected to the Auxiliary Panel where the data is converted to 4-20 mA output to be recorded on the recorder.

Calibration of gas analyzers is controlled via a Chrontrol programmable timer. The system performs the power switching necessary for automatic operation of the CM10's. In addition, since two or more span gases are used in the calibrations, the system controls injection of the correct span gases.

3.2 Sample Analyzers

The following is a brief description of the operation of each analyzer.

3.2.1 Sulfur Dioxide Analyzer CSI Model SA700

CSI will provide a CSI Model SA700 Continuous Fluorescence Sulfur Dioxide Analyzer with the system. The Model SA700 is specific for sulfur dioxide utilizing an ultraviolet source of intermediate intensity and high stability. It is designated by the EPA as an Equivalent Method for sulfur dioxide in the atmosphere for ambient monitoring applications (typically, concentration levels up to 10 ppm). However, when coupled with the CSI Model SD-31 Sample Dilution Probe, the Model SA700 can monitor sulfur dioxide concentrations up to 5,000 ppm or higher.

The recommended maintenance schedule for the SA700 Sulfur Dioxide Analyzer is as follows:

	3-Month Maintenance	Annual Maintenance
Pneumatic Lines		Clean/Replace*
Rotometer		Clean*
Flow Control Valve		Clean*
Pump		Rebuild/Replace*
Optics	Clean**	
Fan, Air Filter,		
Chassis	Clean**	
Reactor		Clean*

*These items may require maintenance more or less often depending on cleanliness of their environment and the exposure rate.

**Should only be replaced if not functioning properly.

Additional specifications and information on the CSI Model SA700 Sulfur Dioxide Analyzer are included in the Appendix of this proposal.

3.2.2 Carbon Monoxide Analyzer Milton Roy Model 3300

CSI will provide an ACS Model 3300 non–dispersive infrared analyzer for the determination of carbon dioxide. The Model 3300 uses a simple single beam optics design, which is made possible by the Microflow Detector, and results in a highly stable and reliable analyzer requiring no optical adjustments and only the simplest maintenance.

A single beam of infrared energy is modulated and passed through a sample cell containing the gas to be measured. The beam emerges attenuated by the amount of energy absorbed by the gas in the sample. Changes of the concentration of the gas result in changes of the intensity of the beam. The remaining energy in the beam is passed serially through two cavities of an infrared detector, a mass–flow sensor filled with gas of the type to be measured. Changes in the intensity of the beam change the pressure differential between the cavities and consequently the balance of the electrical bridge in the detector circuit. Electronic processing and linearization of the balance signal are used to generate an electrical output signal linearly proportional to the concentration of the gas measured.

3.2.3 Total Hydrocarbon Analyzer CSI Model HC500–2D

The Model HC500–2D, Total Hydrocarbon Analyzer, is a self contained system for monitoring ambient concentrations of hydrocarbons.

The HC500–2D utilizes an established flame ionization detector (FID). Hydrocarbons are drawn into the FID via a vacuum pump where they are burned in a flame and converted to ions. An electrostatic field in the burner causes these ions to migrate and collect on an electrode. An electric current is produced which is proportional to the concentration of ions collected.

The FID does not require hydrocarbon free combustion air nor a compressor for sample air, which are necessary requirements for most other commercial FID's.

Total Hydrocarbon outputs are obtained as follows:

Sample air is introduced directly into the FID detector to yield a total hydrocarbon reading which is amplified and presented to the meter and rear panel output for a record.

The HC500–2D design focuses on stable and reliable performance, and ease of service and maintenance. Precise pneumatic and thermal control of critical elements and the utilization of proven solid state circuitry contribute to the performance characteristics of the instrument.

3.2.4 Carbon Dioxide Analyzer Milton Roy Model 3300

CSI will provide a Milton Roy Model 3300 non–dispersive infrared analyzer for the determination of carbon dioxide. The Model 3300 uses a simple single beam optics design, which is made possible by the Microflow Detector, and results in a highly stable and reliable analyzer requiring no optical adjustments and only the simplest maintenance.

A single beam of infrared energy is modulated and passed through a sample cell containing the gas to be measured. The beam emerges attenuated by the amount of energy absorbed by the gas in the sample. Changes of the concentration of the gas result in changes of the intensity of the beam. The remaining energy in the beam is passed serially through two cavities of an infrared detector, a mass-flow sensor filled with gas of the type to be measured. Changes in the intensity of the beam change the pressure differential between the cavities and consequently the balance of the electrical bridge in the detector circuit. Electronic processing and linearization of the balance signal are used to generate an electrical output signal linearly proportional to the concentration of the gas measured.

3.2.5 Oxygen Analyzer Servomex Model 1400A

The Servomex 1400A Oxygen Analyzer utilizes the paramagnetic property of O_2 molecules to measure the O_2 concentration.

All Servomex magneto-dynamic oxygen analyzers measure the relative magnetic susceptibility of the sample gas by a method based on that used by Michael Faraday to determine the molar magnetic susceptibility of gas by measuring the force developed on a diamagnetic test body suspended in a strong non-uniform magnetic field. Most common gases are diamagnetic (i.e., they are repelled by a magnetic field) but oxygen is strongly paramagnetic (i.e., it is attracted by a magnetic field). When oxygen is attracted into a magnetic field, the field is enhanced. This enhancement increases the force acting on a diamagnetic body suspended in that field.

In the Servomex oxygen analyzers based on this principle the test body is a glass dumbbell filled with nitrogen and suspended between the pole pieces of a permanent magnet assembly. It is held in position by a rugged, taut-band platinum ribbon suspension.

When the oxygen content of the gas surrounding the dumbbell changes, the force on the dumbbell changes causing it to rotate slightly. This rotation causes a mirror on the dumbbell to reflect light onto a pair of matched photocells. Movement of the light beam generates a difference signal which is used in a feedback circuit to determine oxygen content of the sample gas. The signal is fed to a feedback coil secured to the dumbbell. The magnetic field created around the coil by this current opposes the displacement force generated by the oxygen present in the sample gas. The dumbbell remains in essentially one fixed position regardless of the actual oxygen content. The feedback current required to hold the dumbbell in position is directly proportional to the oxygen content of the sample to better than 1% linearity throughout the whole 0–100% O_2 range.

The taut-band suspension of the dumbbell provides a system which is extremely resistant to mechanical shock while the null-balance electrical design results in outstanding resolution and linearity.

3.2.6 Oxides of Nitrogen Analyzer (Optional) CSI Model 1600

CSI will provide a Model 1600 Chemiluminescent Oxides of Nitrogen analyzer for the monitoring system. The CSI Model 1600 is designated by the United States EPA as a Reference Method (EPA#RFNA-0977-025) for the determination of nitrogen oxides (NO, NO_2 and NO_x) at ambient concentrations (typically, up to 0.5 ppm). However, when coupled with the CSI Model SD-31 Sample Dilution Probe, the Model 1600 can monitor concentration levels up to 1,500 ppm or higher. The seven switch-selectable ranges on the front panel permit the operator to select the optimum monitoring range for a specific application. The Model 1600 is specific for NO and NO_x utilizing a chemiluminescent reaction of ozone with nitric oxide. Nitrogen dioxide is determined by a catalytic converter which converts NO_2 to NO. The new 1600 vertical converter is the accepted industry standard with its long life, molybdenum catalyst, and easily changed cartridge.

The recommended maintenance schedule for the Model 1600 NO_x Analyzer is as follows:

	Monthly	3-Month	6-Month	Annual
Inlet Air Filter 5 Micron Teflon	Change			
Filter Housing	Clean			
Orifice Protection Filters 7 Micron Sintered SS				Change
Air Dryer Ozone Generator	Check/Replace			
Charcoal Cartridge Assembly (Ozone Scrubber)		Replace		
Fans (2)			Clean/Oil	
NO_2 to NO Converter				Check/ Replace Catalyst
Converter Outlet Filter				Check/ Replace

Additional specifications and information on the CSI Model 1600 Oxides of Nitrogen Analyzer are included in the Literature of this proposal.

3.3 Sampling System

Figure 1 shows the system block diagram for the Model CM6000 monitoring system. Sample gas is extracted from the stack by means of air eduction. The sample is withdrawn through a probe assembly and passes through a short (less than 10 feet) heat-traced umbilical sample line to a CSI Model SC-10D sample conditioner where it is filtered and dried by a permeation dryer. The sample is then transported from the sample conditioner to the analyzer cabinet through Teflon sample line(s) housed in a multi-tube instrument tubing bundle (the umbilical).

The Columbia Scientific Model CM10 control module permits operation of the Model SC-10D sample conditioners from the Analyzer Console. The CM10 also provides for either manual or automatic introduction of calibration gases to the analyzers and manual or automatic blowback of the sample probe. The CM10-1D also provides dilution of any gas that requires dilution.

3.3.1 Probe Assembly

A Columbia Scientific sample probe assembly is provided at the sampling point. The probe body is fabricated from 3/4" Schedule 80 pipe and is RA 446. A mounting hub (traverse-type) is provided with the probe. A locking screw on the mounting hub permits the operator to slide the probe body into the stack to any desired depth of penetration. Caution should be exercised to orient the flash diverter into the flow stream. This provides optimum protection for the porous metal filter.

3.3.2 Sample Conditioners

An SC-10D sample conditioner (shown in figure 2) is mounted on a platform railing or stand at the sampling point (appropriately placed per sampling requirements). The SC-10D is connected to the probe via a heat traced umbilical of about 10 feet in length. The SC-10D is designed to extract a continuous sample from a process stream which, in most cases, is an extremely harsh environment. the SC-10D utilizes a unique, dual bypass filtering arrangement which reliably removes particulates greater that .5 microns. All surfaces that come in contact with the sample are made of 316 stainless steel or Teflon, and are heated above the sample dewpoint, eliminating possible corrosion of the SC-10D by condensed gases.

Sample is drawn from the stack by an air operated eductor. The eductor works on the venturi principle and allows for high sample flowrates without the use of a pump. Clean, oil-free air should be used to operate the eductor. Typically, 30 LPM at 40 psi of instrument air is sufficient. Lower pressure or flow will decrease the amount of extracted sample. The main portion of the extracted sample joins the eductor air and is vented to the outside of the SC-10D via the 3/8" stainless steel tube fitting.

The first stage filter is made of sintered 316 stainless steel and has effective filtering down to 100 microns. This filter is provided with a flyash diverter to protect the sintered element from direct impaction of flyash. A manual blowback solenoid is provided to allow for periodic cleaning of the first filter.

The second stage bypass filter is also made of sintered 316 stainless steel. This element has a pore size of 5 microns. The main flow of extracted sample passes through the inside of the second filter's element, through the eductor and blowback valve and out the vent. The stack sample, used for measurements, is drawn off the main flow at a 90 degree angle through the sintered element. Due to the high velocity of the sample gas, particulates have difficulty making the 90 degree angle. Thus, the effective filtering of the bypass filter is better than the 5 micron pore size and has typically been shown to be ten times finer (.5 micron) than the actual pore size. The bypass filter is also "self cleaning", since particulates do not impact the filter element and are carried to the vent by the high velocity flow.

After filtration, the sample gas passes through a permeation dryer where water is removed, without condensation, to yield a dewpoint of -20°C or less.

3.3.3 Umbilicals

The sample transport line is comprised of instrument tubing bundles (umbilicals) fabricated with an outer PVC jacket (approx. 1-½" OD) and Mylar sheath. The electrical power and control wires for the SC-10 are included in each tube bundle. In this system the umbilical cable will be freeze protected.

The individual tubes in the instrument tubing bundles are utilized as follows:

Tube	Function	
#1	Calibration Gas	Calibration gas to SC-10D sample conditioner; ¼" O.D. Teflon tubing.
#2	Sample	Sample gas from the SC-10D sample conditioner; ¼" O.D. Teflon tubing.
#3	Purge Air	Dry purge air to the SC-10D sample conditioner permeation dryer; ⅜" O.D. polyethylene tube.
#4	Eductor Air	Eductor air to the SC-10D sample conditioner; ⅜" O.D. polyethylene tube.

The tube bundle is brought to the analyzer enclosure through a sample interface panel on the side or top of the electronic rack-mount enclosure. The interface panel will include the following components for each point:

(1) Sample gas from SC-10D; ¼" O.D. 316 stainless Swagelok bulkhead connector.

(2) Calibration gas to SC-10D; ¼" O.D. 316 stainless Swagelok bulkhead connector.

(3) Purge air to the SC-10D; ⅜" O.D. 316 stainless Swagelok bulkhead connector.

(4) Eductor air to the SC-10D; ⅜" O.D. 316 stainless Swagelok bulkhead connector.

(5) Electrical interface to the SC-10D; 10 pin MS type Amphenol connector.

3.3.4 CM10-1D Control Module

The CM10 Control Module permits the operator to perform all operations of the sampling system. The control panel includes provision for leak checking the system, flowmeters for monitoring the gas flows, and provides the ability to introduce the calibration gases either directly to the analyzers or through the sample conditioner.

The CM10-2 has the added capability of controlling two probes and sample conditioners. While the units with a D on the end provide a dilution of the sample before being presented to the analyzers. In this system a diluted sample will be used for the NO_x and SO_2 analyzers.
The CM10-1D control module includes the following components:

Item	Legend	Function
SV1	Zero	Introduces zero air tocalibration manifold with an electrically actuated 2-way solenoid valve.
SV2	Cal	Introduces calibration gas to the calibration manifold with an electrically actuated 3-way solenoid valve.

G1	Compound Gauge	Pressure/vacuum gauge that shows vacuum held on systemduring leak test function and pressure on system during pressurization of system to find a leak.
NV1	Calibration Flow Adjust	Needle valve controls amount of ZERO or CAL gas beingdelivered to the calibration vent.
FI1	CAL BYPASS Flowmeter	Rotameter to indicate that excess CAL or ZERO air is provided to the calibration vent so that system is not starved or over pressurized.
SV3	Leak Test	2-way solenoid valve which closes the calibration source from the vent line in order to allow a vacuum to be drawn on the system for leak testing.
SV4	Inside/Outside	3-way solenoid valve thatdirects CAL/ZERO gas to the sample conditioners for complete system calibration or to the analyzer for instrument calibration only
SV5	Run/Calibrate	3-way solenoid valve thatdirects either sample orcalibration gas to theanalyzers.
SV6	Leak Trap	3-way solenoid valve that traps the vacuum on the CAL and sample lines during leak test while providing room air to the analyzer.
NV2	Sample Flow Adjust	On Line Sample Needle valve that adjusts the amount of sample/calibration gas that is delivered to the analyzers.
P1	Sample Pump	Pump that provides sample/calibration gas to theanalyzers; all materials are Teflon or stainless steel.
NV3	Off Line Sample	Needle valve used to adjustvented offline sample flow rate.
FI-2		Rotameter valve to indicate flow rate to analyzer(s).

FI-3 Rotameter valve to indicate flow rate to analyzer(s). FI-5 Rotameter with needle valve to indicate sample by-pass flowrate.

FI-4 Rotameter with needle valve to indicate sample by-pass flowrate.

3.3.5 Clean Air System

The "Clean Air" System consists of several components designed to deliver air at various levels of cleanliness in terms of oil, water, and particulate content. Air from the compressor room is delivered to the system at 100 to 120 psi. The air then passes to the equipment console for further pressure regulation and "clean-up".

(I) Eductor Air

The first air usage in the system is for the eductor in the SC-10. The air required for this function need not be dry or hydrocarbon-free. It must however be oil-free. This air is supplied to the HD10 panel where it is flow regulated and sent, via the umbilical, to the SC-10.

(ii) Purge Air

The second air usage in the system requires oil-free and dry (-40°C dewpoint) air suitable for delivery to the permapure dryer attached to the SC-10. It is the Permapure device which dries the sample extracted via the probe prior to transport of the sample (via the umbilical) to the console CM10 sample distribution system. The air from the system pressure regulator is dried by a switching desiccant column device. The Permapure purge air is flow and pressure regulated at the HD10 panel and is then sent via the umbilical to the SC-10 system.

(iii) "Zero" Air

The third air usage requires clean, dry and contaminant free air. This air is used as "Zero" calibration air in the periodic ZERO/SPAN checks of the analyzers. Air passes through the Heatless Dryer. The air is further dried, by a simple desiccant drier, and cleaned, by passage through an activated charcoal canister, then sent to the CM10 controller for use as "Zero" calibration air.

The desiccant drier, and activated charcoal air cleaner will require periodic maintenance. The desiccant should be checked for change from blue to pink coloration as moisture collects and should be changed out when material is almost entirely pink. (Spent desiccant can be restored by baking at 300°F until the blue color is restored). Charcoal should be changed on a quarterly basis, unless a drift in "zero" test indicates a need for replacement.

3.3.6 Instrument Enclosure

The analyzer and system components will be installed in a dual NEMA 12 enclosure. The analyzer enclosure is approximately 48 inches wide by 78 inches high by 32 inches deep and provides both front and rear access. The weight without analyzers is approximately 600 lb., and with analyzers 1000 lbs.

The analyzers and the system control panels are rack-mounted on slides for front access. Other system components (sample pump, E/T convertors, interconnecting wiring and tubing, etc.) are mounted inside the enclosure with access through the rear. A sample interface panel is provided on the side or the top of the enclosure for making all pneumatic and electrical connections. The instrument enclosure is designed to be operated in a reasonably well-controlled environment (70 ± 10°F; 50 ± 30% RH). The isolated 4-20 mA outputs will be available on the auxiliary panel. Figure 4 and 5 show a preliminary arrangement of components in the instrument enclosure including optional items that may not have been included in this proposed system. Final arrangement and design features will be coordinated with customers engineers.
The paint standard for the Enclosure is as follows:

Primer 1.5 mil Electrophoresis Dip Bath
Finish 1.5 mil 2-Part Epoxy, Electrostatically Sprayed

The paint standards for the individual rack instruments is as follows:

Panels:
1. Remove all surface defects.
2. Clean Prior to iriditing and painting.
3. Gold iridite all over.
4. Paint near side and edges only with Sherwin Williams Polane T Polyurethane Enamel (Part No. Z99AT1156), Dark Grey, very light texture.
5. S/S with white epoxy ink (Mil I-43553).
6. Cure 24 hrs. prior to packaging and shipment.

Trim:
1. Clean prior to iriditing and painting.
2. Gold iridite all over.
3. Paint all over with Sherwin Williams'Polane T Polyurethane Enamel" (Part No. Z99LT1359) Blue, medium texture.
4. Cure 24 hrs. prior to packaging and shipment.

Covers:
1. Clean prior to iriditing and painting.
2. Gold iridite all over.
3. Paint near (external) side and edges only with Sherwin Williams 'Polane T Polyurethane Enamel' (Part No. Z99AT1184) Light Grey, medium texture.
4. Cure 24 hrs. prior to packaging and shipment.

Chassis:
1. Clean prior to iriditing and painting.
2. Gold iridite all over.
3. Paint far side and edges only with Sherwin Williams "Polane T Polyurethane Enamel" (Part No.Z99AT1184), light grey, medium texture.
4. Cure 24 hrs. prior to packaging and shipment.

H

APPENDIX H

I.D. FAN CURVES

NORTHERN BLOWER

FAN SERIAL No.:

DRAWN: 8/11/1994 MAN

SALES OFFICE: HUTCHCO, INC.

CUSTOMER: ESSTEE P.O. No.:

PROJECT:

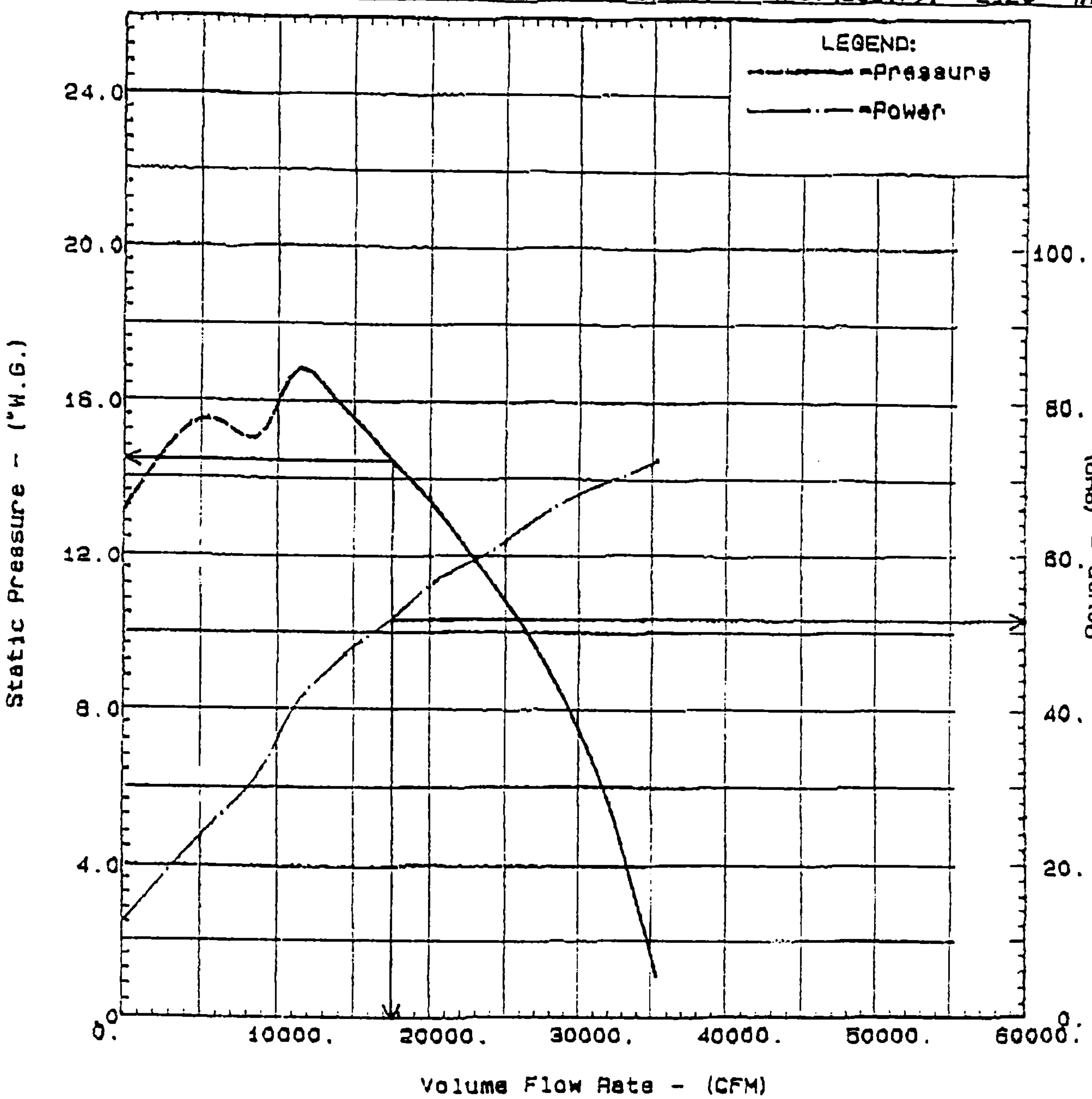
ENGINEER:

TAG:

FAN- DESCRIPTION: Design No. 8812 Size 3650 60 % SISW Centrifugal

SELECTION: 17500. (CFM), 14.500 ("W.G.) SP, 51.88 (BHP)

CONDITIONS: OPERATING: .0422 (lbm/cu.ft), 450. (deg.F), 2120 (RPM)



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NORTHERN BLOWER

FAN SERIAL No.:

DRAWN: 8/11/1994 MAW

SALES OFFICE: HUTCHCO, INC.

CUSTOMER: ESSTEE P.O. No.:

PROJECT:

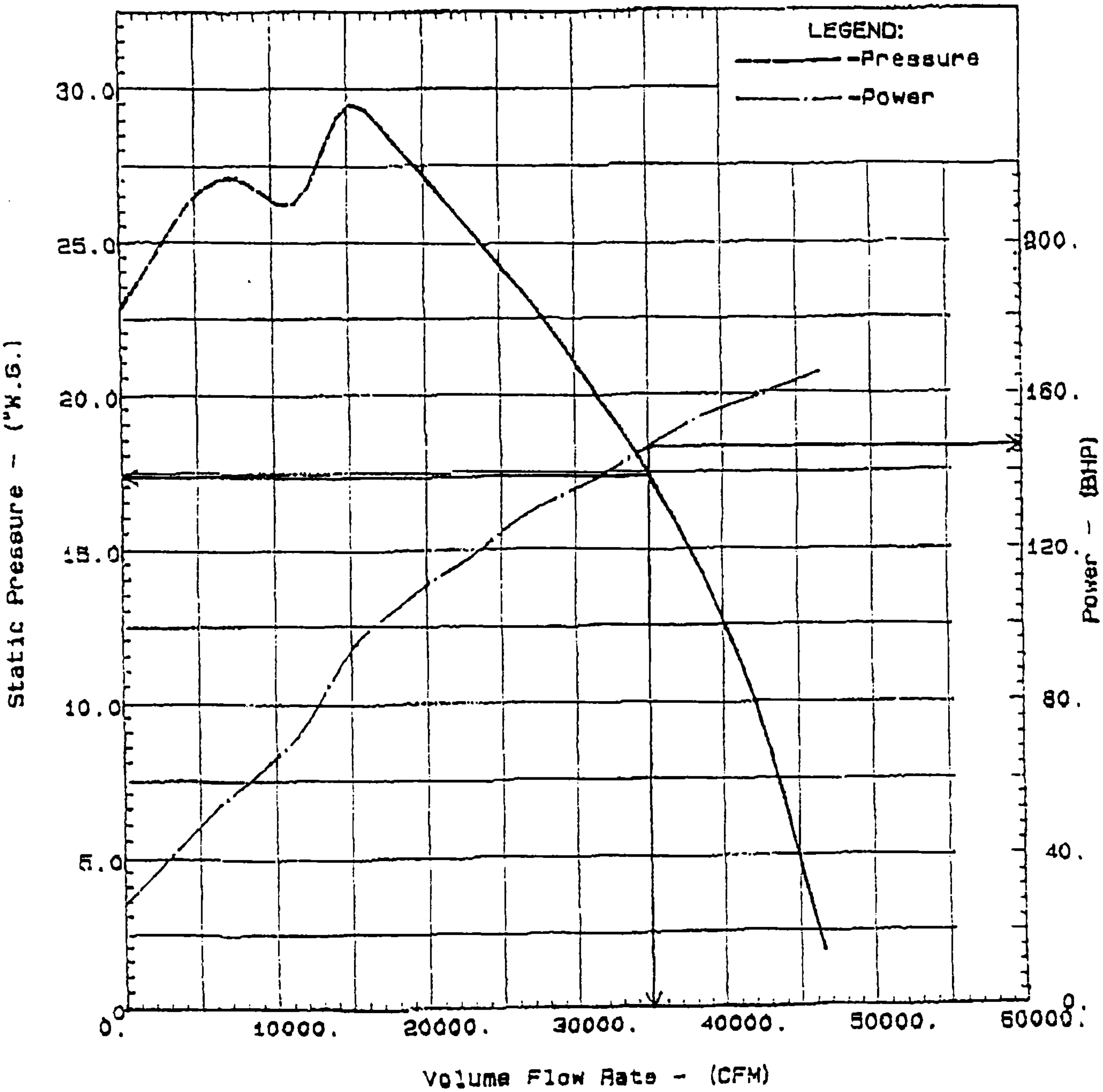
ENGINEER:

TAG:

FAN- DESCRIPTION: Design No. 8812 Size 3650 60 % SISW Centrifugal

SELECTION: 35000. (CFM). 17.400 ("W.G.) SP. 146.5 (BHP)

CONDITIONS: OPERATING: .0422 (lbm/cu.ft). 450. (deg.F). 2790 (RPM)



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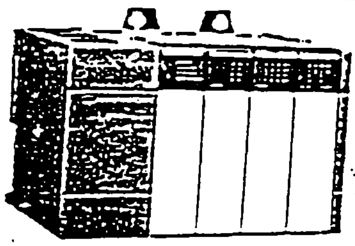
APPENDIX I

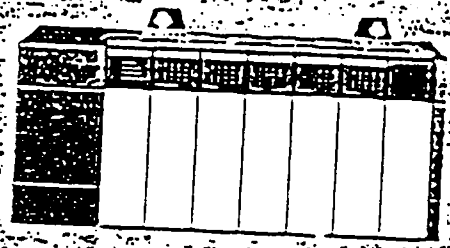
PROGRAMMABLE LOGIC CONTROLLER

MODULAR HARDWARE STYLE ● RACKS

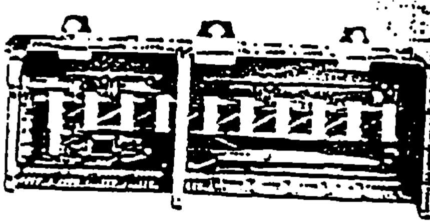
You can customize your control system by selecting hardware components to meet your specific application requirements.



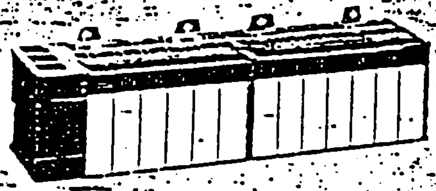
4-Slot Rack
with Power Supply, CPU and Modules



7-Slot Rack
with Power Supply, CPU and Modules



10-Slot Rack
without components



13-Slot Rack
with Power Supply, CPU and Modules

DESCRIPTION — The Rack houses the Central Processor Unit (CPU) and the I/O modules. The power supply mounts on the left side of the rack.

All components easily slide into the racks along guides formed in the racks. No tools are required to insert or remove the I/O modules or SLC 5/01 processor.

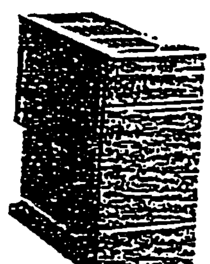
Important: The CPU always occupies the first slot in the first rack.

Description [1]	Catalog Number	Price
4-Slot Rack	1746-A4	$145
7-Slot Rack	1746-A7	240
10-Slot Rack	1746-A10	380
13-Slot Rack	1746-A13	515

[1] Racks do not include interconnect cables. If an interconnect cable is required, refer to Page 339 for ordering information.

Note: The two slot expansion rack (Catalog No. 1746-A2) can only be used in Fixed Hardware configurations.

MODULAR HARDWARE STYLE ● POWER SUPPLIES



To provide power to the CPU and each I/O slot, select a power supply from the table for your application.

For AC power supplies the 120/240 Volt selection is made by a jumper. Simply place the jumper to match the input voltage.

All power supplies are protected against overloads.

Each rack of a modular system requires a power supply.

Important: The power supply does not require a slot in the rack. It simply mounts on the left side of the rack with two screws.

POWER SUPPLY GUIDELINES —

Important: I/O modules containing relay contact outputs require both 24V and 5V power from the power supply. The following table is used to determine the maximum number of relay contact outputs the power supply will support.

Maximum Number of Relay Contact Outputs			
Rack Configuration	Catalog Number 1746-P1	Catalog Number 1746-P2	Catalog Number 1746-P3
CPU Rack with RS-485 Isolated Coupler [2]	24	58	60
CPU Rack without RS-485 Isolated Coupler	32	76	58
Modular System Expansion Racks	40	34	76

[2] If the Isolated Coupler is powered from a separate 24V power source, the maximum number of Relay Contact Points is the same as a CPU Rack without the RS-485 Isolated Coupler.

POWER SUPPLY SELECTION —

1. Select the CPU and Modular I/O, then add the current requirements for each device from I/O Modules Table on Page 337.
2. Determine from the above table the number of relays required for the system and whether or not the system will be used on the RS-485 link.
3. Based on the requirements of both 1 and 2, select the appropriate power supply.

Note: Future system expansion is a consideration to be taken into account when power supply selection is made.

POWER SUPPLY LOADING EXAMPLE

Select a Power Supply for a system containing the following:

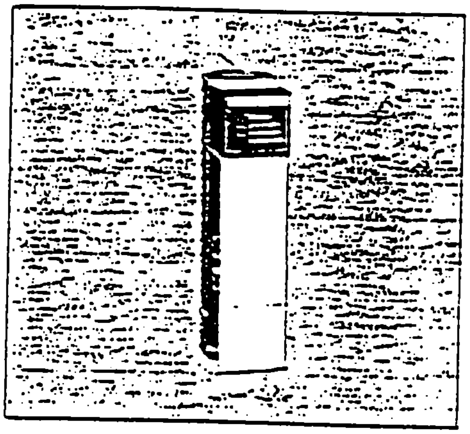
Qty	Description		Value (Amps.)
1	10-Slot Rack	1746-A10	-0-
1	CPU	1747-L511	0.350
4	120V 16 IN	1746-IA16	0.340
3	Relay 16 Out	1746-OW16	0.510
1	Triac 16 Out	1746-OA16	0.370
			1.570 Amps.

In the Example, the 48-Relay Contact Requirement drives the selection to a Catalog Number 1746-P2 Power Supply. Future considerations for placing this system on the RS-485 link will not be a problem. The capacity of the P2 power supply is adequate to accomodate the required relays and RS-485 link activity.

Description	Catalog No.	Price	Catalog No.	Price	Catalog No.	Price
	1746-P1	$240	1746-P2	$330	1746-P3	$255
Line Voltage	85-132/170-265 Volts AC 50/60 Hz		85-132/170-265 Volts AC 50/60 Hz		19.2-28.8 Volts DC	
Internal Current Capacity	2 Amperes at 5 Volts DC		5 Amperes at 5 Volts DC		3.6 Amperes at 5 Volts DC	
User Current Capacity	0.2 Amp at 24 Volts DC		0.2 Amp at 24 Volts DC		—	
Ambient Operating Temperature Rating	0 to +55°C (Current capacity derated by 5% at +60°C)					
Humidity Rating	5-95% (non-condensing)					
Wiring	#14 AWG					

For Accessories — See Page 338.

MODULAR HARDWARE STYLE • SLC 5/01 CENTRAL PROCESSING UNIT (CPU)



DESCRIPTION —

The SLC 5/01 processors are available with a memory range of 1K or 4K of use instructions. These CPUs operate in an industrial environment up to +60°C.

The 1K CPU is supplied with capacitor back-up as standard and optional battery back up. The 4K CPU is supplied with battery back-up as standard.

Optional Memory Modules are also available. Refer to Page 338.

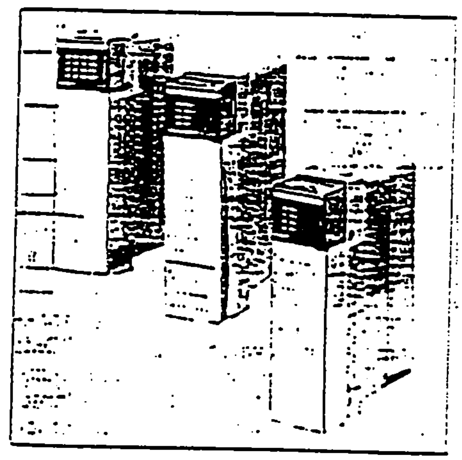
Important: The first slot of the first rack is always reserved for the CPU module.

Description	Power Supply Loading At 5 Volts DC	Catalog Number	Price
SLC 5/01 with 1K user instruction capacity	0.35 Ampere	1747-L511	$420
SLC 5/01 with 4K user instruction capacity		1747-L514	570

I/O MODULES

Description		Number of I/O	Power Supply Loading (Amperes) 5 Volts DC	Catalog Number	Price
AC MODULES					
Input	100/120V AC	4	0.035	1746-IA4	$100
		8	0.050	1746-IA8	145
		16	0.085	1746-IA16	245
	200/240V AC	4	0.035	1746-IM4	90
		8	0.050	1746-IM8	145
		16	0.085	1746-IM16	245
Output (Triac)	120/240V AC	8	0.185	1746-OA8	240
		16	0.370	1746-OA16	340
DC MODULES					
Input (Sink)	24V DC	8	0.050	1746-IB8	110
		16	0.085	1746-IB16	200
Input (Source)	24V DC	8	0.050	1746-IV8	110
		16	0.085	1746-IV16	200
Output (Transistor) (Sink)	10/50V DC	8	0.135	1746-OV8	145
		16	0.270	1746-OV16	240
Output (Transistor) (Source)	10/50V DC	8	0.135	1746-OB8	145
Input (TTL) (Source)	5V DC	16	0.070	1746-IG16	■
Output (TTL) (Sink)	5V DC	16	0.250	1746-OG16	
RELAY MODULES					
Relay Output 10-250V AC/10-125V DC		4	0.045	1746-OW4	115
		8	0.085	1746-OW8	160
		16	0.170	1746-OW16	240
COMBINATION MODULES					
(2) Input-100/120V AC	(2) Output-Relay	4	0.030	1746-IO4	125
(4) Input-100/120V AC	(4) Output-Relay	8	0.060	1746-IO8	220
(6) Input-100/120V AC	(6) Output-Relay	12	0.090	1746-IO12	330

■ Contact nearest Allen-Bradley Sales Office for price and availability — See Page 336



DESCRIPTION — There are four types of I/O modules available:

- AC Input and Output
- DC Input and Output
- Relay Output
- Combination Modules

Terminals on the modules have self-lifting pressure plates that accept two #14 AWG wires. LED indicators on the front of each module display the status of each I/O point.

The LED indicators illuminate when voltage to an input terminal is present or when the processor commands an output to be energized. Select any mix of the modules based on your application requirements. Up to 256 I/O maximum.

For Accessories — See Page 338.

J

APPENDIX J

WEIGH SCALE

TECWEIGH 20

Martin Tech

Bob Martin
(404)/ 737-3700

Installation and Instruction Guide
for all TECWEIGH I, II, IV and VI Conveyor Belt Scales using the TECWEIGH 20 Weight Processor

M. L. BENSON & ASSOCIATES
P. O. BOX 88296
ATLANTA, GA 30356-8296
(404) 393-0884

TECNETICS Industries, Inc.
2180 Old Highway 8
St. Paul, Minnesota 55112
612 780-4880
612 780-5909 fax

TECWEIGH 20

CONTENTS

HAZARD NOTICE

The equipment described in this manual requires a supply voltage of 115 Volts AC, which represents a degree of hazard to the operating personnel. Additional wiring for optional remote equipment may also be connected to other sources of hazardous voltage, which then appears on the terminals of the weight processor.

If wired correctly, the remote components (speed sensor and carriage assembly) have safe, low voltage on their terminals. The WP20 Weight Processor may have hazardous voltage on several terminals.

It is the user's responsibility to obtain a qualified electrician who should be aware of proper wiring procedures. Under no circumstances should voltages higher than 115 VAC be wired into the Weight Processor.

INTRODUCTION

1.1 The TECWEIGH Conveyor Scale was developed in response to an industry need for a simple, economical machine to accurately weigh material being carried by conveyor systems.

1.2 TECWEIGH's design objectives include:

a) *SIMPLICITY* in all aspects; manufacturing, installation, cabling, calibration, maintenance and repair.

b) Elimination of bearings, rubber trunnions, knife-edges, or wear-points, while maintaining weather-tight, "all welded" construction.

c) Elimination of fragile load-cells, freedom from "break-away" counter-balances or special attention to avoid overload damage.

d) Utilization of digital signal levels to permit long cable runs without loss of accuracy and uncomplicated wiring with minimal hook-up points.

e) Digital signal processing without "trims" or adjustments. Direct-reading, all-electronic displays without motors, mechanical counters, or adjustments.

f) Extra power-supply stabilization for accuracy even with regulated generator power

g) Use of latest integrated circuit technology to display and retain Total Tons indication and program variables without batteries.

h) Self-storing Calibration Weight with manually or automatically-operated lifting arm.

i) Speed compensation to eliminate errors from variations in belt speed.

1.3 TECWEIGH scales are available in "single-idler" or "multi-idler" units. Two, four, or six weigh idlers are used for progressively more accurate systems by reducing the adverse effects of belt tension, training and alignment. Therefore, multi-idler TECWEIGH scales are often specified for more critical applications. All operating information given here pertains to either "single-idler" or "multi-idler" TECWEIGH systems.

1.4 Installation of any conveyor scale requires proper alignment and idler modification, as well as careful calibration procedures. Although these instructions are adequate for a correct installation, the more critical user may contact the factory to request the assistance of our trained field engineers during installation and start-up.

1.5 TECWEIGH scales are also included as an integral part of the TECWEIGH line of Weighing Feeders. Most units utilize identical electronic parts and technology. Because the mechanical lay-out may vary in some respects, some installation instructions will not apply, nor will the calibration procedures necessarily be identical.

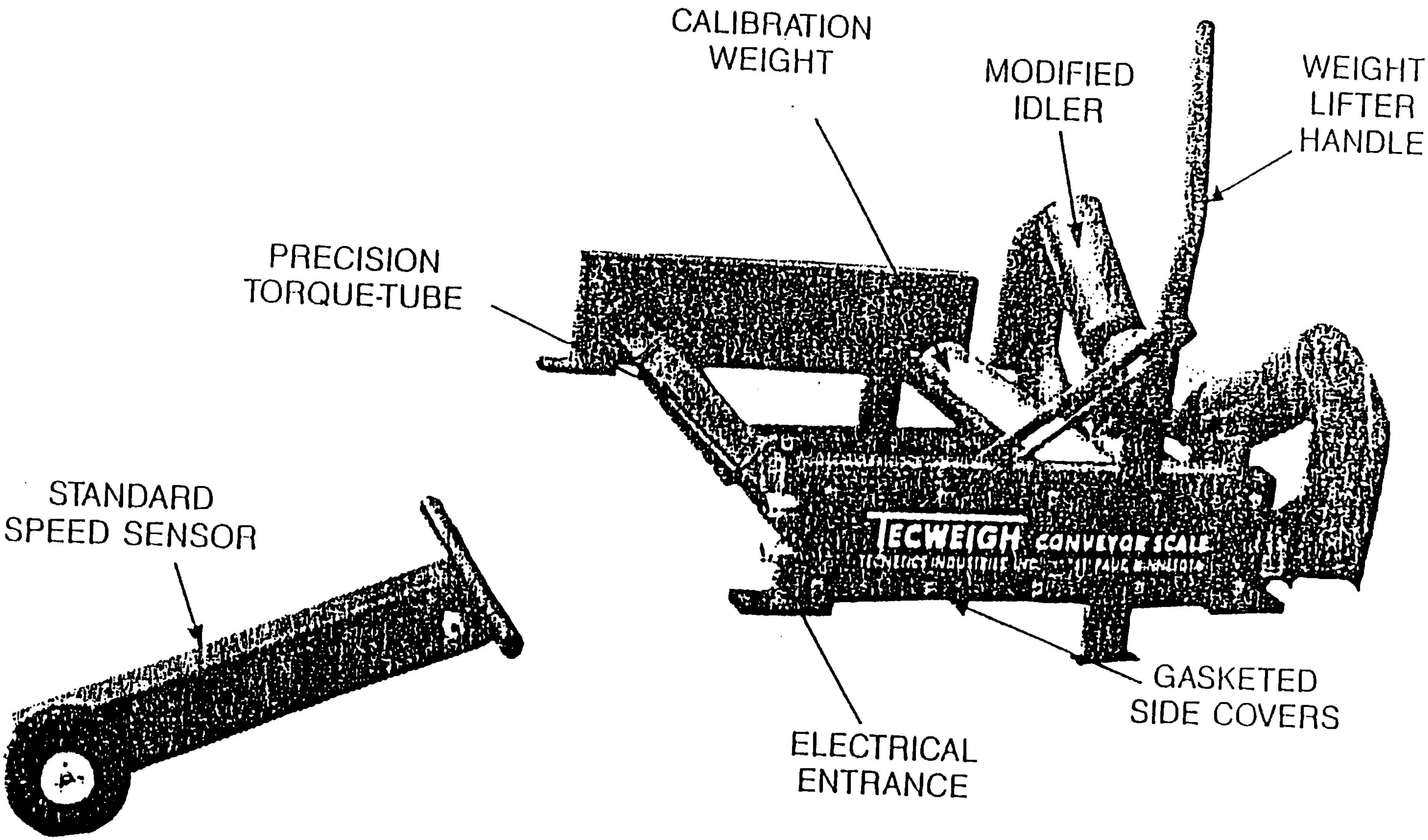


FIG. 1 TECWEIGH I *SINGLE-IDLER CONVEYOR SCALE*

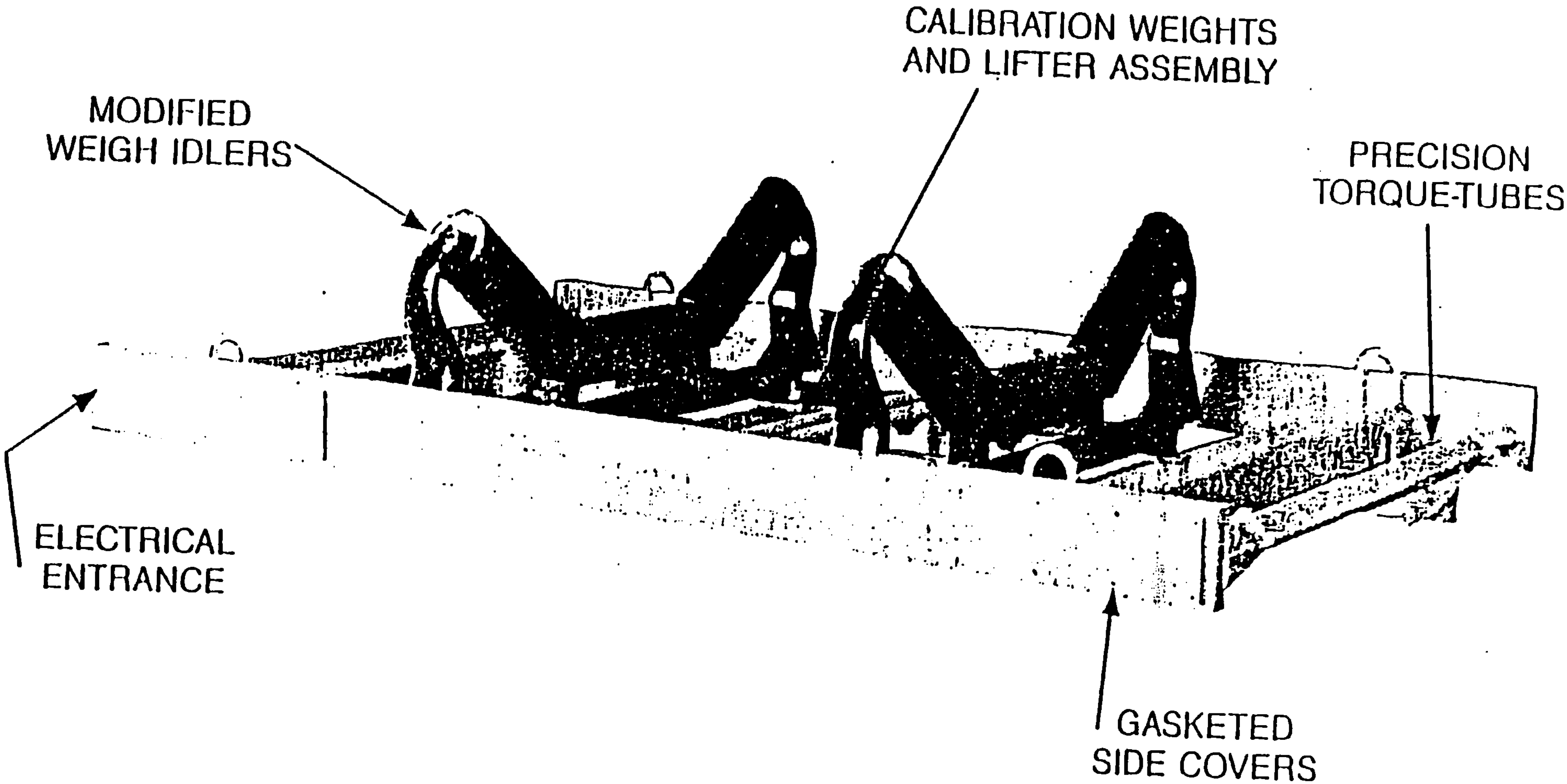


FIG. 2 **TECWEIGH II** *DUAL IDLER CONVEYOR SCALE*

INSTALLATION

PRELIMINARY

2.1 The TECWEIGH Conveyor scale consists of three main elements:
a) The Carriage Assembly including the self-storing Calibration Weight.
b) The Speed Sensor.
c) The Weight Processor (electronics)

The shipment should be immediately inspected for damage and/or completeness.

2.2 Installation consists of:
a) Modification of the user's Weigh Idler and attachment onto the Carriage Assembly.
b) Mounting of the Carriage Assembly onto the conveyor structure.
c) Alignment ("string-lining") of the Weigh Idler along with the other idlers in the area of the scale.
d) Installation of the Speed Sensor.
e) Mounting of the Weight Processor along with any additional equipment used with the scale.
f) Running necessary wiring for power and signal distribution.

2.3 Calibration includes adjustment for Zero (belt running empty) and Span (via Static Calibration Weight, Calibration Chain, or Weighed-Load tests). Additional check-out and/or calibration may be required for remote equipment used in conjunction with the scale.

2.4 TECNETICS has a staff of trained field technicians who are ready to assist with installation, check-out, and calibration. Contact the Factory for further information regarding start-up assistance.

Installation of a TECWEIGH scale usually involves 4-6 hours under normal conditions. One or more helpers are required, plus the availability of a burning torch, welder, and necessary mechanic's tools.

IMPORTANT: There are several conditions which make it difficult or impossible to achieve a scale installation having good accuracy. One or more of the following items may degrade the scale's performance:

a) Vertical curvature or "upturn" in the Conveyor.
b) Mismatched, damaged or misaligned idlers.
c) "Rope" Conveyors or any lack of rigidity in the conveyor's structure.
d) Badly worn belt splices which join belt sections of different thickness or poor belt training.
e) Belts having excessive velocity, therefore causing very light loading (less than 10 Lbs/Ft).
f) Excessive belt loading (exceeding 100 Lbs/Ft).
g) Skirting or any restraint which interferes with belt flexibility.
h) Environmental extremes: (temperature, wind, water, mud build-up, vibration or lack of conveyor stability).
i) "Knob Twisters or Button Pushers" - unqualified personnel who make changes in calibration or program variables.

APPLICATION NOTES

2.5 All TECWEIGH Conveyor scales are manufactured to the highest standards to provide maximum accuracy and reliability. In order to achieve maximum performance, careful attention is required in the installation and application of the devices. A few important items are illustrated below: Consult the Factory if any of these conditions are encountered .

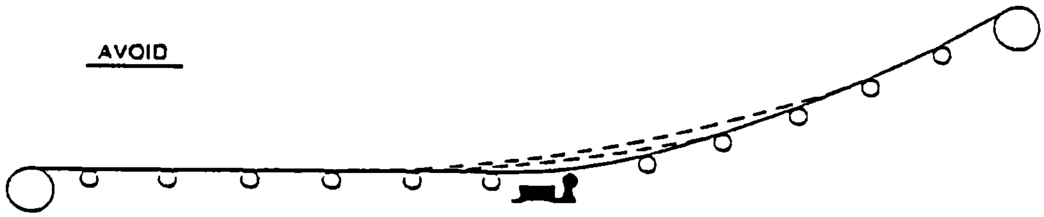


FIG. 3 CONCAVE OR "UPTURNED" CONVEYOR

2.5.1 The "upturned" conveyor is one of the most difficult conditions encountered in belt scale usage. It is virtually impossible to achieve reasonable accuracy unless the scale can be mounted at least 8 idlers away from belt curvature. CONSULT FACTORY.

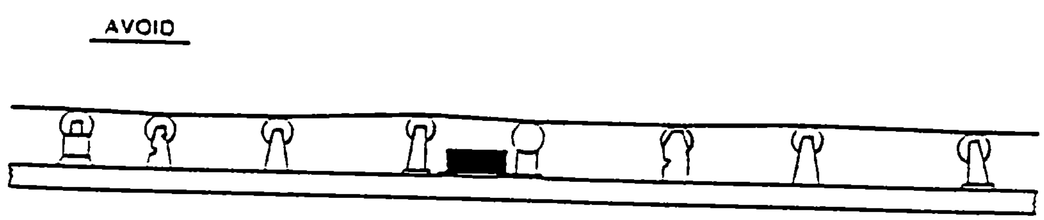


FIG. 4 MISMATCHED OR POORLY ALIGNED IDLERS

2.5.2 All idlers must be identical and in good condition. Often overlooked by users who are unfamiliar with Conveyor scales, poor alignment guarantees poor results. CONSULT FACTORY.

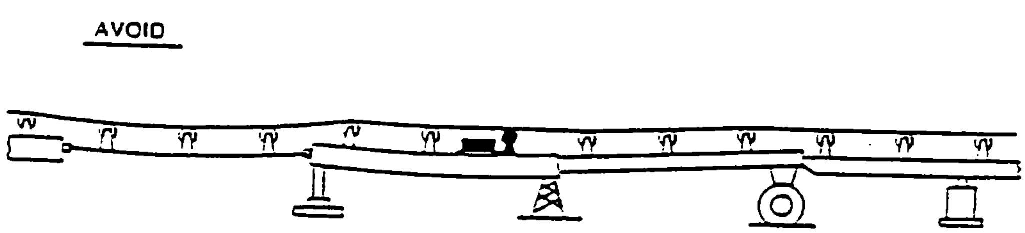


FIG. 5 LACK OF RIGID STABLE CONVEYOR

2.5.3 Good scale performance requires a strong, rigid conveyor. It must not flex or shift under load. "Tire-mounted" conveyors should be "cribbed" or blocked on timbers to avoid "soft" support. No cable-supported conveyors.

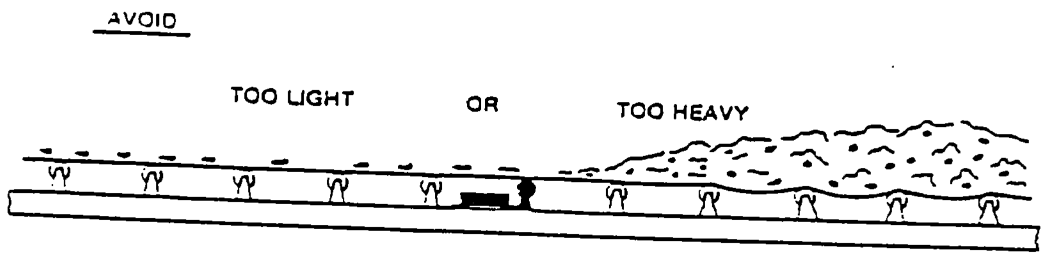


FIG. 6 IMPROPER BELT LOADING

2.5.4 Scale performance is improved by maintaining fairly constant loading. Belt speed may be changed and loading methods used which result in consistent loading in the optimum range of 25-75 Lb/Ft. For very light or heavy loading, CONSULT FACTORY.

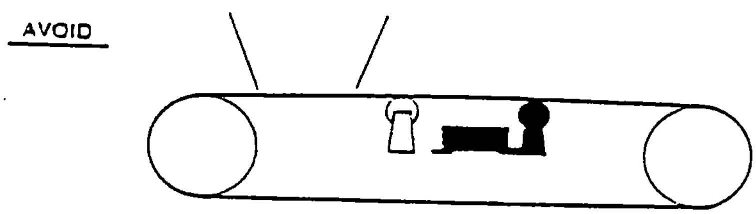


FIG. 7 CONVEYOR TOO SHORT

2.5.5 Three "approach" and three "retreat" idlers should be provided for good scale performance. Don't try to crowd the scale into a short conveyor as poor performance will result.

2.6 HELPFUL HINTS

a) If belt loading is light, use a lighter belt, space the idlers wider, and run the belt slower.
b) Avoid steep troughing angles for best performance.
c) Avoid "limber-rollers", "offset roll" idlers, or "rabbit-ear" (2-roll) idlers.
d) High-tension belts cause extra problems. "Gravity take-ups" are much preferred to provide constant belt tension.
e) Belt "training" is important: the belt must stay in the center of the idler through all levels of loading. Avoid "training" rolls in the area of the scale.
f) Avoid too-steep conveyors: any slippage or "roll-back" of the conveyed material will result in gross errors. Conveyor incline should not exceed 15°.
g) Never allow belt skirting in the area of the scale, or anything which interferes with the free flow of material.
h) "Stacker" conveyors present additional problems. It is quite likely that an AUTO ZERO cycle will have to be completed whenever the stacker is moved. If its angle of inclination is changed, a AUTO SPAN cycle will then be required.
i) Wind screens should be provided for critical applications. Screening should extend above and below the weighing area to shield from sun and precipitation as well.

MECHANICAL INSTALLATION

2.7 Modify the Weigh Idler as shown. IMPORTANT: The idlers used in the scale area must be identical and in good condition. TECWEIGH I (single idler) requires seven identical idlers (including Weigh Idler). TECWEIGH II should include eight matched idlers. TECWEIGH IV ten idlers and a six-idler TECWEIGH should include a total of 12 matched idlers. Poor idlers will yield poor results.

The Weigh Idler(s) must be modified as necessary to provide clearance from the conveyor structure. It is recommended that this modification be done at the factory, where tight tolerances and exact idler placement is achieved. If field modification is required, every effort must be made to attain exact dimensional accuracy.

Many idlers have an arrow to indicate direction of belt travel; be certain it faces correctly. Some idlers have a forward "tilt" to aid belt training. The Weigh Idler *must* be mounted square and vertical; a "tilted" idler will create error forces in the scale.

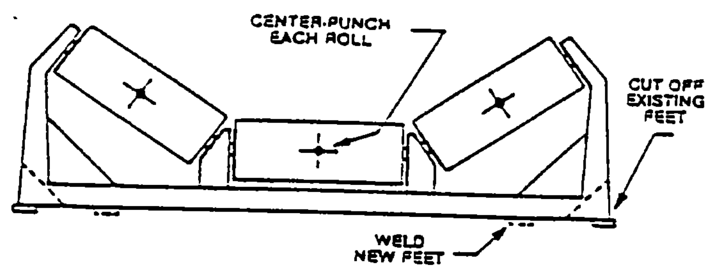


FIG. 8 IDLER MODIFICATION

2.8 Installation of Weigh Idler (Refer to Figures 8 and 9)

The Carriage must be supported on a smooth flat surface during the following alignment procedure:

a) Measure to the exact center of each roll and make a punch mark.
b) Cut off the existing idler feet.
c) Place the idler on the new replacement feet, which are already bolted onto the carriage.
d) The idler is centered on the Carriage, exactly 26 inches on centers from the torque tube. A convenient "bench-mark" is the inside edge of the rear foot on the carriage, which is factory-made on precisely the same center as the torque tube. Use carpenter's squares as shown.
e) Clamp and weld the idler to the new "feet" holding the alignment to within 1/32 inch. Be especially careful to maintain the idler exactly square with the Carriage Assembly.
f) After the idler is welded, recheck all dimensions. If necessary, loosen the four bolts and re-position the idler assembly. Once this alignment is complete, the "feet" should be tack-welded (1/4") to the carriage plates to avoid any chance of movement.
g) Multi-idler TECWEIGH scales are normally supplied with factory-modified idlers. The same procedures apply, should it be necessary to install or replace idlers on a TECWEIGH II or other multi-idler unit. It is essential to maintain uniform idler spacing as well, on multi-idler scales.

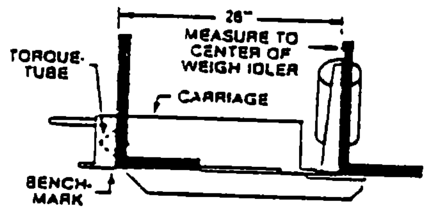


FIG. 9 LOCATING WEIGH IDLER ON CARRIAGE

2.9 Determine the Weigh-Span, or spacing between idlers. It is desirable to set up a scale to provide substantial loading on the Weigh Idler (without overloading). By varying belt speed and/or Weigh-Span, the average and peak loading can be chosen to match the desired range. Loading limits are set out in the chart below; it is always better to work near the center of the ranges.

TECWEIGH STYLE AND WIDTH	MAXIMUM LOAD PER IDLER	MINIMUM LOAD PER IDLER	PREFERRED LOAD PER IDLER
TECWEIGH I (18" - 30")	200 Lb. (peak)	30 Lb. (average)	75-100 Lb. (average)
TECWEIGH I (36" - 48")	300 Lb. (peak)	40 Lb. (average)	100-250 Lb. (average)
TECWEIGH II, IV, VI (18" - 30")	300 Lb. (peak)	30 Lb. (average)	100-200 Lb. (average)
TECWEIGH II, IV, VI (36" - 48")	400 Lb. (peak)	40 Lb. (average)	150-250 Lb. (average)
TECWEIGH II, IV, VI (60" - 72")	600 Lb. (peak)	50 Lb. (average)	200-400 Lb. (average)

Using the chart above, choose the appropriate Weigh-Span and Belt-Speed. It should be obvious that some trade-off is possible, i.e.; heavy loading generally calls for close (36") spacing, while lightly loaded belts should have wider idler spacing of 42", 48", or even 60", depending on belt speed and carrying capacity. Idler spacing must be uniform for all idlers in the weigh section, including three approach and three retreat.

Calculate idler loading as follows:

$$L(\text{Pounds}) = \frac{2.78\,(R)(D)}{(V)}$$

Where:

L = Idler Load (pounds)
R = Feed Rate (TPH)
D = Weigh-Span (inches)
V = Belt Velocity (FPM)

IMPORTANT: It is important that the carriage assembly be located in an area of minimum belt stress or deformation. Generally, that means avoiding the loading area, and the area near the head-pulley. It is preferable that the Weigh Idler be four or five idlers away from the loading area and at least four or five idlers away from the "transition idler" at the head end.

Conveyors shorter than 40 feet usually "crowd" the scale somewhat, and the best rule of thumb is to center the Weigh Idler mid-way between the final "loading idler" and the "transition idler".

Any curvature or "upturn" in the conveyor presents a very serious problem. It is suggested that factory engineers are consulted prior to mounting a scale on such a conveyor.

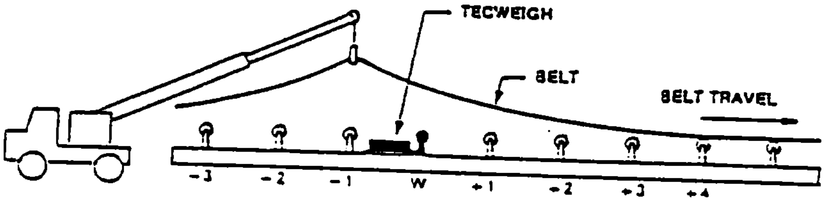


FIG. 10 REMOVE BELT FROM INSTALLATION AREA

2.10 Installing the Carriage Assembly onto the conveyor.

a) It is necessary to raise the belt clear of the idlers in the weigh section. A "cherry picker" is perfect, otherwise it may be necessary to loosen the belt tensioners and block the belt a foot or two above the idlers.

b) Loosen three idlers each side of the scale. (For very short conveyors, it may be necessary to reduce the scale section to two idlers each side. Performance is always improved by aligning longer sections.)

c) Center-punch the center of each roller as shown for the Weigh Idler, Figure 8.

d) Begin the alignment procedure by temporarily placing two 1/8" shims (total 1/4") under the feet of both the +3 and -3 idlers, (one of the 1/8" shims will be removed later).

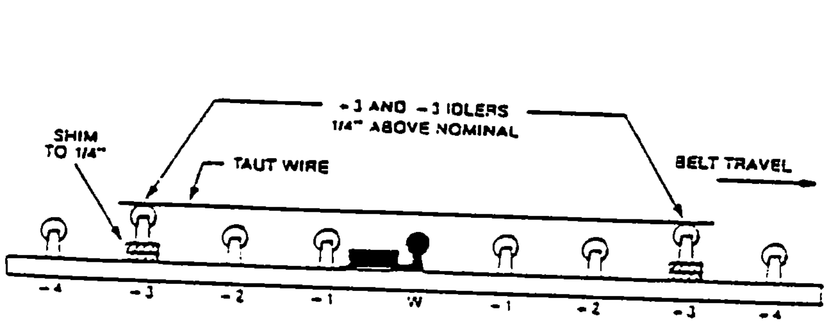


FIG. 11 SHIM +3 AND -3 IDLERS 1/4" HIGH

e) Stretch three wires "banjo-tight" over the punch-marks on the ±3 idlers. Bolt the idlers down exactly six spaces (Weigh-Spans) apart. Example: for 36" Weigh-Span, the ±3 idlers are secured exactly 18 feet center-to-center, and square with the conveyor.

f) Place the Calibration Weight in its cradle, then lower it into its "calibrate" position (handle up). Complete the remaining alignment with the Calibration Weight down, (in the "Calibrate" position).

g) Shim the carriage assembly as required to bring its idler up to 1/16" clearance below the wire. Use a 1/16" shim as a "feeler gauge" to verify the clearance. Be certain that all four carriage feet are firmly supported (without "rocking") and the carriage is square with the conveyor. If all four feet are not at the same height when the carriage is bolted down, twisting of it's metal frame will occur, introducing error into the weighing process. Bolt the carriage securely, aligning it at the exact mid-point between the ±3 idlers.

h) Shim the ±1 idlers to the same 1/16" clearance, using the "feeler gauge" idea described above. Bolt them down lightly, being certain that the Weigh-Span (D) is correct on both sides, and the center punch-marks are aligned on the wire. It should be evident that the Weigh Idler, along with the ±1 idlers, require the greatest care in their positioning (within ±1/32 inch). Careful attention to alignment will yield good accuracy; poor alignment will guarantee poor scale performance.

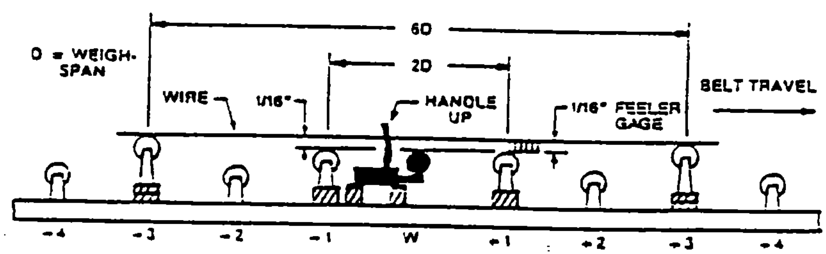


FIG. 12 ALIGNMENT PARTIALLY COMPLETE

i) Shim the remaining idlers as specified above, aligning all punch-marks and bolting everything lightly. Check again after tightening the bolts.

j) After the carriage and all idlers are secured in position, remove one of the 1/8" shims from the ±3 idlers, and re-secure the ±3 idlers in their correct position. This leaves the entire scale section flat between the ±2 idlers, and 1/16" higher than the ±3 idlers.

k) When the carriage and all idlers are correctly secured, a small tack-weld (1/4") should be made to each idler foot, to avoid any possibility of their shifting out of position. On portable conveyors, tack down all idlers to provide extra stability and minimize conveyor twisting.

l) Remove the wires and replace the belt. Run the conveyor and adjust tension until the belt runs true in the center of the idlers. Be certain that all idlers in the scale area turn freely from the pressure of the moving empty belt.

IMPORTANT!!!

IT IS NOT POSSIBLE TO EMPHASIZE STRONGLY ENOUGH THE IMPORTANCE OF PROPER ALIGNMENT. TO RECEIVE THE ACCURACY YOU PAID FOR, AS WELL AS ASSURE YOUR CONTINUING WARRANTY, PUT EXTRA EFFORT INTO ACHIEVING PROPER ALIGNMENT.

2.11 Alignment of multi-idler units (TW II, TW IV, TW VI) follow much the same procedure as described for the TW I scale. Generally, a multi-idler scale is specified because greater accuracy is required, therefore the alignment procedure should be done even more carefully.

Accuracy of multi-idler scales will be improved by supporting the carriage in a symmetrical manner, as shown below. Deflection of the conveyor structure, as well as the scale structure itself, causes the Weigh Idlers to deflect equally. The illustration also shows that additional misalignment error results from an asymmetrical support system.

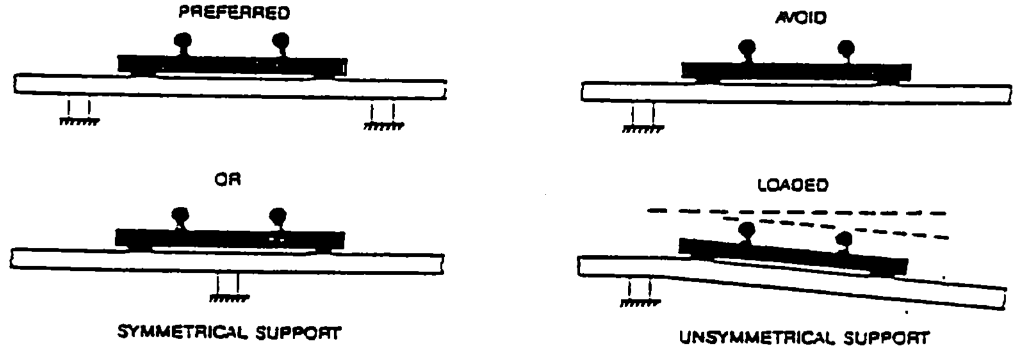


FIG. 13 PLACEMENT OF MULTI-IDLER TECWEIGH

2.12 Stretch wires over the ± 4 idlers as shown, (or ± 3 if inadequate length is available. Longer alignment lengths improve the accuracy!). Use 0.040" music wire, so that very high wire tension (50 Lb) can be used for best alignment.

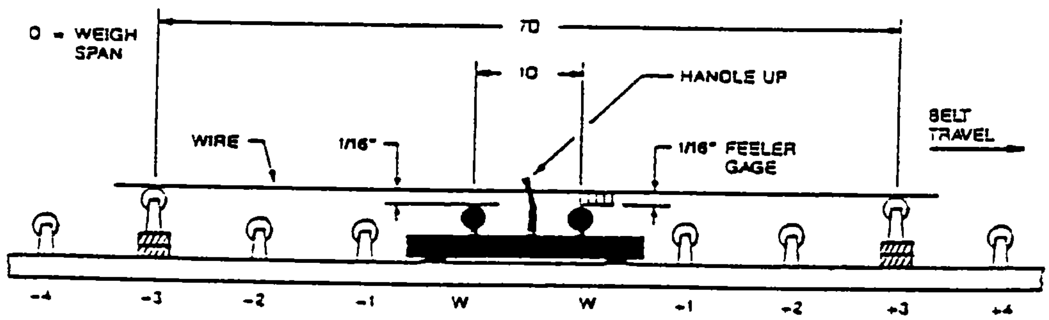


FIG. 14 ALIGNMENT OF DUAL IDLER CARRIAGE

Refer to the procedure described in Section 2.10, and bring all idlers into exact alignment within ±1/32 inch. Be certain that the Calibration Weights are being supported on the scale during this procedure, or otherwise load the scale to its normal operating level. When everything is exactly correct, tack-weld (1/4") the idler and carriage feet to avoid shifting.

Note that the multi-idler TECWEIGH's have center-punched "bench-marks" on the top surface of their side-tubes, to facilitate accurate measurements to their torque tubes and/or Weigh-Idlers.

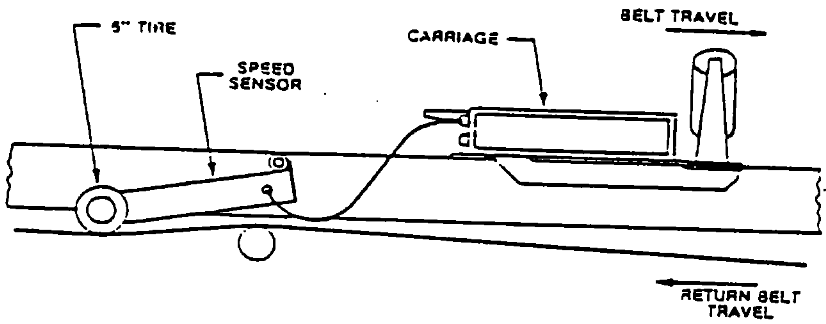


FIG. 15 STANDARD SPEED SENSOR

2.13 Installation of Speed Sensor (Standard "tire" type).

a) The standard Speed Sensor utilizes a single 6" diameter tire which is friction driven by the clean side of the return belt. The unit is generally mounted just behind the scale carriage so that its 10' prewired cable can be easily run into the carriage assembly.

b) The Speed Sensor "floats" on the belt, avoiding rigid couplers, chains and sprockets. It should be placed near (but never directly over) a return roller to run smoothly with minimum bounce or shock.

c) Place a 3/4" steel rod through the pivot tube. Secure the rod between the conveyor stringers so the Speed Sensor is supported as shown. Attach end-checks on the rod to restrain the Sensor near the center of the belt.

d) Run the cable into the carriage assembly using the water-tight fitting supplied. The cable should be secured to avoid contact with the belt or flying debris.

2.14 (Optional) Heavy-Duty Speed Sensor.

a) A 6" full-width drum, along with stronger shaft and bearings, allow the Heavy-Duty Speed Sensor to be loaded more heavily. This is particularly beneficial for very wet or dirty belts or applications requiring ultimate accuracy.

b) Mount the Idler Drum as shown below, obtaining approximately 30° of "wrap". The Drum must be located on the clean side of the belt to avoid caking and build-up. Increase tension and/or wrap until it is impossible to rotate the idler by hand against the stopped belt.

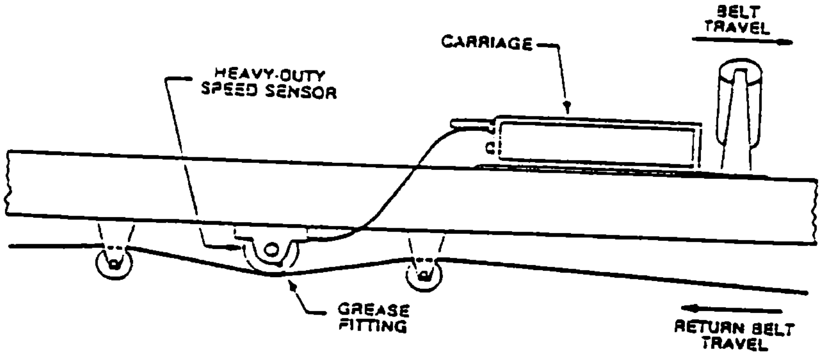


FIG. 16 OPTIONAL HEAVY-DUTY SPEED SENSOR

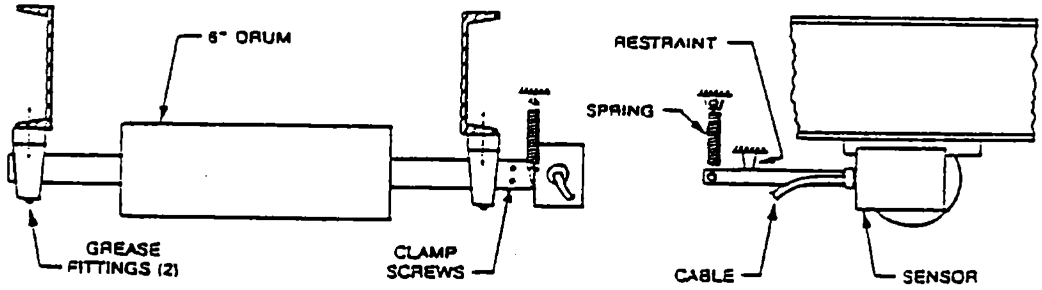


FIG. 17 ATTACH SENSOR ONTO DRUM ASSEMBLY

c) After securing the idler drum as described above, the rotating Speed Sensor is installed as shown. Tighten the clamp screws securely, allowing 1/32" end-clearance. The Sensor "body" floats freely on the shaft: DO NOT restrict the Sensor rigidly, or bearing damage may occur.

d) The Speed Sensor is provided with a coil-spring to restrain it firmly against its stop. DO NOT overlook the need for the restraint or operational problems could result. Use of the "floating" body allows slight misalignment of the Speed Sensor so it is free to "wobble", but its restraint must prevent rotation. DO NOT clamp the Speed Sensor rigidly, it must be free to yield to slight misalignment.

e) Run the prewired cable into the carriage assembly using the water-tight fittings supplied. Secure the cable to avoid contact with the belt or flying debris.

f) Earlier TECWEIGH's were equipped with a shaft-mounted Speed Sensor, usually attached to a "stub" on the Tail-Pulley shaft. As with the Heavy-Duty installation described above, the housing "floats" on its own shaft; the spring-loaded restraint prevents rotation, but permits slight misalignment or "wobble".

g) The Belt Speed indication on the TECWEIGH 20 will compensate for different speed inputs or wheel diameters. See Section 5.11 for further information.

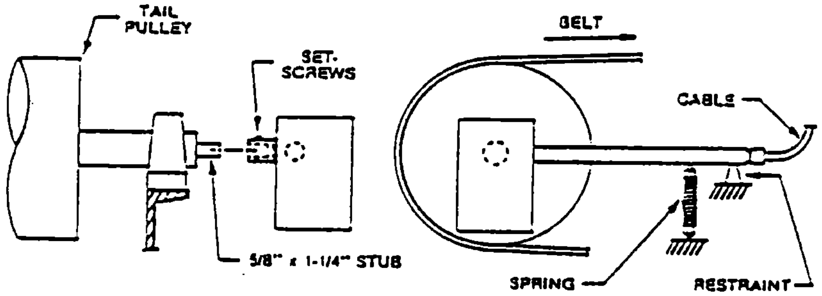


FIG. 18 SHAFT-MOUNTED SPEED SENSOR

WEIGHT PROCESSOR

FUNCTIONAL DESCRIPTION

3.1 The TECWEIGH 20 Weight Processor (WP20) is a microprocessor based integrator that incorporates the latest digital technology. All Zero, Span and Speed computations are performed internally in the microprocessor, which eliminates any linearity or drift problems associated with analog circuitry. Additionally, the WP20 was designed to be a bolt-on replacement for the highly successful first generation WP10. As such, the WP20 can easily be retrofitted to all existing TECWEIGH single, dual and four idler scales as well as all TECWEIGH weigh belt feeders.

3.2 All WP20's are constructed on two coated printed circuit boards, connected together via "locked on" ribbon cable connectors. Components are individually formed and crimp[ed] prior to soldering. High standards of workmanship along with repeated "burn in" a[nd] testing assure the best possible performance and long life.

3.3 The WP20 utilizes low power, high intensity AlGaAs LED Displays. The Rate display is a 4 digit, 1/2" seven segment display. The Total display is an 8 digit, 1/2" seven segment display. The Mode Display is a 16 character, 5 x 7 dot matrix alphanumeric display.

3.4 Although there have been many circuit improvements and functional changes from the original WP10, the new WP20 easily retrofits into any existing Tecnetics scale system.

3.5 A few differences and features are significant:

a) Unlike any earlier models, the WP20 has all automatic calibration, including Auto Zero, Auto Zero Tracking and Auto Span. Other new features include an alphanumeric Mode Display, Full time Self Diagnostics, High/Low Programmable Alarms, Dual Port RS-422 Serial Interface, belt speed calibration and all Front Panel Controls.

b) The WP20 incorporates a Digital Signal Conditioner circuit board, model ET20, inside the Scale Carriage. This circuit board conditions the Speed Sensor and Load Cell signals into a digital format and then transmits to the WP20. The WP20 uses the industry standard RS-422 serial interface to communicate with the Scale Carriage. This allows for distances between units of up to 4000 feet.

c) The Totalizer value and Program Modes of the WP20 are stored internally and will be maintained without the use of battery back-up for 10+ years with no power applied to the WP20. Under normal use, this storage life should approach 20 years.

3.6 The Digital Signal Conditioner located inside the Scale Carriage converts the Speed Senso[r] and LVDT sensor inputs into a digital format. This data, along with "status" and "checksum" information are continuously sampled and stored.

3.7 The WP20 periodically request data from the Signal Conditioner. The WP20 compares the received data to calculated checksum data. If they are not equal, the WP20 will immediately request the data again. This procedure provides 100% error free transmission of signals.

3.8 The WP20 performs digital calculations based upon this data, and then applies the Zero, Span, and Damp settings. These calculated values feed the Rate Display, Total Display, Speed Display and output terminals.

FULL TIME SELF DIAGNOSTICS

3.9 During power up the WP20 will automatically perform diagnostic tests of the electronic circuits and load cell(s). During this test the mode display will read **self test** and, if all systems are functional, immediately advance to the Run Mode, indicated by the Mode display reading **tons per hour**. If a malfunction is found while the WP20 is in operation, the Mode display will identify the error as one of following problems:

- zero belt speed - No belt speed signal available. Indicates a stopped belt or a speed sensor problem.
- low power - Low input power available to WP20. Indicates less than 95 VAC at power input terminals.
- interlock open - Connection between terminal 3 and 10 is open. The WP20's rate and total displays will not function with the interlock jumper removed.
- auto zero error - WP20 cannot achieve zero tons per hour. A load cell(s) is out of alignment and must be adjusted.
- auto span error - Auto span cannot reach target rate. (Target is to high or to low) User set-up parameters are out of range. Consult factory for assistance.
- scale data error - Communication problems between scale and WP20. Indicates a problem with the wiring between the scale carriage and the WP20, an extremely low AC input voltage, a problem with the signal conditioner board in the scale carriage, or a problem with the WP20.
- LVDT error - Improper load cell data. Indicates a load cell is drastically out of adjustment or a defective load cell.

TECWEIGH 20 FRONT PANEL CONTROLS

3.10 MODE - The WP20 incorporates a Mode display to indicate the selected unit of measurement for both RATE and TOTAL. Units of measurement can be displayed in Tons, Tonnes, Pounds or Kilograms. This reduces the possibility of operator confusion.

3.11 RATE DISPLAY - A large 1/2" four digit LED displays the rate of material passing on the conveyor belt. Rate is displayed as a unit of measurement such as Tons per Hour, Pounds per Hour, etc.

3.12 TOTAL DISPLAY - A large 1/2" eight digit LED displays the total weight of material processed since the WP20 was initially installed or reset. When calibrating a scale, the totalized value is placed into memory until the calibration cycle is completed. Therefore, unlike other units, the WP20 TOTAL display indicates only the material processed and excludes any artificial totals caused by calibration procedures.

3.13 AUTO ZERO - Used when it is necessary to fine tune the calibration of the scale while it is running (for example, when product build up on the belt causes a shift in zero). When the AUTO ZERO button is held for 5 seconds, the WP20 assumes that the belt is empty and then automatically zeros the RATE display. During the Auto Zero cycle, while the selected period of time passes (belt revolutions or minutes), the Mode display will read **auto zero (wait)**. Once the Auto Zero cycle is complete the display will return to the preset mode of Tons per Hour, Pounds per Hour, etc. To cancel an auto Zero cycle, just press the RESET button to return to normal control.

3.14 AUTO SPAN - Used for actual scale calibration. After holding the AUTO SPAN button for 5 seconds, the Mode display will direct the operator to lower the calibration weight. Once the calibration weight has been lowered the WP20 will automatically calibrate the scale for a selected period of time (belt revolutions or minutes). After following the directions in the Mode display and finally raising the calibration weight, the Auto Span cycle is complete. To cancel an auto Span cycle, just press the RESET button to return to normal control.

3.15 STOP COUNT - Press and hold the stop count button to stop the totalizer from counting. When the button is released, counting will continue on the totalizer.

3.16 RESET - Used to reset the TOTAL display value. To prevent the accidental resetting of the TOTAL display, the RESET button must be depressed and held for 5 seconds before reset occurs.

3.17 FUNCTION AND SELECT - Holding the FUNCTION button in for five seconds will allow access to the Program Mode. Pushing the FUNCTION button momentarily will toggle between the **tons per hour** display and the **speed:** xxx fpm display.

NOTE: Upon entering the Program Mode the totalizer value is saved and the rate, total, speed and all output terminals are temporally disabled. If material is present on your running belt, it will not be recorded.

3.18 After entering the Program Mode, press the FUNCTION button to move forward through the program functions. Holding the DECREASE button while pressing the FUNCTION button moves backward through the functions.

3.19 When the mode to be changed appears in the Mode display, press the SELECT button to highlight the mode variable to be changed. (Mode variables are indicated by capitol letters or numeric values). The highlighted mode variable will flash on and off. Use the INCREASE or DECREASE buttons to change the highlighted mode variable. Once the new value is entered, either press the FUNCTION button to locate a new mode to change, or hold the FUNCTION button in for five seconds to leave the Program Mode and enter the Run Mode. Note that each mode indicates is current setting and any changes will be stored automatically.

3.20 Once back in the Run Mode, the WP20 will automatically recall the TOTAL value and return to normal operation. The Mode display will return to **tons per hour**.

3.21 AFTER entering the Program Mode, the Mode display will read either **simulation:** OFF or **code:** 000000. If the Mode display reads **code:** 000000, the 6 digit lock code number must be entered before advancing to any of the program modes. Entering the proper code will then allow access to the Program Mode.

The following is a complete description of each of the functional program menu options available within the WP20:

1). **simulation** - Produces a simulated rate, speed and total as if material were being run over the conveyor scale. Signal wires to carriage need not be attached. Used during calibration of optional equipment such as chart recorders, PLC's, feed rate controllers, remote displays, etc. When **simulation:** ON, the **rate zero** and **rate span** settings are automatically stored into memory and will be automatically recalled when **simulation:** OFF is set or by exiting the Program Mode.

Variables: ON = Simulated rate, speed, total
OFF = Normal Run Mode.

2). **unit** - Selects the units of measurement: tons, tonnes, pounds or kilograms. When changing from an English unit (tons or pounds) to a Metric unit (tonnes or kilograms) the calibration weight, calibration chain, weigh span, belt length and the speed display will automatically be converted to metric, and will be automatically converted back to English if an English unit is later selected. After selecting a new unit, an Auto Span cycle must be completed to calibrate the scale to the selected unit of measurement.

Variables:

	TONS/HR	= tons per hour (English)
	TONS/MIN	= tons per minute (English)
	PPH x 1000	= lbs per hour x 1000 (English)
	LBS/HR	= lbs per hour (English)
	LBS/MIN	= lbs per minute (English)
	TONNES/HR	= tonnes per hour (Metric)
	TONNES/MIN	= tonnes per minute (Metric)
	KG/HR	= kilograms per hour (Metric)
	KG/MIN	= kilograms per minute (Metric)

3). **cal factor** - Sets the Auto Span calibration factor for various models. If a calibration chain is being used the cal factor should be set to .03 regardless of the scale model.

Variables:
- .01 for WF11 weigh feeders
- .02 for WF10 weigh feeders
- .03 for any scale model when a calibration chain is being used.
- .27 for WY10, WY20 or WY40
- .36 for WF4 or WF18 weigh feeders
- .54 for WY10 heavy duty or WY11

4). **cal wt** - Used to enter the exact weight of the calibration weight. Entered in pounds when ENGLISH units are selected, 000.00 to 999.99 pounds, or entered in kilograms when METRIC units are selected, 000.00 to 453.59 kilograms. (see mode 2). This setting is critical to the accuracy of the Auto Span function.

5). **cal chain** - Used to enter the weight of the calibration chain. Entered in pounds per foot when ENGLISH units are selected, 000.00 to 999.99 pounds per foot, or entered in kilograms per meter when METRIC units are selected, 000.00 to 148.79 kilograms per meter. (see mode 2). This setting is critical to the accuracy of the Auto Span function.

6).* **weigh spn** - The exact on-center distance between first advance to first retreat idler from the scale carriage, divided by two (weigh span). Entered in inches when ENGLISH units are selected, 00.00 to 99.99 inches or entered in meters when METRIC units are selected, 0.000 to 2.539 meters. (see mode 2). This measurement is critical to the accuracy of the Auto Span function.

7).* **belt len** - Used to enter the exact length of the conveyor belt. Entered in feet when ENGLISH units are selected, 0000.00 to 9999.99 feet, or entered in meters when a METRIC unit is selected, 0000.00 to 3047.99 meters. (see mode 2). This setting may directly reflect the timing source of the Auto Zero or Auto Span functions.

8). **asc fact** - For entry of the auto span control factor, 0.5000 to 1.5000. Used to adjust the Auto Span function so the scale system can be calibrated to agree with a platform scale or any other type of scale. To determine the Auto Span Control Factor, complete the following formula: Other Scale weight ÷ TECWEIGH weight x Auto Span Control Factor = new Auto Span Control Factor.

* Parameters that are not preset at the factory. They must be accurately entered by the customer before the initial calibration of the scale system.

9). **azt** - Used to enter the Auto Zero Tracking set-point, 00 to 99 tons per hour. Auto Zero Tracking watches the weight of the conveyor belt when empty, and automatically adjusts the **rate zero** setting to compensate for any changes in belt weight due to moisture, material build-up, etc. When the RATE display falls below the AZT preset value, the microprocessor will begin to track for the preselected time interval (belt revolutions or minutes), and the mode display will read **zero tracking**. After a successful zero tracking cycle, the AUTO ZERO mode will then begin and mode display will read **auto zero (wait)**, which will zero the RATE display. If at any time during an Auto Zero Tracking cycle the RATE display exceeds the AZT set point value, the Auto Zero Tracking cycle will be canceled and no adjustments would have been made to the **rate zero** setting. Setting AZT to 00 will disable Auto Zero Tracking.

NOTE: Do not set the AZT level above your lowest normal material flow rate. This may allow the WP20 to zero the belt with material still on it. If very low feed rates or occasional material trickle are present in your process, do not use AZT.

10). **track on REVS/MINS** - Selects the zero tracking timing source. When set to REVS the zero tracking source will be timed on belt revolutions. The belt length setting and the indicated speed will then be critical to the duration of the **zero tracking** cycle. (see mode 11). When set to MINS, the WP20 will ignore the belt length setting and indicated speed, and the **zero tracking** cycle will be timed on actual minutes. (see mode 12).

Variables: REVS - Zero Tracking is timed on belt revolutions
MINS - Zero Tracking is timed on actual minutes

11). **track on xx revs** - Used to enter the number of belt revolutions (01 to 99) to be used during a **zero tracking** cycle. If the operator chooses to track on belt revolutions, a value should be entered that will allow for a 5 to 6 minute **zero tracking** cycle, which will allow time for the conveyor belt to completely empty and relax into place before the Auto Zero cycle begins.

12). **track on xx mins** - Used to enter the number of minutes (01 to 99) to be used during a **zero tracking** cycle. A setting of 5 or 6 minutes will allow the conveyor belt to completely empty and relax into place before the Auto Zero cycle begins.

13). **zero on REVS/MINS** - Selects the Auto Zero timing source. When set to REVS the Auto Zero cycle will be timed on belt revolutions. (see mode 14). The belt length setting and the indicated speed will then be critical to the duration of the Auto Zero cycle. When set to MINS the WP20 will ignore the belt length setting and indicated speed, and the Auto Zero cycle will be timed on actual minutes. (see mode 15).

Variables: REVS - Auto Zero is timed on belt revolutions
MINS - Auto Zero is timed on actual minutes

14). **zero on xx revs** - Used to enter the number of belt revolutions (01 to 99) to be used during a Auto Zero cycle. A setting of 2 or 3 belt revolutions is recommended which will allow the WP20 to store enough data for an accurate zero adjustment.

15). **zero on xx mins** - Used to enter the number of minutes (01 to 99) to be used during a Auto Zero cycle. If the operator chooses to zero on minutes, a value should be entered that will allow for 2 or 3 belt revolutions to pass during the Auto Zero cycle. This will allow the WP20 to store enough data for an accurate zero adjustment.

16). **span on REVS/MINS** - Selects the Auto Span timing source. When set to REVS the Auto Span cycle will be timed on belt revolutions. (see mode 17). The belt length setting and the indicated speed will then be critical to the duration of the Auto Span cycle. When set to MINS the WP20 will ignore the belt length setting, and the Auto Span cycle will be timed on actual minutes. (see mode 18)

Variables: REVS - Auto Span is timed on belt revolutions
MINS - Auto Span is timed on actual minutes

17). **span on xx revs** - Used to enter the number of belt revolutions (01 to 99) to be used during a Auto Span cycle. If the operator chooses to span on belt revolutions, a value should be entered that will allow for a 5 or 6 minute Auto Span cycle. This will allow the WP20 to store enough data for an accurate span adjustment.

18). **span on xx mins** - Used to enter the number of minutes (01 to 99) to be used during a Auto Span cycle. A setting of 6 minutes is recommended which will allow the microprocessor to store enough data for an accurate span adjustment.

19). **rate dp** - Sets the RATE display decimal point. Set to ONES when the maximum operating rate is greater than 100, set to TENS when the maximum operating rate is less than 100 and set to HUNDS when the maximum operating rate is less than 10. An Auto Span cycle must be completed after selecting a new rate decimal point.

Variables: ONES = xxxx
TENS = xxx.x
HUNDS = xx.xx

20). **rate damp** - Enters the RATE damping factor in seconds of Averaging (01 to 99). A higher setting allows for a more stable RATE display reading. Rate damping does not effect the TOTAL. Press the STOP COUNT button to view actual rate.

21). **rate zero** - This is the manual adjustment (-4999 to +4999) that is used to zero the RATE display. The Auto Zero function will automatically adjust the **rate zero** setting. This mode is most useful during LVDT alignment. Press the STOP COUNT button to view actual rate.

NOTE: Any manual adjustment made to the **rate zero** function will be over-written by the AUTO ZERO cycle, as required. This mode should only be used while balancing the LVDT sensors.

22). **rate span** - This is the manual adjustment (00000 to 99999) that is used to manually calibrate the scale system. This mode is most useful during the **simulation: ON** mode while calibrating optional equipment. Press the STOP COUNT button to view actual rate.

NOTE: Any manual adjustment made to the **rate span** function will be over-written by the AUTO SPAN cycle, as required. This mode should only be used while calibrating WP20 outputs for remote equipment.

23). **speed dp** - Selects the SPEED display decimal point. After selecting a new SPEED display decimal point, the speed display must then be recalibrated to agree to actual conveyor belt speed, then an auto Span cycle is required to calibrate the scale to the new indicated belt speed. Press the STOP COUNT button to view the speed display.

Variables: ONES = xxxx
TENS = xxx.x
HUNDS = xx.xx

24). **speed damp** - Used to enter the SPEED damping factor in seconds (01 to 99). A higher setting allows for a more stable SPEED display reading. Speed damping does not effect the TOTAL but does effect how fast the RATE display, m/amp output and HFR output will respond to changes in belt speed. Press the STOP COUNT button to view the speed display.

25). **speed spn** - Used to calibrate the SPEED display to agree with actual conveyor belt speed. The indicated speed value is critical to Auto Span, any changes to the **speed spn** value will then require an Auto Span cycle to calibrate the scale to the new indicated belt speed. Press the STOP COUNT button to view the speed display.

26). **m/amp damp** - Enters the milliamp damping factor in seconds (01 to 99) of averaging. A higher setting will provide for a more stable milliamp output signal.

27). **m/amp zero** - This mode will adjust the 4 milliamp output at terminal 39. The **m/amp zero** setting (0000 to 9999) does not represent actual current. Increasing the **m/amp zero** setting will increase the current at terminal 39 and decreasing the setting will decrease the current.

28). **m/amp spn** - Used to calibrate the 0 - 16 milliamp output signal terminal 32. The **m/amp spn** setting (00000 to 99999) does not represent actual current. Increasing the **m/amp spn** setting will increase the current at terminal 32 and decreasing the setting will decrease the current.

29). **hfr damp** - Enters the High Frequency Rate damping factor (01 to 99) in seconds of averaging. A higher setting will provide for a more stable rate output at terminal 4.

30). **hfr span** - Calibrates the High Frequency Rate output at terminal 4 to agree with the RATE display. The **hfr spn** setting (00000 to 99999) does not represent actual frequency. A higher **hfr span** setting will yield more pulses per second.

31). **total dp** - Selects the TOTAL display decimal point.

Variables:
- ONES = xxxxxxxx
- TENS = xxxxxxx.x
- HUNDS = xxxxxx.xx
- THOUS = xxxxx.xxx

NOTE: To select a TOTAL decimal point of THOUS, the rate decimal point must equal TENS or HUNDS.

32). **down count** - This mode will enable or disable down counting of the TOTAL display. When set to **down count** NO the totalizer will not count down (backwards) when the RATE display is indicating negative.

Variables:
- YES = enables down counting.
- NO = disables down counting.

33). **rly 1 func** - Selects the function that Relay 1 will perform when ENABLED. (see mode 34 and 35).

Variables:

TPR	- Total Pulse Repeater.	(see modes 36 and 37)
LRA	- Low Rate Alarm.	(see modes 38 and 40)
HRA	- High Rate Alarm.	(see modes 39 and 40)
HLRA	- High/Low Rate Alarm.	(see modes 38, 39 and 40)
LSA	- Low Speed Alarm.	(see modes 38 and 40)
HSA	- High Speed Alarm.	(see modes 39 and 40)
HLSA	- High/Low Speed Alarm.	(see modes 38, 39 and 40)
SPAN	- AUTO SPAN lower and raise calibration weight output.	

34). **rly 1: ENABLE/DISABLE** - Used to enable or disable the outputs at terminals 16 and 17. If this mode is set to rly 1:ENABLED then terminals 16 and 17 may be used for the selected function. When set to rly 1: DISABLED terminals 16 and 17 will remain in their selected logic state, opened or closed.

Variables: ENABLED = relay 1 enabled.
DISABLED = relay 1 disabled.

35). **rly 1 logic: N.O/N.C** - This mode will select the logic of the outputs at terminals 16 and 17. When set to **rly 1 logic: N.O** the contact at terminals 16 and 17 will remain open until the selected function is true. The exact opposite will be true when set to **rly 1 logic: N.C**

Variables: N.O = normally open contacts.
N.C = normally closed contacts.

36). **rly 1 pulse: xx** - Selects the totalizer pulse durations at terminals 16 and 17. The pulse duration in seconds (.01 to .99) will determine the maximum pulses per second. For example, when set to **rly 1 pulse: .10** each totalizer pulse will last one tenth second, which will allow for 9 pulses per second before the pulses run together. To prevent this condition from happening either reduce the pulse durations or select the next most significant totalizer digit to pulse on.

37). **rly 1 ts: xxxxxx** - When using the TPR function, this mode will select the scaling factor (000001 to 999999) for the relay output at terminals 16 and 17. For example: when set to **rly 1 ts: 000010** a pulse will occur at terminals 16 and 17 for every ten counts on the TOTAL display.

38). **rly 1 low: xxxx** - Low alarm setpoint (0000 to 9999) for Rate or Speed alarms. If Rate or Speed decimal place has been set, it may be reflected in this setpoint as well. Low Rate and Speed alarms are activated by choosing the correct function of mode 33 and by setting mode 34 to ENABLE.

39). **rly 1 hgh: xxxx** - High alarm setpoint (0000 to 9999) for Rate or Speed alarms. If Rate or Speed decimal place has been set, it may be reflected in this setpoint as well. High Rate and Speed alarms are activated by choosing the correct function of mode 33 and by setting mode 34 to ENABLE

40). **rly 1 delay: xx** - Delay in seconds (00 to 99) before the relay contact will actuate after the selected alarm function is true. For example, if a low rate alarm (LRA) of 0050 TPH is set, but the alarm shouldn't go off until it has been under 50 TPH for 10 seconds, set **rly 1 delay: 10.**

41). **rly 2 func:** - Selects the function that Relay 2 will perform when ENABLED. (see mode 42 and 43).

Variables:

TPR	- Total Pulse Repeater.	(see modes 44 and 45)
LRA	- Low Rate Alarm.	(see modes 46 and 48)
HRA	- High Rate Alarm.	(see modes 47 and 48)
HLRA	- High/Low Rate Alarm.	(see modes 46, 47 and 48)
LSA	- Low Speed Alarm.	(see modes 46 and 48)
HSA	- High Speed Alarm.	(see modes 47 and 48)
HLSA	- High/Low Speed Alarm.	(see modes 46, 47 and 48)
SPAN	- AUTO SPAN lower and raise calibration weight output.	

42). **rly 2: ENABLE/DISABLE** - Used to enable or disable the outputs at terminals 18 and 19. If this mode is set to **rly 2: ENABLED** then terminals 18 and 19 may be used for the selected output. When set to **rly 2: DISABLED** terminals 18 and 19 will remain in their selected logic state, opened or closed.

Variables: ENABLED = relay 2 enabled
DISABLED = relay 2 disabled

43). **rly 2 logic: N.O/N.C** - This mode will select the logic of the outputs at terminals 18 and 19. When set to **rly 2 logic: N.O** the contact at terminals 18 and 19 will remain open until the selected function is true. The exact opposite will be true when set to **rly 2 logic: N.C**

Variables: N.O = normally open contacts.
N.C = normally closed contacts.

44). **rly 2 pulse: xx** - Selects the totalizer pulse durations at terminals 18 and 19. The pulse duration in seconds (.01 to .99) will determine the maximum pulses per second. For example, when set to **rly 2 pulse: .10** each totalizer pulse will last one tenth second, which will allow for 9 pulses per second before the pulses run together. To prevent this condition from happening either reduce the pulse durations or select the next most significant totalizer digit to pulse on.

45). **rly 2 ts: xxxxxx** - When using the TPR function, this mode will select the scaling factor (000001 to 999999) for the relay output at terminals 18 and 19. For example: when set to **rly 2 ts: 000010** a pulse will occur at terminals 18 and 19 for every ten counts on the TOTAL display.

46). **rly 2 low: xxxx** - Low alarm setpoint (0000 to 9999) for Rate or Speed alarms. If Rate or Speed decimal place has been set, it may be reflected in this setpoint as well. Low Rate and Speed alarms are activated by choosing the correct function of mode 41 and by setting mode 42 to ENABLE.

47). **rly 2 hgh: xxxx** - High alarm setpoint (0000 to 9999) for Rate or Speed alarms. If Rate or Speed decimal place has been set, it may be reflected in this setpoint as well. High Rate and Speed alarms are activated by choosing the correct function of mode 41 and by setting mode 42 to ENABLE.

48). **rly 2 delay: xx** - Delay in seconds (00 to 99) before the relay contact will actuate after the selected alarm function is true. For example, if a high rate alarm (HRA) of 0300 TPH is set, but the alarm shouldn't go off until it has been over 300 TPH for 30 seconds, set **rly 2 delay: 30.**

49). **view serial: YES/NO** - This mode is used only to allow access to the serial interface set up modes. When set to **view serial: NO** the serial interface set up modes will not appear in the mode display. When set to **view serial: YES** all of the serial interface set up modes will be accessible to the user.

Variables: NO = Serial modes are not accessible
YES = Serial modes are accessible

50). **station ID: A thru P** - Selects the WP20 station identifier for both Port A and Port B. The WP20 will only respond to commands that have the corresponding Station I.D. character. If the received command requests data to be transmitted, then the selected Station ID character will also be transmitted along with the requested data.

51). Port A par: NONE/ODD/EVEN - This mode will select the parity type for serial Port A transmitter and receiver.

Variables:
NONE = No Parity.
ODD = Parity type is odd.
EVEN = Parity type is even.

52). txa baud: - This function will select the baud rate for which the Port A transmitter will operate on.

Variables:
300 = 300 baud
600 = 600 baud
1200 = 1200 baud
2400 = 2400 baud
4800 = 4800 baud
9600 = 9600 baud
19.2k = 19.2K baud

53). txa menu: 00 to 19 - This mode will select the data to automatically transmit out of Port A. When set to txa menu: 00, data will only be transmitted upon request from the host. When the txa menu is set to other than zero (01 - 19), the selected menu option below will determine the data to be automatically transmitted every tenth second, and all external data requests will be ignored.

Variables:
00 = no command, data requests active.
01 = transmit rate.
02 = transmit total.
03 = transmit speed.
04 = transmit rate and total.
05 = transmit rate and speed.
06 = transmit average rate.
07 = transmit average speed.
08 = transmit average rate and total.
09 = transmit average rate and average speed.
10 = transmit status byte.
11 = transmit rate and status byte.
12 = transmit total and status byte.
13 = transmit speed and status byte.
14 = transmit rate, status byte and total.
15 = transmit rate, status byte and speed.
16 = transmit average rate and status byte.
17 = transmit average speed and status byte.
18 = transmit average rate, status byte and total.
19 = transmit average rate, status byte and average speed.

54). rxa baud: - This function will select the baud rate for which the Port A receiver will operate on.

Variables:
300 = 300 baud
600 = 600 baud
1200 = 1200 baud
2400 = 2400 baud
4800 = 4800 baud
9600 = 9600 baud
19.2k = 19.2K baud

55). Port B par: NONE/ODD/EVEN - This mode will select the parity type for serial Port B transmitter and receiver.

Variables:
- NONE = No Parity.
- ODD = Parity type is odd.
- EVEN = Parity type is even.

56). **txb baud:** - This function will select the baud rate for which the Port B transmitter will operate on.

Variables:
- 300 = 300 baud
- 600 = 600 baud
- 1200 = 1200 baud
- 2400 = 2400 baud
- 4800 = 4800 baud
- 9600 = 9600 baud
- 19.2k = 19.2K baud

57). **txb menu: 00 to 19** - This mode will select the data to automatically transmit out of Port B. When set to **txb menu: 00**, data will only be transmitted upon request from the host. When the **txb menu** is set to other than zero (01 - 19), the selected menu option below will determine the data to be automatically transmitted every tenth second, and external data requests will be ignored.

Variables:
- 00 = no command, data requests active.
- 01 = transmit rate.
- 02 = transmit total.
- 03 = transmit speed.
- 04 = transmit rate and total.
- 05 = transmit rate and speed.
- 06 = transmit average rate.
- 07 = transmit average speed.
- 08 = transmit average rate and total.
- 09 = transmit average rate and average speed.
- 10 = transmit status byte.
- 11 = transmit rate and status byte.
- 12 = transmit total and status byte.
- 13 = transmit speed and status byte.
- 14 = transmit rate, status byte and total.
- 15 = transmit rate, status byte and speed.
- 16 = transmit average rate and status byte.
- 17 = transmit average speed and status byte.
- 18 = transmit average rate, status byte and total.
- 19 = transmit average rate, status byte and average speed.

58). **rxb baud:** - This function will select the baud rate for which the Port B receiver will operate on.

Variables:
- 300 = 300 baud
- 600 = 600 baud
- 1200 = 1200 baud
- 2400 = 2400 baud
- 4800 = 4800 baud
- 9600 = 9600 baud
- 19.2k = 19.2K baud

59). **lock auto zero:** YES/NO - This mode is used to lock out the AUTO ZERO button. When set to: **lock auto zero:** YES, then the AUTO ZERO button will be locked, manual entrance to the Auto Zero cycle will be disabled. Locking the AUTO ZERO button does not disable Auto Zero Tracking.

Variables: YES = AUTO ZERO button locked.
NO = AUTO ZERO button unlocked.

60). **lock auto span:** YES/NO - This mode is used to lock out the AUTO SPAN button. When set to: **lock auto span:** YES, then the AUTO SPAN button will be locked, entrance to Auto Span cycle will be disabled.

Variables: YES = AUTO SPAN button locked.
NO = AUTO SPAN button unlocked.

61). **lck stp cnt:** YES/NO - This mode is used to lock out the STOP COUNT button. When set to: **lck stp cnt:** YES, then the STOP COUNT button will be locked.

Variables: YES = STOP COUNT button locked.
NO = STOP COUNT button unlocked.

62). **lock reset:** YES/NO - This mode is used to lock out the RESET button. When set to: **lock reset:** YES, then the reset button will be locked and totalizer reset will be disabled.

Variables: YES = RESET button locked.
NO = RESET button unlocked.

To reset the TOTAL display when the RESET button is locked:

1. Hold the FUNCTION button 5 seconds to enter the Program Mode.
2. Locate the **lock reset** mode and set it to **lock reset:** NO.
3. Hold the FUNCTION button 5 seconds to return to normal Run Mode.
4. Hold the RESET button 5 seconds to reset the TOTAL display.
5. Hold the FUNCTION button 5 seconds to return to the Program Mode.
6. Locate the **lock reset** mode and set it to **lock reset:** YES.
7. Hold the FUNCTION button 5 seconds to return to normal Run Mode.

63). **lck code** - This mode is used to enter the Program Mode lock code, (000000 to 999999), which will disable access to all of the Program Mode set up parameters. If a lock code is entered other than zero, then that same number will have to be entered upon entrance into the Program Mode. The Mode display will read **code: 000000**. If the correct lock code is not entered within 25 seconds the WP20 will then automatically return to normal Run Mode. (Pressing the INCREASE or DECREASE buttons will reset the 25 second timer). A Lock Code setting of 000000 will disable the Program Mode lock out, allowing complete use of the WP20 without any code entry.

If a Lock Code is entered and cannot be remembered, no program changes will be possible. If any buttons have been locked out, they will remain unusable. Write the Lock Code down and keep it in a safe place. Verify the Lock Code number BEFORE leaving the Program Mode.

WIRING

INSTALLING THE TECWEIGH 20 WEIGHT PROCESSOR

4.1 Select a dry, reasonably clean area, free of severe heat and vibration. Avoid areas of bright sunlight since the displays may be difficult to read.

NOTE: Where outdoor installation is necessary, the WP20 should be mounted under a "roof" or "dog house" to provide rain or snow protection as well as shade against the sun. Wire only into the bottom of the enclosure to avoid leakage from top or side mounted cable entrances. Allow room for the enclosure door to swing out.

4.2 While the WP20 may be located up to 4000 feet from the Scale Carriage, keep in mind that the calibration requires access to both units. Remote indicators may be the preferred way to display at great distances, even though the WP20 is mounted near the Scale Carriage.

4.3 Many permanent installations require "hard" conduit to comply with local codes. Functionally, the signal levels from the scale carriage to the WP20 are compatible with open cabling. If conduit is to be installed, the printed circuit boards should be removed from their enclosures to avoid damage during the installation. In either case, it is essential that water-tight fittings be used to avoid moisture or other contamination inside the enclosures.

4.4 It is sometimes desirable to install cabling via quick-disconnects. In those cases, use high quality military-style connectors for weather protection. It is essential that the shields are wired through the connector as well as the signal wires. Tecnetics stocks all the necessary connectors for your application. Contact the factory for more details.

4.5 Speed Sensor wiring need not be run in conduit except where adjacent to high-voltage lines. The Speed Sensor is prewired with 10 feet of cable, usually enough to wire directly into the Scale Carriage.

4.6 If it is necessary to make longer runs from the Speed Sensor, splice using an 18 gauge or larger twisted wire pair shielded cable, typically Beldon 8760. The Speed Sensor is wired only to the Scale Carriage. The insulated shield wire should be connected to terminal S of the carriage circuit board.

4.7 Scale Carriage wiring includes the Speed Sensor input cable and the signal wires to the WP20. The signal wires are a 18 gauge, 4 conductor shielded cable, typically Beldon 9418.

NOTE: The 1/2" NPT holes in the Scale Carriage are intended to be used with weather-tight compression fittings. Severe damage can result if these holes are left open to contamination or moisture entrance.

4.8 The WP20 wiring includes the 4 conductor shielded signal cable, AC power input, and an optional remote equipment. Wires should be pulled only into the bottom to avoid moisture problems. To prevent possible shorts to terminals or to the printed circuit boards, avoid wire "pile ups" and insulate all shields.

4.9 Twenty five feet of signal cable is provided with each TECWEIGH Conveyor Scale. Extra cable is available from stock, Beldon 9418. Maximum rated distance is 4000 feet between the Scale Carriage and the WP20.

TERMINAL STRIP WIRING CODES

4.10 Terminals H, N: 115 VAC:
These are the 115 VAC input power terminals. The WP20's input power may range from 95 VAC to 140 VAC

4.11 Terminals 16-17, 18-19: RLY 1, RLY 2:
Relay contact outputs. The relay outputs require any 2 conductor 16 gauge cable. Do not wire the relay outputs into high power devices as they are rated at 50VA max, pilot duty only. Inductive loads require contact suppression. Used with remote totalizers, ticket printers, load controllers and PLC's. May also be used for high/low rate, speed and positive flow alarm outputs.

4.12 Terminal 28: 28V:
28vdc output. 50ma maximum. Requires 18 gauge 2 conductor shielded cable, typically Beldon 8760. Used as power for optional TECWEIGH remote equipment, such as load controllers, rate/total displays, etc.

4.13 Terminals 32-39: M/AMP output:
4-20 milliamp Rate output signal. Requires 18 gauge 2 conductor shielded cable, typically Beldon 8760. Provides a linear DC current source to feed chart recorders, process controllers, PLC's, etc. The output at terminal 32 follows the indicated RATE display. Either a 0-20ma or 4-20ma signal may be generated. Terminal 39 supplies a constant 4ma output. Adjustable damping, (averaging), can be applied to smooth out rapid changes in current.

4.14 Terminal 4: HFR output:
High Frequency Rate output signal. Requires 18 gauge 2 conductor shielded cable, typically Beldon 8760. Normally delivers displayed RATE x 10 pulses per second, 5vdc pulses, 11 microseconds in duration. Used with remote rate meters and PLC's.

4.15 Terminal 1: RST input:
Remote Totalizer Reset input terminal. Requires 18 gauge 2 conductor shielded cable, typically Beldon 8760. Will reset the totalizer when momentarily connected to common, terminal 10.

4.16 Terminal 2: POL output:
HFR polarity output signal. Requires 18 gauge 2 conductor shielded cable, typically Beldon 8760. Used with remote counters and PLC's to detect negative high frequency rate output, indicating a negative RATE.

4.17 Terminal 3: INT input:
Interlock input terminal. Factory jumper to terminal 10. Otherwise use 18 gauge 2 conductor shielded cable, typically Beldon 8760. Used to disable both the rate and total displays.

4.18 Terminals 90-93, 94-97: PORT A, PORT B:
Serial Interface inputs/outputs. Half Duplex communications use 18 gauge 2 conductor shielded cable, typically Beldon 8760. Full Duplex communications use 18 gauge 4 conductor shielded cable, typically Beldon 9418. Used with PC's and PLC's to gather rate and total data from the WP20 using standard RS-422 communications. Remote calibration of the WP20 may also be accomplished via these ports.

4.19 Terminals 10, 20, 22, 29, S: SCALE INPUT:
Scale carriage signal inputs. Communication between the scale carriage and WP20 is accomplished using the industry standard RS-422 protocol. Terminal 10 is signal common, Terminal 29 is DC voltage (approximately 24vdc) to power carriage-based signal conditioner and terminals 20 and 22 are RS-422 digital communications. Scale carriage may be located up to 4000' away from WP20.

WARNING: Terminal 10 at the WP20 and the Signal Conditioner should under no circumstances be wired to Earth Ground. It is the signal reference to the internal circuitry on the printed circuit boards. Permanent damage will result if these terminals are wired to Earth Ground. Use the lower left hand mounting screw inside the WP20 enclosure for wiring to Earth Ground.

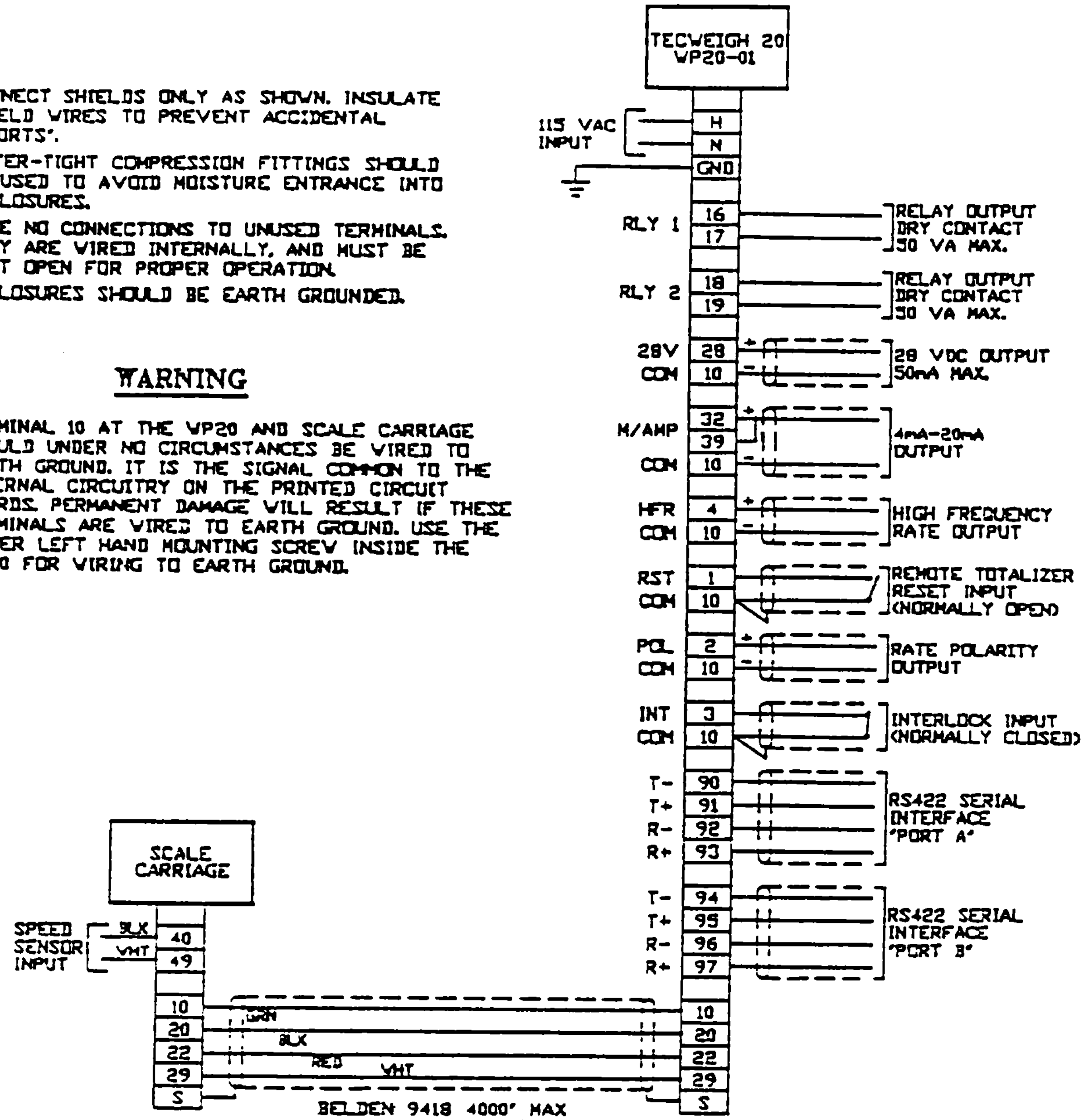
field wiring diagram

NOTES:

1. CONNECT SHIELDS ONLY AS SHOWN. INSULATE SHIELD WIRES TO PREVENT ACCIDENTAL "SHORTS".
2. WATER-TIGHT COMPRESSION FITTINGS SHOULD BE USED TO AVOID MOISTURE ENTRANCE INTO ENCLOSURES.
3. MAKE NO CONNECTIONS TO UNUSED TERMINALS. THEY ARE WIRED INTERNALLY, AND MUST BE LEFT OPEN FOR PROPER OPERATION.
4. ENCLOSURES SHOULD BE EARTH GROUNDED.

WARNING

TERMINAL 10 AT THE WP20 AND SCALE CARRIAGE SHOULD UNDER NO CIRCUMSTANCES BE WIRED TO EARTH GROUND. IT IS THE SIGNAL COMMON TO THE INTERNAL CIRCUITRY ON THE PRINTED CIRCUIT BOARDS. PERMANENT DAMAGE WILL RESULT IF THESE TERMINALS ARE WIRED TO EARTH GROUND. USE THE LOWER LEFT HAND MOUNTING SCREW INSIDE THE WP20 FOR WIRING TO EARTH GROUND.



FIELD WIRING DIAG.
TECWEIGH 20
SCALE SYSTEM

DWG NO. 20128400 REV -

CALIBRATION

GENERAL INFORMATION

5.1 Upon initial start-up of the WP20 there are some program parameters that are not preset at the factory and must be entered prior to scale calibration. These program parameters, identified in section 3.21 with an asterisk (*), must be correctly entered for proper scale accuracy.

INITIAL CALIBRATION AND OPERATING INSTRUCTIONS

5.2 Once the initial installation of the TECWEIGH scale carriage and the WP20 are completed and the WP20 parameters are determined and entered in the program it is time to calibrate the scale. Scale calibration procedures, as listed in section 5.4 and 5.5 below, are the same regardless if the scale is being calibrated for the first time after installation or if it is a weekly or monthly calibration.

5.3 For day to day operations of the WP20, the operator need only concern himself with the following four blue buttons on the face of the WP20:

- Auto Zero
- Auto Span
- Stop Count
- Reset

Of the above 4 buttons, most operators will find that they only use the first two buttons (Auto Zero and Auto Span) in actual day to day scale operations.

AUTO ZERO (AUTOMATIC ZERO)

5.4 AUTO ZERO should be accomplished before the calibration step and is used when the operator finds it necessary to fine tune the calibration of a TECWEIGH scale due to product build up on the weigh idlers and/or conveyor belt. Once the operator determines that the belt is empty he should:

a) Depress the AUTO ZERO button for 5 seconds. (note: the Mode display will change to read **hold to zero** during the 5 seconds the button is pressed. If the AUTO ZERO button is not pressed for the full 5 seconds, the WP20 will automatically return to normal Run Mode).

b) When the Mode display changes to read **auto zero (wait)** the operator must then wait until the preselected time interval (belt revolutions or minutes) has elapsed.

c) Once the Auto Zero cycle is completed, the WP20 will automatically return to the normal Run Mode, the Mode display will read **tons per hour** and the RATE will read 000. If the Mode display reads **auto zero error**, then the load cells have been determined to be out of balance and will need to be realigned (see Sections 8.13 or 8.14 on LVDT alignment). No zero adjustment would have been made. Press the RESET button to return the Mode display back to **tons per hour**.

5.5 AUTO SPAN (SCALE CALIBRATION)

a) Press and hold the AUTO SPAN button for 5 seconds and follow the directions in the Mode display. (NOTE: the Mode display will change to read **hold to span** during the 5 seconds the button is pressed. If the AUTO SPAN button is not depressed for the full 5 seconds, the WP20 will return to normal Run Mode).

b) When the Mode display reads **lower cal weight** proceed to the TECWEIGH scale carriage and lower the calibration weight. After the calibration weight is lowered, the RATE display must be indicating greater than 50 units (0050, 005.0 or 00.50) before the microprocessor will recognize the calibration weight. If the RATE display is not greater than 50 units, increase conveyor belt speed.

c) Once the calibration weight is in place, the Mode display will change to read **auto span (wait)**. The operator must now wait until the preselected time interval (belt revolutions or minutes) has elapsed.

d) After the Auto Span cycle has ended, the Mode display will change to **raise cal weight**, at which time the operator should do so. Once the calibration weight is raised the WP20 will then automatically return to the normal Run Mode.

e) No further actions are required by the operator as the calibration cycle is now complete.

STOP COUNT

5.6 This button can be useful during manual calibration. Pressing the STOP COUNT button will stop the totalizer from counting, thereby freezing the TOTAL display. The Mode display will change to read **stop count**. When the button is released, totalizer operation will resume as normal.

RESET

5.7 This button is used to reset the current value in the TOTAL display. Press the RESET button and the Mode display will change to read **hold to reset**. The TOTAL will stop counting. If held for 5 seconds, the totalizer will be cleared to zero. Releasing the RESET button allows the TOTAL to continue counting.

CURRENT OUTPUT CALIBRATION

5.8 The current (m/amp) signal consists of two output terminals, 32 and 39. Terminal 39 is a constant 4 milliamp output signal and terminal 32 is the 0-16 milliamp output signal. Installing a jumper wire across these terminals will provide a 4 to 20 milliamp output signal. The **m/amp zero** mode is used to adjust the 4 milliamp signal and the **m/amp spn** mode is used for calibrating the 0-16 milliamp signal.

Terminal 10 is common (negative) reference to terminals 32 and 39.

5.9 EXAMPLE #1: A 4-20 milliamp signal can be calibrated to follow a 0-600 RATE by:

a) Install a jumper wire across terminals 32 and 39.
b) Attach a milliamp test meter red lead to terminal 32, black lead to terminal 10.
c) Hold the FUNCTION button for 5 seconds to enter the Program Mode.
d) Advance to the **m/amp zero** mode and adjust its setting for a 4 milliamp output signal at terminals 32 and 39.
e) Locate the **simulation:** OFF mode and change it to **simulation:** ON.

f) Advance to the rate span mode and adjust its setting to get 600 on the RATE display. Any change made to the rate span while the simulation mode is ON will be temporary. The original rate span value will return automatically after returning to the Run Mode.

g) Advance to the **m/amp spn** mode and adjust its setting for a 20 milliamp output (4ma + 16ma) signal at terminals 32 and 39.

h) Hold the FUNCTION button for 5 seconds to return to normal Run Mode. This will turn the **simulation:OFF** automatically.

You are now ready to run.

5.10 EXAMPLE #2: A 0-20 milliamp signal can be calibrated to follow a 0-400 RATE by:

a) Remove the jumper wire from terminals 32 and 39.
b) Attach a milliamp test meter red lead to terminal 32, black lead to terminal 10.
c) Hold the FUNCTION button for 5 seconds to enter the Program Mode.
d) Change **simulation: OFF** to **simulation: ON**
e) Advance to the **rate span** mode and adjust its setting to get 400 on the Rate display. Any change made to the **rate span** while the simulation mode is ON will be temporary. The original **rate span** value will return automatically after returning to the Run Mode.
f) Advance to the **m/amp spn** mode and adjust its setting for a 20 milliamp output signal at terminal 32.
g) Hold the FUNCTION button for 5 seconds to return to normal Run Mode. This will turn the **simulation:OFF** automatically.

You are now ready to run.

SPEED DISPLAY CALIBRATION

5.11 Exact belt speed is critical to the operation and accuracy of the TECWEIGH Scale System. The WP20 has been configured based upon the data received for your application. Should the indicated belt speed differ from actual belt speed for any reason, (misentered speed calibration data, speed wheel wear, change of speed sensor type, etc.), gross errors in accuracy could result. Verifying the exact belt speed and correcting any errors can be done quickly and easily with the WP20.

5.12 Depress the FUNCTION button to change the Mode display to read conveyor belt speed: **speed: xxx fpm**. Calibrating the speed display to agree to actual conveyor belt speed is completed as follows:

a) Calculate the actual belt speed: Measure the EXACT belt length. If this length differs with the setting of the belt len mode, enter the new value. Time 5 exact revolutions of the belt with a stopwatch. Divide the total number of seconds by 5 to get the exact seconds per revolution. Divide the belt length in feet by the seconds per revolution to achieve feet per second. Multiply by 60 to get feet per minute.

EXAMPLE:	Actual belt length	= 558 feet
	Time for 5 revs	= 425 seconds (7 min, 5 sec)
	Time for 1 rev	= 85 seconds (425/5)
	feet per second	= 558 feet/85 seconds
		= 6.5647 feet/second
	feet per minute	= 6.5647 feet/second X 60 seconds
		= 393.9 feet/minute

b) Hold the FUNCTION button for 5 seconds to enter the Program Mode.
c) Locate the **speed spn** mode and adjust its setting until the speed display exactly agrees with the actual conveyor belt speed. (Press the STOP COUNT button to view speed display).
d) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

HFR OUTPUT CALIBRATION

5.13 The HFR output (High Frequency Rate) at terminal 4 provides a DC digital pulse output directly proportional to RATE. Calibrating the HFR output to agree with RATE display is completed as follows:

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.
b) Change **simulation: OFF** to **simulation: ON**.
c) Advance to the **rate span** mode and adjust its setting until the RATE displays equals maximum operating rate. The original **rate span** value will return automatically after returning to the Run Mode.
d) Locate the **hfr span** mode and adjust its setting until the Remote Rate Indicator (wired to terminals 4 and 10) agrees with the RATE display.
e) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

RELAY FUNCTIONS

The WP20 output terminals provide two relay output contacts. These relay contacts are completely independent of each other but may be programmed to operate identically or to provide separate output functions. The following explains each of the relay output functions provided by the WP20. Relay 1 uses terminals 16 and 17, while Relay 2 uses terminals 18 and 19. Relay 1 is used in all of the following examples.

6.1 PROGRAMMING RELAY OUTPUT TO BE A TOTALIZER PULSE REPEATER

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

b) Advance to the **rly 1 func** mode and set it to **rly 1 func: TPR**

c) Press the FUNCTION button to advance to next mode; Set **rly 1: ENABLED**

d) Press the FUNCTION button to advance to the **rly 1 logic** mode.

Selects the logic of the pulse outputs. When set to **rly 1 logic: N.O** the contact at terminals 16 and 17 will remain open until the totalizer scale setting is true. The contact will then close for the programmed pulse duration, and then open again. The exact opposite will be true when set to **rly 1 logic: N.C**

e) Press the FUNCTION button to advance to **rly 1 pulse** mode.

This mode selects the pulse durations at terminals 16 and 17. The pulse duration may determine the maximum pulses per second. For example, when set to **rly 1 pulse: .10** each pulse will last one tenth second. This will allow for 9 pulses per second before the pulses *run together*. To prevent this condition from occurring, reduce the pulse durations or select the next most significant totalizer digit to pulse on.

f) Press the FUNCTION button to advance to the next mode, **rly 1 ts: xxxxxx**

This mode is the totalizer scale factor for which terminals 16 and 17 will pulse on. For example, when set to **rly 1 ts: 000020** the pulses will only occur on every 20 counts of TOTAL.

g) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

6.2 PROGRAMMING RELAY OUTPUT TO BE A LOW RATE ALARM

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

b) Advance to the **rly 1 func** mode and set it to **rly 1 func: LRA**

c) Press the FUNCTION button to advance to next mode; Set **rly 1: ENABLED**

d) Press the FUNCTION button to advance to the rly 1 logic mode.

Selects the logic of the alarm output. When set to rly 1 logic: N.C the contact at terminals 16 and 17 will remain closed until the RATE falls below the rly 1 low setpoint. When set to rly 1 logic: N.O the contact at terminals 16 and 17 will remain open until the RATE falls below the rly 1 low setpoint.

e) Press the FUNCTION button to advance to the rly 1 low mode.

This mode is used to enter the low setpoint for which the alarm output will activate. For example, if the user requires an alarm output when the RATE falls below 75 TPH he should set rly 1 low: 0075. Note, if a RATE decimal point or a new unit of measurement is later selected, the operator would then have to re-enter a new rly 1 low setpoint to reflect the change that has been made.

f) Press the FUNCTION button to advance to the rly 1 delay mode.

This mode is used to program in a "delay on operate" for the alarm output. For example, if the operator requires a delay of 45 seconds after the RATE falls and remains below the rly 1 low setpoint, he should set rly 1 delay: 45. If the operator wanted an instant response he should set rly 1 delay: 00.

g) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

6.3 PROGRAMMING RELAY OUTPUT TO BE A HIGH RATE ALARM

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

b) Advance to the rly 1 func mode and set it to rly 1 func: HRA

c) Press the FUNCTION button to advance to next mode; Set rly 1: ENABLED

d) Press the FUNCTION button to advance to the rly 1 logic mode.

Selects the logic of the alarm output. When set to rly 1 logic: N.C the contact at terminals 16 and 17 will remain closed until the RATE exceeds the rly 1 hgh setpoint. When set to rly 1 logic: N.O the contact at terminals 16 and 17 will remain open until the RATE exceeds the rly 1 hgh setpoint.

e) Press the FUNCTION button to advance to the rly 1 hgh mode.

This mode is used to enter the high setpoint for which the alarm output will activate. For example, if the user requires an alarm output when the RATE exceeds 875 TPH he should set rly 1 hgh: 0875. Note, if a RATE decimal point or a new unit of measurement is later selected, the operator would then have to re-enter a new rly 1 hgh setpoint to reflect the change that has been made.

f) Press the FUNCTION button to advance to the rly 1 delay mode.

This mode is used to program in a "delay on operate" for the alarm output. For example, if the operator requires a delay of 15 seconds after the RATE exceeds and remains above the rly 1 hgh setpoint, he should set rly 1 delay: 15. If the operator wanted a 10 second delay he should set rly 1 delay: 10.

g) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

6.4 PROGRAMMING RELAY OUTPUT TO BE A HIGH / LOW RATE ALARM

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

b) Advance to the **rly 1 func** mode and set it to **rly 1 func: HLRA**

c) Press the FUNCTION button to advance to next mode; Set rly 1: ENABLED

d) Press the FUNCTION button to advance to the **rly 1 logic** mode.

Selects the logic of the alarm output. When set to rly 1 logic: N.C the contact at terminals 16 and 17 will remain closed until the RATE falls below the rly 1 low setpoint or until the RATE exceeds the **rly 1 hgh** setpoint. When set to rly 1 logic: N.O the contact at terminals 16 and 17 will remain open until the RATE falls below the rly 1 low setpoint or until the RATE exceeds the **rly 1 hgh** setpoint.

e) Press the FUNCTION button to advance to the **rly 1 low** mode.

This mode is used to enter the low setpoint for which the alarm output will activate. For example, if the user requires an alarm output when the RATE falls below 35 TPH he should set **rly 1 low: 0035**. Note, if a Rate decimal point or a new unit of measurement is later selected, the operator would then have to re-enter a new rly 1 low setpoint to reflect the change that has been made.

f) Press the FUNCTION button to advance to the **rly 1 hgh** mode.

This mode is used to enter the high setpoint at which the alarm output will activate. For example, if the user requires an alarm output when the RATE exceeds 450 TPH he should set **rly 1 hgh: 0450**. Note, if a Rate decimal point or a new unit of measurement is later selected, the operator would then have to re-enter a new **rly 1 hgh** setpoint to reflect the change that has been made.

g) Press the FUNCTION button to advance to the **rly 1 delay** mode.

This mode is used to program in a "delay on operate" for the alarm output. For example, if the operator requires a delay of 60 seconds after the RATE falls and remains below the rly 1 low setpoint or when the RATE exceeds and remains above the rly 1 **hgh** setpoint, he should set rly 1 **delay: 60**. If the operator wanted an instant response he should set **rly 1 delay: 00**.

h) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

6.5 PROGRAMMING RELAY OUTPUT TO BE A LOW SPEED ALARM

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

b) Advance to the **rly 1 func** mode and set it to **rly 1 func: LSA**

c) Press the FUNCTION button to advance to next mode; Set rly 1: ENABLED

d) Press the FUNCTION button to advance to the rly 1 logic mode.

Selects the logic of the alarm output. When set to rly 1 logic: N.C the contact at terminals 16 and 17 will remain closed until the SPEED falls below the rly 1 low setpoint. When set to rly 1 logic: N.O the contact at terminals 16 and 17 will remain open until the SPEED falls below the rly 1 low setpoint.

e) Press the FUNCTION button to advance to the rly 1 low mode.

This mode is used to enter the low setpoint for which the alarm output will activate. For example, if the user requires an alarm output when the SPEED falls below 15 FPM he should set rly 1 low: 0015. Note, if a SPEED decimal point or a metric unit of measurement is later selected, the operator would then have to re-enter a new rly 1 low setpoint to reflect the change that has been made.

f) Press the FUNCTION button to advance to the rly 1 delay mode.

This mode is used to program in a "delay on operate" for the alarm output. For example, if the operator requires a delay of 45 seconds after the SPEED falls and remains below the rly 1 low setpoint, he should set rly 1 delay: 45. If the operator wanted an instant response he should set rly 1 delay: 00.

g) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

6.6 PROGRAMMING RELAY OUTPUT TO BE A HIGH SPEED ALARM

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

b) Advance to the rly 1 func mode and set it to rly 1 func: HSA

c) Press the FUNCTION button to advance to next mode; Set rly 1: ENABLED

d) Press the FUNCTION button to advance to the rly 1 logic mode.

Selects the logic of the alarm output. When set to rly 1 logic: N.C the contact at terminals 16 and 17 will remain closed until the SPEED exceeds the rly 1 hgh setpoint. When set to rly 1 logic: N.O the contact at terminals 16 and 17 will remain open until the SPEED exceeds the rly 1 hgh setpoint.

e) Press the FUNCTION button to advance to the rly 1 hgh mode.

This mode is used to enter the high setpoint for which the alarm output will activate. For example, if the user requires an alarm output when the SPEED exceeds 100 FPM he should set rly 1 hgh: 0100. Note, if a SPEED decimal point or a metric unit of measurement is later selected, the operator would then have to re-enter a new rly 1 hgh setpoint to reflect the change that has been made.

f) Press the FUNCTION button to advance to the rly 1 delay mode.

This mode is used to program in a "delay on operate" for the alarm output. For example, if the operator requires a delay of 15 seconds after the SPEED exceeds and remains above the **rly 1 hgh** setpoint, he should set **rly 1 delay: 15**. If the operator wanted an instant response he should set **rly 1 delay: 00**.

g) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

6.7 PROGRAMMING RELAY OUTPUT TO BE A HIGH / LOW SPEED ALARM

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

b) Advance to the **rly 1 func** mode and set it to **rly 1 func: HLSA**

c) Press the FUNCTION button to advance to next mode: Set **rly 1: ENABLED**

d) Press the FUNCTION button to advance to **rly 1 logic** mode.

Selects the logic of the alarm output. When set to **rly 1 logic: N.C** the contact at terminals 16 and 17 will remain closed until the SPEED falls below the **rly 1 low** setpoint or until the SPEED exceeds the **rly 1 hgh** setpoint. When set to **rly 1 logic: N.O** the contact at terminals 16 and 17 will remain open until the SPEED falls below the **rly 1 low** setpoint or until the SPEED exceeds the **rly 1 hgh** setpoint.

e) Press the FUNCTION button to advance to the **rly 1 low** mode.

This mode is used to enter the low setpoint for which the alarm output will activate. For example, if the user requires an alarm output when the SPEED falls below 35 FPM he should set **rly 1 low: 0035**. Note, if a SPEED decimal point or a metric unit of measurement is later selected, the operator would then have to re-enter a new **rly 1 low** setpoint to reflect the change that has been made.

f) Press the FUNCTION button to advance to the **rly 1 hgh** mode.

This mode is used to enter the high setpoint at which the alarm output will activate. For example, if the user requires an alarm output when the SPEED exceeds 450 FPM he should set **rly 1 hgh: 0450**. Note, if a SPEED decimal point or a metric unit of measurement is later selected, the operator would then have to re-enter a new **rly 1 hgh** setpoint to reflect the change that has been made.

g) Press the FUNCTION button to advance to the **rly 1 delay** mode.

This mode is used to program in a "delay on operate" for the alarm output. For example, if the operator requires a delay of 39 seconds after the SPEED fails and remains below the **rly 1 low** setpoint or when the SPEED exceeds and remains above the **rly 1 hgh** setpoint, he should set **rly 1 delay: 39**. If the operator wanted a 10 second delay he should set **rly 1 delay: 10**.

h) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run.

6.7 PROGRAMMING RELAY OUTPUT TO LOWER AND RAISE THE CAL WEIGHT

(Note: the scale carriage must be equipped with an automatic lifter assembly)

a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

b) Advance to the **rly 1 func** mode and set it to **rly 1 func: SPAN**

c) Press the FUNCTION button to advance to next mode; Set **rly 1: ENABLED**

d) Press the FUNCTION button to advance to **rly 1 logic** mode.

Selects the logic of the contact output. When set to **rly 1 logic: N.O** the contact at terminals 16 and 17 will remain open during normal operation. The contacts will close during a Auto Span cycle when the Mode display is indicating **lower cal weight** and **auto span (wait)**. They will then automatically open when the Mode display reads **raise cal weight** and remain open until a Auto Span cycle is repeated. The exact opposite will be true if **rly 1 logic: N.C**

e) Hold the FUNCTION button for 5 seconds to return to normal Run Mode.

You are now ready to run

6.16 PROGRAMMING THE M/AMP OUTPUT USING A CHART RECORDER

The current (m/amp) signal that drives the Chart Recorder consists of three output terminals: 10, 32 and 39. Terminal 39 is a constant 4 milliamp output signal and terminal 32 is a 0-16 milliamp output signal. The **m/amp zero** mode is used to adjust the recorder pen for a zero reading on the chart. The **m/amp spn** mode is used to adjust the recorder pen for a 100% (full scale) reading on the chart.

Terminals 32 and 39 are the positive (+) references to the Chart Recorder.
Terminal 10 is negative (-) reference to the Chart Recorder.

EXAMPLE: Calibrating the Chart Recorder for 0-600 TPH range charts:

a) Install a jumper wire across terminals 32 and 39, wire Chart Recorder to WP20.

b) Hold the FUNCTION button for 5 seconds to enter the Program Mode.

c) Advance to the **m/amp zero** mode and adjust its setting for a zero pen reading on the Chart Recorder.

e) Locate the **simulation: OFF** mode and change it to **simulation: ON**.

f) Advance to the **rate span** mode and adjust its setting to get 600 on the RATE display. (Any change made to the **rate span** while the simulation mode is ON will be automatically recalled after returning to the Run Mode.)

g) Advance to the **m/amp spn** mode and adjust its setting until the recorder pen is indicating 600 (full scale) on the chart.

h) Hold the FUNCTION button for 5 seconds to return to normal Run Mode. This will turn the **simulation: OFF** automatically.

You are now ready to run.

SERIAL INTERFACE

INTRODUCTION

7.1 The TECWEIGH 20 Serial Interface allows remote computers and programmable controllers to access the WP20's Rate/Total information and remotely operate the Weight Processor. The WP20 serial ports are industry standard RS-422 compatible, providing noise immunity and long transmission distance (up to 4000 feet) capability. RS-422 also supports multi-dropping, or connecting of up to 16 serial ports together in series to allow multiple stations to be active on one host serial port. The WP20 contains two serial ports, labeled PORT A and PORT B, which may be programmed to operate identically or to provide separate input and or output functions. Note that each port will share the same Station Identifier selected in mode 50.

REQUESTING DATA

7.2 All communication with the WP20 must be directed to the unit with the appropriate Station Identifier. Station Identifiers are the capital letters A-P, or ASCII 65-80, hex $41-$50. Since up to 16 WP20's may be multi-dropped together using only one host serial port, each WP20 on that port must have a different Station Identifier.

7.3 The byte format is 8 data bits and 1 stop bit. Once the proper Station Identifier, parity and baud rates have been selected, choose what data you wish to receive from the WP20 and when you want to receive it. The WP20's Rate, Total, Speed, Average Rate, Average Speed and Status Byte may be requested, as described in Section 3, Weight Processor, modes 49-58.

7.4 If the txa menu modes 53 or 57 are set to any number from 01-19, the selected data will be sent at 1/10 second intervals. If set to 00, a request from the host is required to receive data. The data appears in fixed formats.

SERIAL COMMANDS

7.5 All serial commands received by the WP20 must employ the following format. Commands must begin with the proper Station Identifier, then receive a valid two character command and be terminated by an hex carriage return. If this format is not followed exactly the WP20 will simply ignore the command. Listed below is a proper four character command sequence required by the WP20.

[station id]	ASCII A-P
[two character command]	hex $30 $31 - $31 $39
[carriage return]	hex $0D

Note that the WP20 has a 16 command input buffer. Be careful not to overload the input buffer since received commands are only processed one at a time on 1/10 second intervals. It is recommended that not more than one command is received per second.

The following chart illustrates the data request commands available from the WP20:

station id	command	carriage return	ASCII data returned
ASCII A-P	hex S30 S30	hex S0D	no command, WP20 will not respond
ASCII A-P	hex S30 S31	hex S0D	[id] Rate [CR]
ASCII A-P	hex S30 S32	hex S0D	[id] Total [CR]
ASCII A-P	hex S30 S33	hex S0D	[id] Speed [CR]
ASCII A-P	hex S30 S34	hex S0D	[id] Rate and Total [CR]
ASCII A-P	hex S30 S35	hex S0D	[id] Rate and Speed [CR]
ASCII A-P	hex S30 S36	hex S0D	[id] Avg. Rate [CR]
ASCII A-P	hex S30 S37	hex S0D	[id] Avg. Speed [CR]
ASCII A-P	hex S30 S38	hex S0D	[id] Avg. Rate and Total [CR]
ASCII A-P	hex S30 S39	hex S0D	[id] Avg. Rate and Avg. Speed [CR]
ASCII A-P	hex S31 S30	hex S0D	[id] Status [CR]
ASCII A-P	hex S31 S31	hex S0D	[id] Rate and Status [CR]
ASCII A-P	hex S31 S32	hex S0D	[id] Total and Status [CR]
ASCII A-P	hex S31 S33	hex S0D	[id] Speed and Status [CR]
ASCII A-P	hex S31 S34	hex S0D	[id] Rate, Status and Total [CR]
ASCII A-P	hex S31 S35	hex S0D	[id] Rate, Status and Speed [CR]
ASCII A-P	hex S31 S36	hex S0D	[id] Avg. Rate and Status [CR]
ASCII A-P	hex S31 S37	hex S0D	[id] Avg. Speed and Status [CR]
ASCII A-P	hex S31 S38	hex S0D	[id] Avg. Rate, Status and Total [CR]
ASCII A-P	hex S31 S39	hex S0D	[id] Avg. Rate, Status and Avg. Speed [CR]

Note that all data transmitted from the WP20 will begin with the selected Station id character, followed by the corresponding data and then terminated by a carriage return.

Example #1: If the command [station id] [S30 S36] [CR] was received by the WP20 when the Rate display indicated 450, the requested data would be returned in the following format:

[station id]	ASCII A-P	(one character)
[Rate data]	hex S30 S34 S35 S30	(four characters)
[carriage return]	hex S0D	(one character)

Example #2: If the command [station id] [S30 S36] [CR] was received by the WP20 when the Speed display indicated 375, the requested data would be returned in the following format:

[station id]	ASCII A-P	(one character)
[Rate data]	hex S30 S33 S37 S35	(four characters)
[carriage return]	hex S0D	(one character)

Example #3: If the command [station id] [S31 S38] [CR] was received by the WP20 when the Rate display indicated a positive 103.8 and with a current Total of 399.75, the requested data would be returned in the following format:

[station id]	ASCII A-P	(one character)
[Rate data]	hex S31 S30 S33 S38	(four characters)
[Status Byte]	ASCII P	(one character)
[Total data]	hex S30 S30 S30 S33 S39 S39 S37 S35	(eight characters)
[carriage return]	hex S0D	(one character)

Note, if mode 53 is set to other than 00 any data request commands received by the Port A receiver will not be processed. This also applies to mode 57 for the Port B receiver. However, modes 53 and 57 do not effect any incoming calibration commands received by Port A or Port B.

All calibration functions of the WP20 may be also performed remotely by sending serial commands to the unit. The following is a list of the remote calibration commands:

station id	command	carriage return	Action taken
ASCII A-P	hex $33 $30	hex $0D	Resets the Total display
ASCII A-P	hex $33 $31	hex $0D	Starts an Auto Zero Cycle
ASCII A-P	hex $33 $32	hex $0D	Starts an Auto Span Cycle
ASCII A-P	hex $33 $33	hex $0D	Cancels an Auto Zero or Auto Span Cycle.

STATUS BYTE

7.6 The Status Byte may be sent along with requested data. It is a one byte ASCII character that reports any operating or error conditions that may occur. Normally, the Status byte will be 'P' for positive Rate polarity. Conditions that change the status byte are listed below.

ASCII	hex	dec	description
P	$50	80	Positive Rate Polarity
N	$4E	78	Negative Rate Polarity
Z	$5A	90	Auto Zero Mode in progress
T	$54	84	Auto Zero Tracking in progress
S	$53	83	Auto Span Mode in progress
A	$41	65	Customer configured high/low alarm
E	$45	69	Weight Processor Error as described in Sections 8.4

COMMUNICATION ERRORS

7.7 The following messages will appear on the Mode display for a 5 second period upon a communication error:

message	probable cause
framing error A	Incorrect host stop bit or baud rate settings at Port A
parity error A	Incorrect host parity setting at Port A
framing error B	Incorrect host stop bit or baud rate settings at Port B
parity error B	Incorrect parity setting at Port B

The WP20 will not process commands that have been received with any of the above communication errors. Be sure that modes 52,54 and or 55,58 are entered correctly for proper communication with the host system.

TROUBLE SHOOTING

8.1 Troubles can be broadly classified as either "Start-up Problems" or "Performance Problems" which arise some time after the unit has operated correctly. While Tecnetics has one of the most comprehensive warranties in the industry, there are a number of problems which are beyond our control. Wiring errors, faulty alignment, inferior conveyors, incorrect calibration procedures; these are problems beyond the scope of our Warranty. The user should consider carefully the benefits of having Tecnetics Field Engineers make the initial installation, calibrate the unit, and train the operating personnel.

8.2 TECNETICS will do everything possible to help you get your conveyor scale in operation. We can often explain over the telephone how to solve your problem. However, it is extremely important that we obtain some basic information so we can promptly assist you.

8.3 We urge you to double check your wiring. Mistakes in wiring account for the greatest majority of start-up problems. When you're sure that the TECWEIGH system is wired properly, then use the following check list to quickly pin-point the source of trouble. Please be prepared to answer the questions which follow if you call for assistance.

WARNING!!!

Remove power from the WP20 and any optional equipment *before* replacing or wiring to circuit boards as permanent damage may result.

FULL TIME SELF DIAGNOSTICS

8.4 During power up the WP20 will automatically perform diagnostic tests of the electronic circuits and load cell(s). During this test the mode display will read **self test** and, if all systems are functional, immediately advance to the Run Mode, indicated by the Mode display reading **tons per hour**. If a malfunction is found while the WP20 is in operation, the Mode display will then identify the error.

The following chart gives some possible causes and repair procedures for each of the diagnostic error messages.

	Error message	Possible cause and repair procedures
8.5	**zero belt speed**	Indicates a zero belt speed signal. • The conveyor belt is stopped. Start conveyor • The speed sensor tire is not turning. The speed sensor motor (SloSyn SS-50) may be jammed. • Check for broken or shorted cabling from the speed sensor to Signal Conditioner terminals 40 and 49.

- Measure terminals 40 and 49 for 2-8 VAC depending on belt speed. If this voltage is not present, replace the Speed Sensor motor (SloSyn SS-50).
- The Signal Conditioner is defective.

8.6 **low power**

WP20 is unable to power the Signal Conditioner.

- Low input power to available to WP20, less than 95 Vac.
- Signal wires to scale carriage are exceeding 4000 feet.
- Optional equipment connected to terminal 28 is drawing to much current. Disconnect wiring from terminal 28.
- Defective Signal Conditioner in scale carriage.

8.7 **interlock open**

The connection on terminals 3 and 10 are open. The Rate, Total and output terminals are disabled during this condition.

- Connect terminals 3 and 10 for normal operation. Note, in some cases the interlock terminal is controlled automatically by Tecnetics optional equipment. Check your field wiring diagram.

8.8 **auto zero error**

An Auto Zero cycle could not zero the Rate display. Press the RESET button to clear this error message.

- Rocked jammed under weigh idler.
- Calibration Weight is in the lowered position
- Conveyor belt was not empty during an Auto Zero cycle.
- LVDT(s) jammed or damaged.
- LVDT(s) are beyond zero tolerance. See sections 8.13 or 8.14 on LVDT alignment.

8.9 **auto span error**

An Auto Span cycle could not achieve target Rate. Target is to high or to low. Press the RESET button to clear this error message.

- Belt Skirting or jammed weigh idler
- Conveyor belt speed to slow. Increase belt speed.
- Improper factor/user set-up. Check Program Mode for proper entry of data, or consult factory for assistance.

8.10 scale data error

Indicates a communication problem between the WP20 and the Scale Carriage:

- Possible miswired terminals, broken or shorted signal cabling or loose terminal screws.
- Terminal 10 at the WP20 or the Signal Conditioner is wired to Earth Ground.
  Remove wire to Earth Ground
- An extremely low AC input voltage to the WP20.
- Defective Signal Conditioner inside the Scale Carriage.
- Defective WP20. Check for +24 VDC at terminals 20 and 29.

8.11 lvdt error

Indicates an improper LVDT load cell signal.

- Defective load cell(s). Most field problems are caused by broken or miswired terminals. The first step should always be careful inspection of wiring. Check carefully for loose terminal screws and over stressed wires. An over stressed LVDT wire will eventually cause an intermittent problem. Each LVDT should also be inspected for missing bearings or springs.
- The LVDT(s) may be extremely out of alignment and are operating beyond their performance range. See section 8.13 or 8.14 on LVDT alignment.

LVDT test

1. Disconnect power from the WP20, conveyor stopped.
2. Remove the side-cover at the carriage assembly to expose the Signal Conditioner. Use the following chart to test LVDT(s).

For single idle scale (WY10), Signal Conditioner Model ET20-01:

lvdt A		lvdt B	
terminals	resistance	terminals	resistance
1 and 3	70 Ω	2 and 3	70 Ω
4 and 6	100 Ω	4 and 7	100 Ω
5 and 8	100 Ω	5 and 6	100 Ω

If a resistance reading does not measure within 20 % of the listed value, replace that LVDT. See section 8.12 on LVDT replacement.

For dual idle scale (WY20), Signal Conditioner Model ET20-02:

lvdt A		lvdt B	
terminals	resistance	terminals	resistance
1 and 3	70 Ω	4 and 5	70 Ω
11 and 13	100 Ω	11 and 12	100 Ω
8 and 15	100 Ω	8 and 9	100 Ω

lvdt C terminals	lvdt C resistance	lvdt D terminals	lvdt D resistance
3 and 4	70 Ω	2 and 3	70 Ω
6 and 12	100 Ω	6 and 14	100 Ω
7 and 9	100 Ω	7 and 13	100 Ω

If a resistance reading does not measure to within 20% of the listed value, replace that LVDT. See section 8.12 on LVDT replacement.

8.12 LVDT REPLACEMENT (see figure 19)

a) Back off the two outer set screws on the LVDT clamp.
b) Remove the wiring from terminals on the Signal Conditioner. Color codes must followed exactly.
c) Remove the two carriage bolts from the LVDT clamp, permitting the LVDT assembly to be withdrawn from the carriage.
d) Loosen the clamp screw, and slide the LVDT out of the clamp.
e) Install the new LVDT in approximately the same position, and assemble in revers order, tightening the set-screws last. Re-wire to the Signal Conditioner terminal st being careful to keep the wiring away from the deflection arm.
f) Position LVDT(s) per step 8.13 or 8.14 below.

8.13 LVDT ALIGNMENT for Single Idler scale. (see figure 20)

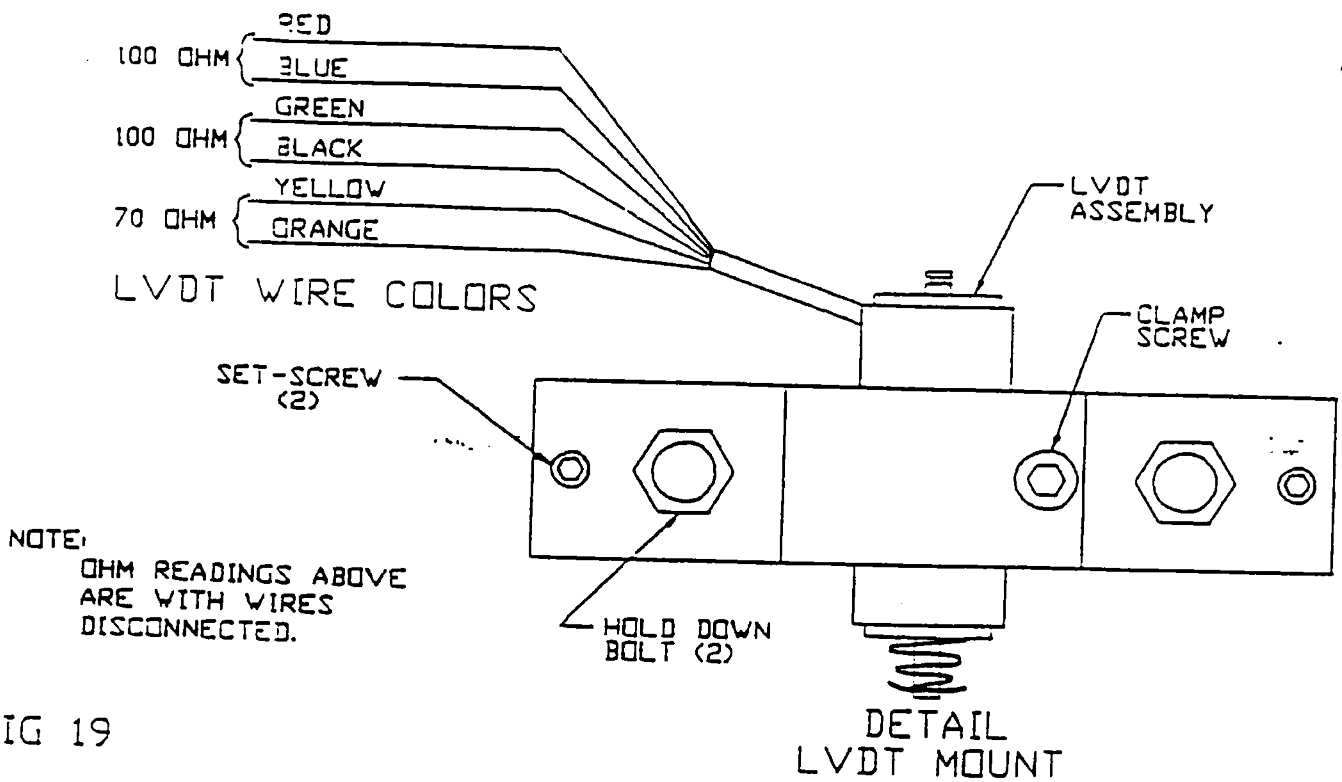
a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.
b) Advance to the **azt** mode and set it to **azt +/- 00**. Be sure to record its current setting: **azt +/-** ______, you will need to re-enter it later.
c) Advance to the **rate damp** mode and set it to **rate damp: 01**. Be sure to record its current setting: **rate damp:** _______, you will need to re-enter it later.
d) Advance to the **rate zero** mode and set it to **rate zero: 0000**.
e) Hold the FUNCTION button for 5 seconds to return to normal run mode.
f) Start conveyor, running empty.
g) Locate the Signal Conditioner board inside the scale carriage. Find the two test points labeled TP1 and TP2 and jumper them together. They are in the extreme upper left hand corner on the Signal Conditioner board.
h) Adjust the 'A' side LVDT up or down as required until the Rate display is indicating close to zero, within +/- 30 units is good enough. Clamp the LVDT in that position. Remove the jumper from TP1 and TP2 and then repeat this step using LVDT 'B'.
i) Hold the FUNCTION button for 5 seconds to enter the Program Mode.
j) Re-enter in the values previously recorded in steps 'b' and 'c'.
k) Hold the FUNCTION button for 5 seconds to return to normal run mode
l) Complete an AUTO ZERO cycle to zero the Rate display.
m) Complete an AUTO SPAN cycle to calibrate the scale system.

You are now ready to run.

8.14 LVDT ALIGNMENT for Dual Idler scale. (see figure 21)

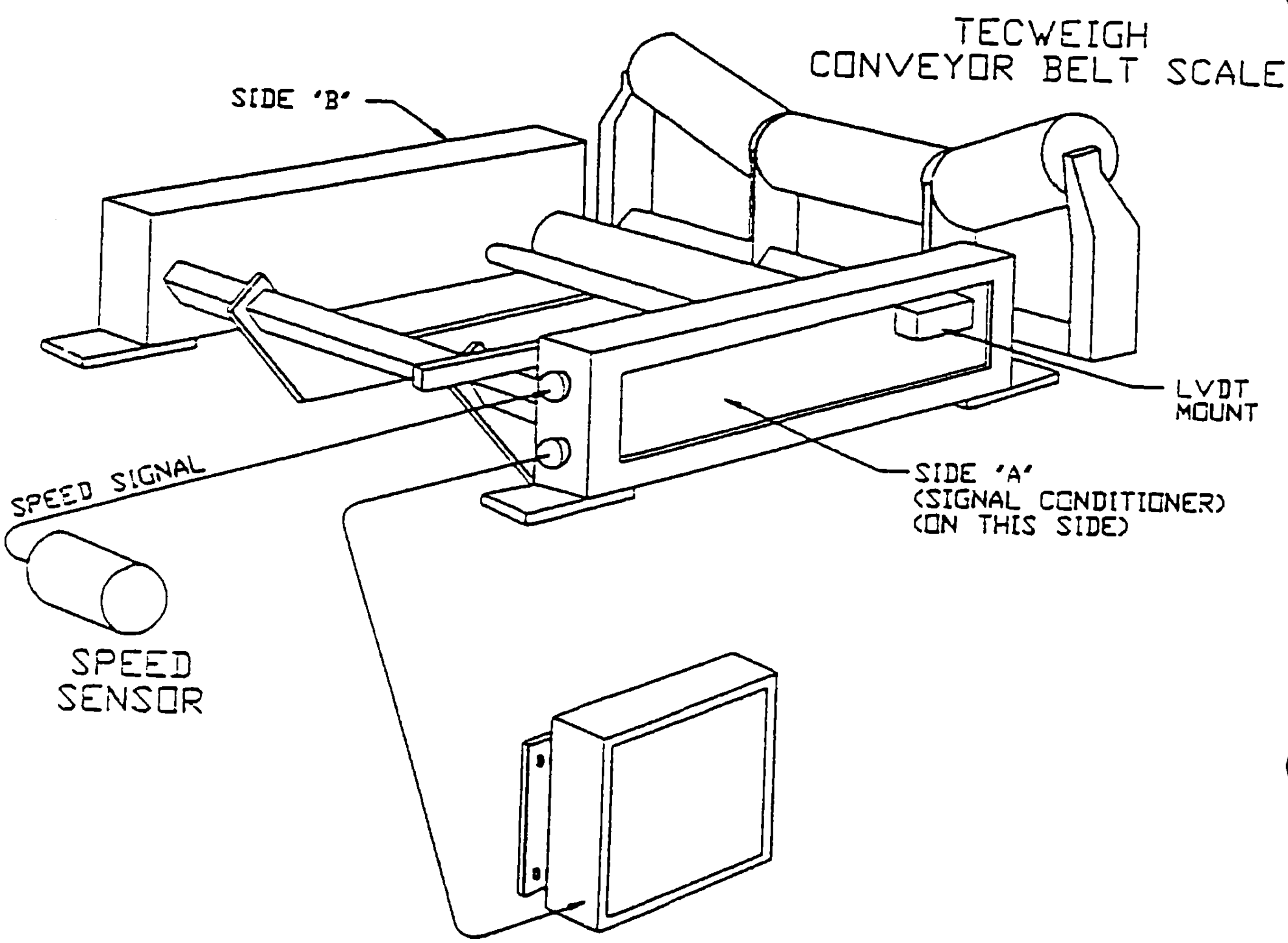
a) Hold the FUNCTION button for 5 seconds to enter the Program Mode.
b) Advance to the **azt** mode and set it to **azt +/- 00**. Be sure to record its current setting: **azt +/-** ______, you will need to re-enter it later.
c) Advance to the **rate damp** mode and set it to **rate damp: 01**. Be sure to record its current setting: **rate damp:** _______, you will need to re-enter it later.
d) Advance to the **rate zero** mode and set it to **rate zero: 0000.**
e) Hold the FUNCTION button for 5 seconds to return to normal run mode.
f) Start conveyor, running empty.
g) Locate the Signal Conditioner board inside the scale carriage. Find the four test points labeled TP1 , TP2 , TP3 and TP4 . They are in the extreme upper left hand corner on the Signal Conditioner board.
h) Jumper TP1 and TP4 together and adjust the 'A' side LVDT up or down as required until the Rate display is indicating close to zero, within +/- 30 units is good enough. Clamp the LVDT in that position.
i) Jumper TP1 and TP3 together and adjust the 'B' side LVDT up or down as required, like in step 'h'.
j) Jumper TP1 and TP2 together and adjust the 'C' side LVDT up or down as required, like in step 'h'.
k) Remove the jumper TP1 and TP2 and adjust the 'D' side LVDT up or down as required, like in step 'h'.
l) Hold the FUNCTION button for 5 seconds to enter the Program Mode.
m) Re-enter in the values previously recorded in steps 'b' and 'c'.
n) Hold the FUNCTION button for 5 seconds to return to normal run mode.
o) Complete an AUTO ZERO cycle to zero the Rate display.
p) Complete an AUTO SPAN cycle to calibrate the scale system.

You are now ready to run.



RED
100 OHM
BLUE
GREEN
100 OHM
BLACK
YELLOW
70 OHM
ORANGE
LVDT WIRE COLORS
LVDT ASSEMBLY
CLAMP SCREW
SET-SCREW (2)
NOTE:
OHM READINGS ABOVE ARE WITH WIRES DISCONNECTED.
HOLD DOWN BOLT (2)
DETAIL LVDT MOUNT

FIG 19



TECWEIGH
CONVEYOR BELT SCALE
SIDE 'B'
LVDT MOUNT
SIDE 'A' (SIGNAL CONDITIONER) (ON THIS SIDE)
SPEED SIGNAL
SPEED SENSOR

FIG 20

TECWEIGH 20

Section 9

Job Number: 4410

Customer: Williams Service Group

TECWEIGH 20: Model: WP20-01B, S/N: 9101-33, Software: WP20-1

Signal Cond: Model: DSC10-01, S/N: 9107, Software: ET20-

Scale Carriage: Model: WW10-01-18 L.W., Carriage number: .066-9106

Date Shipped: 7/30/91, Set-up by: BR

PRELIMINARY DATA: (order information)

Unit of measurement: TONS PER HOUR

Feed Rate: ____ min, 15.0 avg, 30.0 max.

Belt Speed: ____ min, 200 FPM avg, ____ max.

Belt Width: 18", Belt Length: 22'

Scale Carriage: Size: 18", Style: LIGHTWEIGHT

Factory Idler Mod: YES, Offset Idler: NO

Speed Sensor: Model: SS12-01, Style: STANDARD

WP20 supply voltage: 115 VAC

WP20 milliamp output set at: 4-20 mA = 0-30.0 TPH

SPECIAL 50 ft of #8407 Belden Cable

Shim Kit

WP20 PROGRAM MODE, FACTORY SET-UPS:

1). simulation: OFF (Used to "simulate" weight signal from carriage)

2). unit: TONS/HR (Unit of Measurement for Rate and Total displays)

3). cal factor: .27 (Calibration Factor)

4). cal wt: 027.00 (Calibration Weight; pounds or kilograms)

5). cal chn: 000.00 (Calibration Chain; lbs per foot or kgs per meter)

6). weigh spn: 36.00 (Weigh Span; inches or meters)

7). blt len: 0022.00 (Belt Length; feet or meters)

8). asc fact: 1.0000 (Auto Span Control factor)

9). azt: +/- 0.1 (Auto Zero Tracking set-point)

10). track on: REVS (Auto Zero Tracking timing source)

11). track on 06 revs (Auto Zero Tracking timing variable)

12). track on ____ mins (Auto Zero Tracking timing variable)

13). zero on: REVS (Auto Zero timing source)

14). zero on: 03 revs (Auto Zero timing variable)

15). zero on: ____ mins (Auto Zero timing variable)

16). span on: REVS (Auto Span timing source)

17). span on: 06 revs (Auto Span timing variable)

18). span on: ____ mins (Auto Span timing variable)

19). rate dp: TENS (Rate display decimal point setting)

20). rate damp: 15 (Rate display damping factor; seconds)

The rate zero and rate span functions are updated automatically by the WP20 as needed. DO NOT re-enter the below numbers to return your unit to "factory settings", they are for factory reference only. The AUTO ZERO and AUTO SPAN controls are to be used to reset these values.

21). *rate zero:* -0114 (Rate display zero setting; reference only)

22). *rate span:* 50324 (Rate display span setting; reference only)

23). speed dp: -ONES (Speed display decimal point setting)

24). speed damp: 15 (Speed display damping factor; seconds)

25). speed spn: 18800 (Speed display span setting; reference only)

26). m/amp damp: 15 (M/AMP output damping factor; seconds)

27). m/amp zero: 2669 (M/AMP output zero setting; reference only)

28). m/amp spn: 19119 (M/AMP output span setting; reference only)

29). hfr damp: 15 (HFR output damping factor; seconds)

30). hfr span: 10000 (HFR output span setting; reference only)

31). total dp: Hunds (Total display decimal point setting)

32). down count: NO (Enables or Disables totalizer down counting)

33). rly 1 func: TPR (Selects Relay 1 function as follows:)

- a) TPR - Total Pulse Repeater.
- b) LRA - Low Rate Alarm.
- c) HRA - High Rate Alarm.
- d) HLRA - High/Low Rate Alarm.
- e) LSA - Low Speed Alarm.
- f) HSA - High Speed Alarm.
- g) HLSA - High/Low Speed Alarm.
- h) SPAN - AUTO SPAN lower and raise calibration weight output.

34). rly 1: DISABLED (ENABLE/DISABLE Relay 1 output)

35). rly 1 logic: N.O (Relay 1 logic, normally open or closed)

36). rly 1 pulse: .10 (Relay 1 pulse duration; seconds)

37). rly 1 ts: 000001 (Relay 1 totalizer scale)

38). rly 1 low: ______ (Relay 1 Low Alarm setpoint)

39). rly 1 hgh: ______ (Relay 1 High Alarm setpoint)

40). rly 1 delay: ______ (Relay 1 delay before alarm output; seconds)

41). rly 2 func: TPR (Selects Relay 2 function as follows:)

- a) TPR - Total Pulse Repeater.
- b) LRA - Low Rate Alarm.
- c) HRA - High Rate Alarm.
- d) HLRA - High/Low Rate Alarm.
- e) LSA - Low Speed Alarm.
- f) HSA - High Speed Alarm.
- g) HLSA - High/Low Speed Alarm.
- h) SPAN - AUTO SPAN lower and raise calibration weight output.

42). rly 2: DISABLED (Enables or Disables Relay 2 output)

43). rly 2 logic: N.O (Relay 2 logic, normally open or closed)

44). rly 2 pulse: .10 (Relay 2 pulse duration; seconds)

45). rly 2 ts: 000001 (Relay 2 totalizer scale)

46). rly 2 low: ______ (Relay 2 Low Alarm setpoint)

47). rly 2 hgh: ______ (Relay 2 High Alarm setpoint)

48). rly 2 delay: ______ (Relay 2 delay before alarm output; seconds)

49). view serial: NO (Enables/Disables access to the serial interface modes)

50). station ID: ______ (WP20 serial interface station ID character)

51). port A par: ______ (Port A parity type)

52). txa baud: ______ (Port A transmitter baud rate)

53). txa menu: ______ (Port A transmitter menu)

54). rxa baud: ______________ (Port A receiver baud rate)

55). port B par: ______________ (Port B parity type)

56). txb baud: ______________ (Port B transmitter baud rate)

57). txb menu: ______________ (Port B transmitter menu)

58). rxb baud: ______________ (Port B receiver baud rate)

59). lck auto zr: NO (Locks or unlocks the AUTO ZERO button)

60). lck auto sp: NO (Locks or unlocks the AUTO SPAN button)

61). lck stp cnt: NO (Locks or unlocks the STOP COUNT button)

62). lock reset NO (Locks or unlocks the RESET button)

63). lck code: 000000 (Program Mode lock code setting)

CS SERIES

TECWEIGH® Conveyor Scales are designed simply, yet effectively to provide precise weighing of material carried by belt conveyors. We start with a solid steel, weather-tight all welded carriage that incorporates a weigh idler and precision torque tube. The weight of material on the weigh idler causes a slight twisting of the torque tube. LVDT's then measure the degree of twisting via the integral deflection arms. A speed sensor on the return belt measures belt speed, integrates it with the LVDT signal to produce an exact measurement of the ... of the material carried by the belt. This ... eliminates fragile load cells.

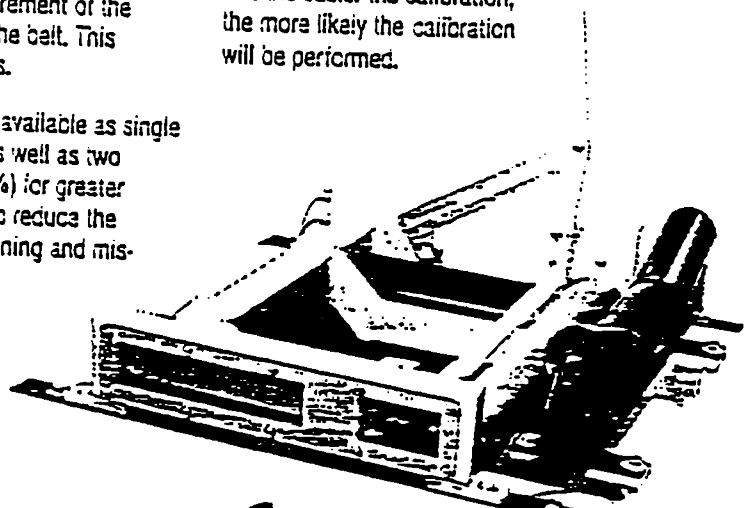
...GH® Conveyor Scales are available as single ...its with ± ½ % accuracy as well as two (± ¼ %), four (± ⅓ %) or six (± ⅛ %) for greater accuracy. Multi-idler units also help reduce the adverse effects of belt tension, training and misalignment.

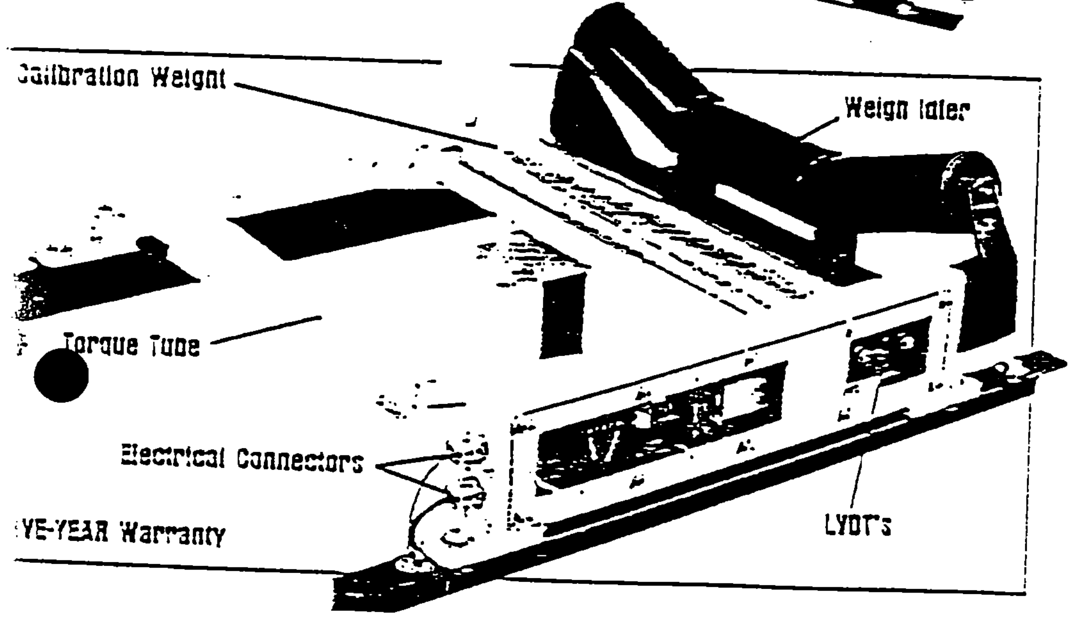
TECWEIGH Weighing Systems

TECWEIGH® Conveyor Scales easily integrate into most systems and can interface with PLC's or computers. Remote displays of rate and total tons are possible because of the high frequency rate signal. Our Conveyor Scales can be set to deliver a specific sized load or a desired TPH feed rate to blend ingredients in a selected ratio. Other options include circular chart recorders, ticket printers, explosion proof models and even 12 volt DC battery systems for portable applications.

Easy and Precise Calibration Saves Time and Money

Simple and convenient! To operate the calibration weight(s), use the built-in lever (or optional air operated cylinder) to raise and lower the weights onto the scale for an effortless calibration. After calibration, the weight is easily raised and stored *right on the scale carriage!* No chains or hang-on weights. *Calibration is accomplished in minutes.* Your operator stays safe, there's less down time, and the easier the calibration, the more likely the calibration will be performed.

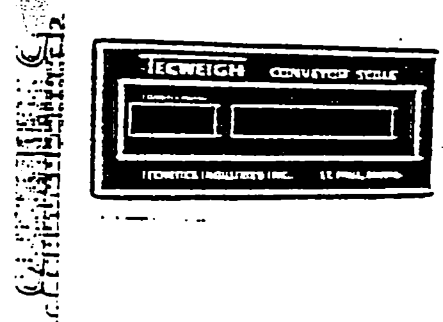




...VE-YEAR Warranty

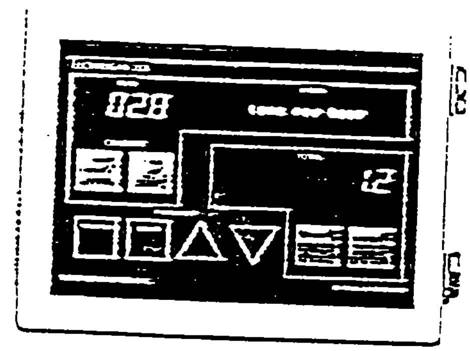
TECWEIGH Weight Processor

The WP-10 Weight Processor is standard on all Conveyor Scales, and include Rate and Total displays using ½" LED's. Utilizing solid-state electronics and avoiding mechanical counters and motors, it features a non-volatile memory that maintains information up to ten years without battery back-up.



WP-10

The optional WP-20 Weight Processor is also available for those applications that require a Micro Processor Based Unit with advanced features such as Auto Zero, Auto Span, Auto Zero Tracking, self diagnostics, adjustable dampening, Access Protection, RS422 Interface.
Weight measurements in tons, tonnes, pounds or kilograms per hour. Can be retrofit on all TECWEIGH® Scales and feeders. Special needs can be met by our complete in-house engineering staff.



WP-20

TECWEIGH
CONVEYOR SCALES

Tecnetics Industries
2180 Old Highway 8, St. Paul, MN 55112
612/780-7880 FAX: 612/780-5909

K

APPENDIX K

REFRACTORY SPECIFICATIONS

CARBORUNDUM

The Carborundum Company
Fibers Division
P.O. Box 808
Niagara Falls, New York 14302-0808
Telephone: 716 278-6221 Telex: 68-54335
Telefax: 716 278-4962
Cable (Foreign): CRBCINUW

Anchor-Loc® Ceramic Fiber Modules

Product Specifications

Introduction

The Anchor-Loc® module system is a family of ceramic fiber module products designed to meet a wide range of application requirements in a variety of heat processing vessels.

Ceramic fiber modules used in the Anchor-Loc systems are constructed with Durablanket® S, Durablanket HP-S, Durablanket 2600 or Fibermax® mat. Each type of Anchor-Loc ceramic fiber module can be easily fastened to interior steel shells of all types of heat processing equipment with several different attachment systems.

The ceramic fiber blanket or mat is secured by two alloy through-rods to a metallic module anchor. Flanges on the end of the through-rods effectively lock the position of the rods relative to the anchor at the time of installation.

Anchor-Loc ceramic fiber modules are manufactured in several configurations. A choice of attachment systems is provided to meet a wide range of application needs:

Weld-Loc™ Ceramic Fiber Modules

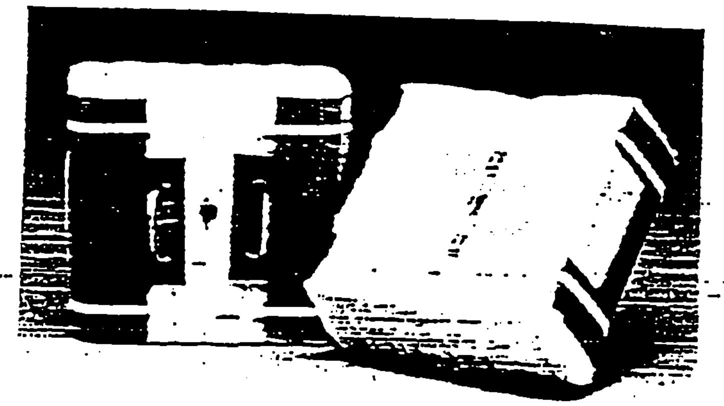
A special weld assembly is installed in each Weld-Loc ceramic fiber module. This stud assembly permits fusion of the stud base to the furnace casing and allows a threaded fastener to be torqued on the stud, drawing the module to the plate. Advantages which are offered by the Weld-Loc module include:

- High installation speed
- Ease and simplicity of installation
- Permits random placement of modules on the casing
- Multiple welds per module are possible
- System provides a positive torque test of the welds

Power-Loc™ Ceramic Fiber Modules

A hardened steel pin mechanically secures each Power-Loc module to the steel casing plate. The anchor pin is installed with a special Hilti® powder actuated fastening tool and powder booster. Advantages which are offered by the Power-Loc ceramic fiber module include:

- High installation speed
- Casing preparation is eliminated
- Permits random placement of modules on the casing
- Ease and simplicity of installation
- Positive mechanical attachment of modules to the casing plate
- Setup time is reduced



Thread-Loc® Ceramic Fiber Modules

Provided with an all-thread weld stud and flanged nut, the Thread-Loc ceramic fiber module is designed for installation on a prepositioned stud pattern. The Thread-Loc attachment system has several advantages:

- Compatibility with mastic coatings, backup insulation, and foil vapor barriers
- Module design compensates for variations in stud placement
- Access to the welded fastener for full testing before the module is installed

Screw-Loc® Ceramic Fiber Module

A self-tapping screw supplied with each Screw-Loc ceramic fiber module easily penetrates mild steel up to ½" in thickness. The Screw-Loc attachment system provides the following installation advantages:

- Multiple, random anchor placement
- Ease of removal and replacement
- Furnace casing preparation is eliminated
- Low cost installation equipment is readily available

Anchor-Loc ceramic fiber modules offer the same advantages as layered Fiberwall™ furnace linings when compared to refractory construction. They are:

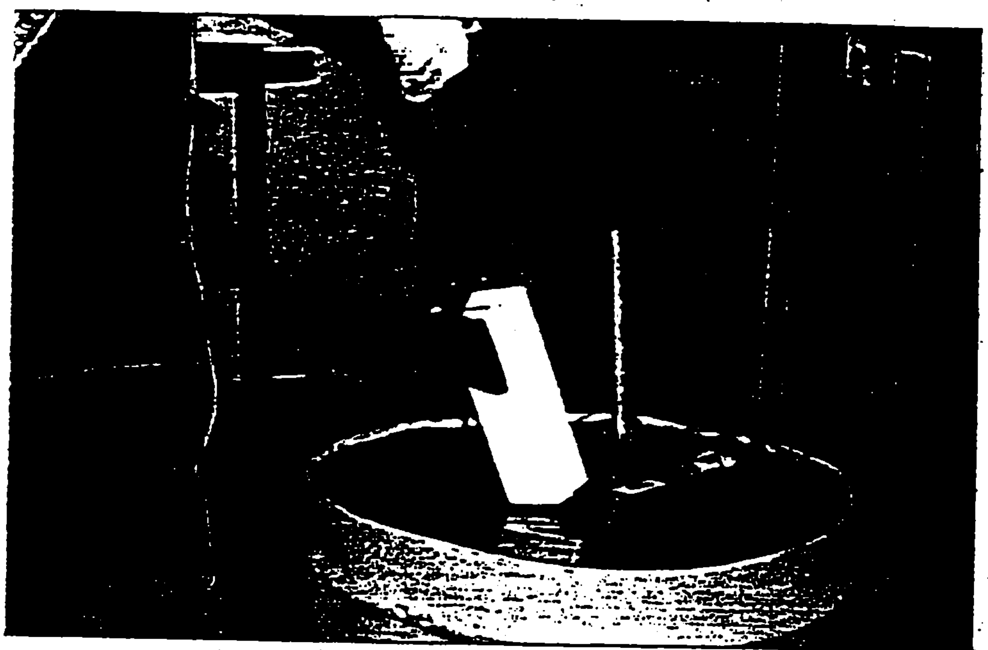
- Faster temperature cycling
- Lower heat storage
- Lower fuel costs
- Increased productivity
- Lower installed cost
- Easier repairs

Hilti® is a trademark of Hilti Tool Corporation.

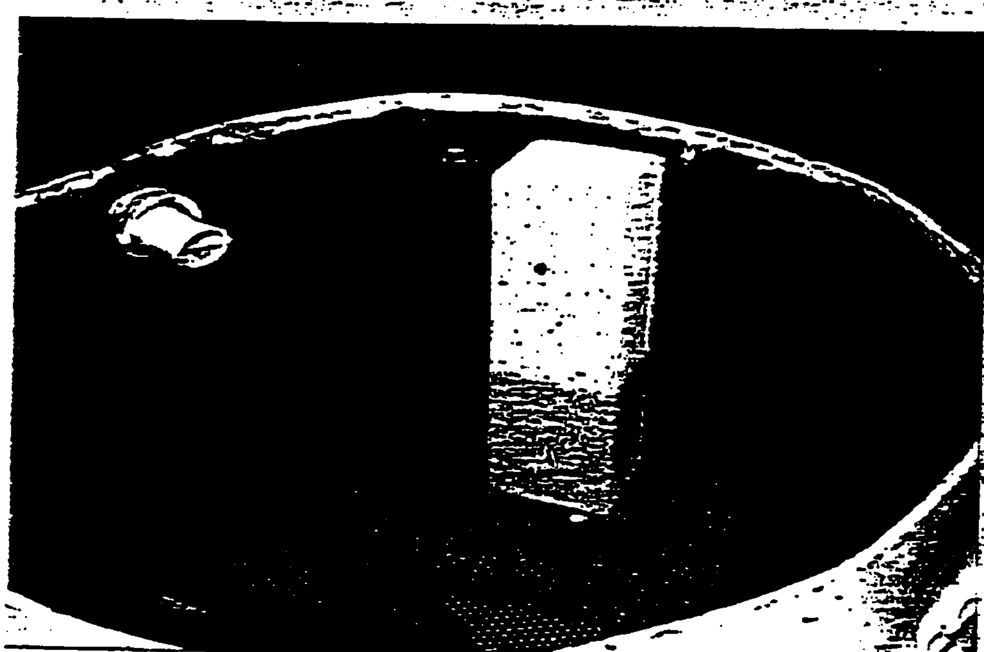
Form C-1428 Effective 3/90
Supersedes Form C-1220-A 12/87

ULTRA-GREEN 57A

ULTRA-GREEN 57A is a 57% alumina, andalusite base, ultralow cement castable with outstanding thermal shock resistance in applications having extreme cyclic temperature conditions. The andalusite base of ULTRA-GREEN 57A provides this superior ability to resist shattering, cracking, and loss of structural stability when subjected to extreme temperature changes. When compared to other ultralow cement castables, ULTRA-GREEN 57A has the best thermal shock resistance! In addition, it has the regular advantages of ULCC's.....high hot strength, good density, and low porosity.



Several ULTRA-GREEN 57A 9x2½x2½" soaps were preheated to selected temperatures such as 1500° F., 2000° F., and 2500° F., and then cooled. Each soap was then placed in a hot furnace at 2600° F. for 30 minutes. It was then taken from the furnace and the bottom half was immediately immersed in 70° F. water. NO SIGNIFICANT CRACKING. NO SHATTERING. Fantastic thermal shock resistance! ULTRA-GREEN 57A also has the same excellent properties as other ULTRA-GREEN products..... • **Superior Hot Strength** • **High Density** • **Low Porosity**.



(See reverse side for successful applications)

ULTRA-GREEN 57A
Applications

ULTRA-GREEN 57A has given excellent service in numerous applications.....surpassing the service life of previously used competitive materials.

- ❑ Coke Oven Door Plugs
- ❑ Pre-cast Piers For Heat Treating Furnaces
- ❑ Treatment Lances In Steel Mills
- ❑ Iron Ladle Linings
- ❑ Rotary Kilns Processing Roofing Granules
- ❑ Car Tops
- ❑ Aluminum Reverb Door Lintels
- ❑ Soaking Pit Coping Tile
- ❑ Crematory Furnace Hearths

Other Suggested Applications Are:

- ✓ Forge Furnace Hearths And Slots
- ✓ Pre-cast Shapes For All Areas Having Extreme Thermal Shock Conditions
- ✓ Carbon Bake Furnaces–Headwall Blocks And Flue Port Blocks
- ✓ Aluminum Reverb Door Jambs

L

APPENDIX L

OPERATIONS MANUAL FOR TPU 4

WESI*TPU4

INSTRUCTION MANUAL

For

WILLIAMS ENVIRONMENTAL SERVICES, INC.

ATLANTA, GEORGIA

THERMAL DESORPTION SYSTEM TPU #4

PROPRIETARY INFORMATION
Issued to: Jack Lane, Chief Engineer, WESI

TABLE OF CONTENTS FOR WESI*TPU4

SECTION 1

INTRODUCTION

These instructions have been prepared for the use of Williams Environmental Services' design and operating personnel. They describe the contaminated soil treating process as performed by the WESI*TPU4 Thermal Processing Unit and include a discussion of the equipment and control.

The following discussion encompasses general principles of the process and equipment operation. The information presented in this manual constitutes statements of expected relationships based on design parameters, calculations, engineering judgment and previous experience with similar installations and it explains the flow of materials and the manner in which they are processed by the plant equipment. This information is not to be construed as constituting a warranty, express or implied, but is intended to be used solely for describing WESI*TPU4 equipment and its operation while processing contaminated soil.

SECTION 2

SAFETY GUIDELINES

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SECTION 2: SAFETY GUIDELINES FOR WESI*TPU4

2.1 Introduction

Safety should be uppermost in the minds of all personnel participating in the operation of WESI*TPU4. It is imperative that all personnel understand and undertake all necessary precautions to protect themselves and the equipment when operating this unit. This section should not be viewed as a complete safety manual. Personnel should read and understand not only this section but also the operating manuals of specific equipment with which they may work, as well as other standard safety guidelines. In addition, processing operations of this type require training programs providing further directions to be followed for personal protection. All personnel should be familiar with the contents of each site specific health and safety plan which is prepared for each project this unit is employed on.

> IT IS THE RESPONSIBILITY OF INDIVIDUAL OPERATORS AND ATTENDANTS OF WESI*TPU4 TO BECOME INFORMED OF THE HAZARDS INVOLVED AND TO OBSERVE ALL SAFETY PRECAUTIONS.

2.2 General Precautions

Extreme care should be taken by all personnel when adjusting or performing maintenance on all equipment. Such work should not be performed when the equipment is in operation unless it is absolutely necessary to do so and then it must be done under supervision.

The following safety precautions must be exercised throughout the plant regardless of the type, location and function of the equipment being attended to.

Prior to any personnel inspecting or working on any equipment, the control room operator must be notified.

Safe access to all equipment must be provided.

Where exposure to potentially contaminated or hot material, hot dust, or gases is a possibility, adequate and approved head, face, hand and body protection must be employed.

Approved ear protection must be worn in areas of intense and/or prolonged noise.

All walking and access areas must be maintained open at all times.

All access areas and equipment must be maintained free of oil, water, debris, etc.

Inspection ports, doors or hatches on any equipment which may contain hot or toxic gas or material should not be opened while the equipment is in operation unless it is absolutely necessary and then only by authorized personnel.

Extreme care must be exercised whenever inspection ports, doors, or hatches are opened, particularly on any equipment which may contain hot gases or material.

When opening doors or hatches, personnel should stand to the hinged side of the cover using the door itself as protection from the escape of hot or toxic gas or spillage of hot material.

All personnel who are not actively involved in the actual work should stand well clear of the area until it is safe to approach.

The areas around all equipment must be obstruction free and adequately ventilated.

Only authorized and qualified personnel should be permitted to operate or service equipment.

Caution, danger or warning signs should be posted where appropriate to alert personnel to possible hazards.

Personnel must be instructed in the operation of equipment and any emergency procedures that may be required.

In addition to the specific operating and maintenance instructions, all plant safety regulations and normal safety precautions must be observed when servicing and/or operating equipment.

DO NOT, under any circumstances, tamper with or bypass interlocks whether they be electrical or mechanical. Bypassing an interlock defeats its purpose, thereby exposing personnel to serious injury and equipment to serious damage.

Piping and/or equipment which is subjected to extreme high temperatures must be allowed to cool to a safe temperature before servicing the equipment.

All personnel who climb and/or work at extreme heights must wear an approved safety belt harness.

Adequate protection as required must be provided to prevent injuries from pipes, cables, ropes, levers, chains, or other equipment which may be a potential hazard due to its proximity to normal walkways.

Compressed air should never be used to clean dust or dirt from personnel. The force of the compressed air may cause dust or dirt to penetrate the skin and cause injury.

Before removing covers, doors, or hatches, and before anyone enters any equipment, the control room operator must ensure that the equipment cannot be started or jogged either locally or remotely.

The operators in the control room must be informed of impending work and, in addition, the equipment starter must be de-energized by tripping the appropriate breaker on the starter in the motor control center.

The supervisor or operator must then install his locking device. The locking device must not be removed until all work is completed, all personnel in the area are accounted for, and all covers, guards, etc., reinstalled and secured. After these steps are completed, the operators should be informed of the status of the equipment.

Circuit breakers and/or related electrical equipment being serviced should be tagged "out of service".

Isolate the equipment being serviced by closing off all valves or gates associated with the equipment. Tag such valves or gates "out of service" and padlock shut if possible.

When performing maintenance or adjustments which require that the equipment be operating, observe the precautions listed in the specific equipment instructions as well as all normal safety precautions which must be observed when servicing operating equipment.

2.3 Material Hazards

Because hazardous materials may be processed, the responsibility remains with WILLIAMS ENVIRONMENTAL SERVICES, INC. and its personnel, or any other user or operator of WESI*TPU4, to determine the hazards involved with respect to the specific materials being processed and to properly train all persons that may become exposed to such hazards. This training should include the establishment and enforcement of all necessary precautions and procedures, including the provision of protective clothing and equipment, the posting of necessary warning signs and the erection of barricades to protect individuals against the potential for explosion and exposure to materials hazardous to their health. Specific details for each project will be contained in the project health and safety plan.

2.4 Fire

Fires is one of the most serious hazards present in a plant environment. Rapid reaction to any problem in this area is imperative in order to protect plant personnel and minimize equipment losses.

The most critical activity in a fire is the detection of the fire itself. Heat detection or light detection are two methods that can be used to spot fires before the situation becomes unwieldy. Most of the time, however, detection must be done visually by plant personnel. All personnel must be thoroughly trained to ascertain any potential fire and immediately report such conditions to the control room operator. The operator in turn should notify the appropriate personnel, implement actions to contain the fire and, if necessary, shut down the system and evacuate.

Once a fire has been detected, containment and extinction are necessary to minimize damage. Fuel, oxygen and sufficient temperature are required to sustain combustion. The removal of any one of these elements will extinguish a fire. The simplest method is to isolate the fire and let it burn itself out.

In a baghouse, this can be accomplished by closing all inlet and outlet dampers, shutting down the baghouse I.D. fan and shutting off any dust discharge valves. However, due to air leaks that may be present in the baghouse, the fire may continue to burn until all bags are consumed.

In other areas within the system, similar procedures should be followed to isolate the fire from the fuel source and air supply.

Any personnel that come in contact with the fire must be provided with acceptable fire retardant gear. As smoke inhalation is a major hazard with any fire, properly operating inhalation equipment should also be worn by personnel in the area of the fire.

AS A FIRE GENERATES A GREAT DEAL OF HEAT, PERSONNEL MUST BE WARNED AGAINST TOUCHING ANY SURFACES WHICH MAY BE CONDUCTING THE HEAT OF THE FIRE. SERIOUS BURNS CAN RESULT FROM SUCH ACTIONS.

2.5 Explosion

The best and surest method to deal with an explosion is prevention. The vast majority of explosions that occur do so because of operator error. As long as the operator is attentive to the temperatures present in the circuit and maintains a sufficient excess of oxygen in the gas stream, excess combustibles should not form. Hence, the risk of explosion is greatly reduce.

Explosions occur when two of the three elements for combustion (fuel and oxygen) are present and well dispersed, and the third element (ignition source or temperature) is added, after an explosive mixture exists. Avoiding explosions, therefore, can be accomplished by avoiding the above situation. Fuel and air should, therefore, never be introduced to equipment unless a positive ignition source is already present, so that combustion will result instead of an explosive mixture.

Explosions in WESI*TPU4 could occur due to the presence of excess combustibles in the gas stream. Such combustibles are formed by an insufficient amount of oxygen in the area of flame propagation. When a source of combustibles is ignited by a spark, flame or heat source, an explosion occurs.

Should an explosion occur, the procedures outlined previously for fire control should be followed since one of the main dangers associated with an explosion, after the debris has settled, is the ensuing fire that may occur.

2.6 Rotating and Moving Equipment

Rotating equipment is present throughout the plant. By the nature of the power necessary to drive a large rotating apparatus, care must be exercised when dealing with such equipment. The following precautions should be exercised.

Loose fitting clothing should not be worn as it can easily be entangled in moving machinery.

Jewelry such as rings, bracelets, neck chains, etc., should not be worn.

Personnel should not reach or extend themselves over rotating equipment while the equipment is in motion.

Personnel should avoid touching the outer surface of any rotating equipment. Burns or severe contusions can result.

As with all other equipment, procedures laid out in the introduction section should be followed implicitly.

2.7 Auxiliary Equipment

Auxiliary equipment, such as chain and belt conveyors, air locks, and material hoppers, are present in many areas throughout the plant. By observing proper operating procedures when dealing with such equipment, the risk of injury can be minimized. Outlined below is a brief series of instructions which operating personnel should be thoroughly familiar with:

When dealing with pneumatic equipment, be certain to relieve any residual pressure prior to servicing.

Do not attempt to cross or "jump over" any moving conveyors.

Avoid contact with a moving conveyor or any of the rollers, support or drive mechanisms.

Do not open an access entry on a collecting or storage unit when the unit is filled.

Do not open an access door to any collecting or storage unit which is under pressure unless provisions for access, under operating conditions, have specifically been provided.

Do not enter equipment unless it is empty, completely ventilated, cooled to a safe temperature with the entry door to the unit secured in the "OPEN" position, and a supervisor or the control room operator is aware of the entry.

Do not enter equipment without adequate and approved breathing equipment.

Do not enter equipment alone. Always have someone outside the unit ready to render assistance if required.

Do not enter any equipment without first being certain that there is no material or equipment overhead which could fall.

Extreme caution must be exercised when inspecting or working on gates on transfer collectors, receiving and/or separating equipment, air lock valves, etc. At the start of the dump cycle, the dusty material being discharged can be hot. At the end of the dump cycle, the gates will close with sufficient force to cause serious injuries if hands are between the gate and seat.

2.8 Process Gases

Process gases throughout the system may present a hazardous situation if encountered without proper protection. In addition, uncontrolled release of gases may indicate operational difficulties.

In general, process gasses pose a hazard due to their high temperature and entrained particulates. Personnel should avoid direct contact to prevent burns and, even if the gas is cool, should wear appropriate respiratory protection against particulates.

Since the system is designed to treat potentially hazardous materials through volatilization and burning of these constituents, process gases may contain varying concentrations of contaminants depending on location and operational mode.

In locations and situations in which personnel may come in contact with potentially contaminated gases, appropriate respiratory protection should be employed. This particular hazard should be more well-defined in the required training programs.

Additional possible process gas contaminants include carbon monoxide (CO) and acid gases.

The presence of carbon monoxide and hydrocarbons in the combustion gases not only represents a considerable heat loss to the system, but also can result in poisoning or explosion. The main source for the creation of CO is incomplete combustion. The simplest security measure to avoid generation of CO is to provide a sufficient excess of combustion air during the ignition and operation of any burner.

As carbon monoxide is odorless, colorless, and tasteless, caution must be exercised in areas in which CO may be present.

Workmen employed in areas subject to possible concentrations of CO must work in pairs, preferably with one man outside of the area subjected to the presence of CO. Symptoms of carbon monoxide exposure are dizziness, headaches, or nausea. At the first sign of such exposure, the workmen should vacate the area and be administered oxygen.

Another potential danger are acid gases. The presence of acid gases can be noted by choking sensation, watery eyes, and difficulty in breathing. Since they are toxic and very harmful, extreme caution must be exercised when dealing with them.

The following procedures should be followed when plant personnel are about to work in an area in which they may be subjected to any potentially dangerous gases.

Personnel are to inform the Control Room Operator prior to beginning any work on the system. The operator should adjust the system as required to allow a sufficiently negative draft so that potentially harmful gases are contained within the system.

Personnel are to wear properly fitted and equipped respirators if there is a change of contact with any dangerous gases.

As stated previously, workmen must never work alone in an area where potentially dangerous gases may be present.

SECTION 3

PROCESS DESCRIPTION

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SECTION 3: PROCESS DESCRIPTION FOR WESI*TPU4

3.1 GENERAL

The process described in this section employs the WESI*TPU4 Thermal Processing Unit. This process treats soils at temperatures of up to 1000°F in order to volatize the hazardous organic constituents in the soil and achieve required cleanup levels. A description of the major items of equipment which comprise this unit is presented in Section 6.

The dryer is used to volatize moisture and organics contained in the excavated soil. The off-gases from the dryer are then treated in a baghouse filter to remove particulate matter. Destruction of organics contained in the gas stream is accomplished by a thermal oxidizer. Following the oxidizer, a scrubber will remove 99% of the HCl present in the off-gases. A process flow diagram complete with a heat and material balance is included at the end of this section.

3.2 FEED PROCESSING

The feed material for WESI*TPU4 consists of soil which has been excavated and stockpiled on site. The soil is removed from the stockpile with a front-end loader and delivered to the feed metering unit (SF-FU) where it is screened to remove large rocks and debris and then drops into the feed hopper. An apron feeder moves the soil from the hopper to a belt conveyor which will elevate the soil to the feed belt (SF-BC-1) at the dryer. The speed of the apron feeder is regulated from the control room and is used to set the soil feed rate to the dryer at up to 50 tons per hour. The lifting belt contains a load cell for the continuous weighing of the feed soils. The instantaneous and cumulative weights are displayed in the control room. Testing procedures and sampling are as outlined in the Performance Test Plan. Additional screening and rock crushing can be added as required.

3.3 SOIL TREATMENT

A countercurrent thermal desorbing dryer (PC-RD) is used to volatilize (evaporate) the moisture and organic constituents from the soil. The dryer has internal flights to ensure intimate contact between the soils and desorbed gases. The soils enter at the same end where the exhaust gases leave. The exit gas temperature should not exceed 500°F. The actual gas exit temperature is determined by the performance test. While the soil passes through the dryer, the soil temperature initially rises to 212°F as water is removed. After the moisture has been removed, the soils move toward the discharge end of the dryer where the soil temperature increases to as much as 1000°F. Since countercurrent flow is utilized, high exit soil temperatures can be readily obtained.

This rear area, or "superheated" section of the dryer is where the soil is heated sufficiently to volatize the contaminants. Heat is transferred by direct radiation and by conduction from contact with special flights in the hot end of the drum. The soil is converted to ash dust as it rolls around the drum. Dust from the Baghouse is re-introduced into the dryer at the beginning of the hot zone. Any contaminants that may be in the BH dust are volatized completely.

3.4 ASH TREATMENT

The heat- treated soils exit from the dryer into the ash conditioning pugmill (AS-PM) where they are quenched to cool the soil and minimize fugitive dust emissions. A negative pressure is maintained on the soil conditioner to capture any steam from the soil re-moisturization operation. The conditioned soil discharges onto a belt conveyor (AS-BC-3) for stacking. The treated soils are removed from the stacking area by a front-end loader to the interim storage area for subsequent analysis.

Any material not passing analysis after treatment is "recycled" to the waste feed area and placed into piles for further treatment. These piles are resampled in order to verify contaminant concentrations prior to treating them a second time. This "recycled" soil will not necessarily be stored separately from the "virgin" soil, but documentation is kept of the amounts of "virgin" soil processed versus "recycled" soil processed.

3.5 GAS CLEANING

The gas stream leaving the dryer contains particulates, dust, moisture, and volatilized organics. This stream must be treated to remove the particulate and organic matter in order to achieve air emission standards before the gas is discharged to the atmosphere. A baghouse dust collector (BH-DC) and a thermal oxidizer (SC-TO) and an acid absorber (AB-SCR) are used to achieve these removals.

The air from the dryer enters the baghouse below 450°F. It passes through the filter cloth where dust and other particulate matter is "strained" out of the gas stream. Particulate-free gas exits the baghouse at about 400°F. The dust cake is removed from the filter bags by air pressure pulses. It falls into the hopper.

The dust is removed from the baghouse hoppers by three screw conveyors (BH-SC) which discharge into other totally enclosed screw conveyors (BH-SC-6/7), for transfer to the hot end of the dryer for additional heat treatment.

After removal of particulates, the gas stream enters the thermal oxidizer (SC-TO) where oxidation of the volatile organic compounds occurs. The oxidation efficiency depends on the temperature inside the thermal oxidizer, the turbulence of the gases, and the retention time of the gases inside the thermal oxidizer chamber. The chamber is sized to provide sufficient retention time (> 2 seconds) at up to 2000 °F to oxidize the organics. After the organics have been oxidized, the clean gases are quenched to reduce their temperature, then are passed through the scrubber to remove any further particulates and acid gases, and finally through the stack to the atmosphere. The clean stack gases are monitored using a continuous emissions monitoring (CEM) system.

3.6 PROCESS RESIDUAL STREAMS

The WESI*TPU4 operation will generate the following residual streams: (1) oversize debris too large for treatment (> 3 inches cube), (2) treated soil prior to laboratory confirmation

3.6.1 Oversized Material and Debris

Thermal desorption requires a significant amount of material handling. A cutoff size is established through experience in handling on-site soils to determine which material will be screened out. Through experience at other sites, Williams believes the cutoff size will be 3 inches or less. This oversized material will not be treated by the thermal desorption process because it cannot be handled via the material handling equipment involved with the thermal desorption process.

3.6.2 Treated Soil Prior to Laboratory Confirmation

Treated soils exit the rotary dryer and pass through the Ash Handling system. The treated soils are removed from the stacking area by a front-end loader to an interim storage area for subsequent sampling and analysis. While awaiting laboratory confirmation, soil piles remain within the confines of the containment area and are covered by plastic sheeting. The covering helps prevent dusting due to wind and runoff due to rain. Any runoff that may occur from the treated soil piles is collected in a sump and further treated by the unit's aqueous phase carbon adsorption system.

3.7 PROCESS HEAT & MASS BALANCE

The process heat and mass balance will depend on throughput rate and moisture content of the feed, among others. Heat requirements of the feed are mainly utilized for the vaporization of moisture from the contaminated soil. Hence, process gas flow and feed rate of soil will depend on the moisture content of the feed. Table 3.7.1 shows a typical heat and mass balance for the case of 20% feed moisture content at 30 tons per hour. Figure 3.7.2 shows a typical Process Flow Diagram for WESI*TPU4.

TABLE NO. 3.7.1 TYPICAL HEAT AND MASS FLOW DATA FOR WESI*TPU4

		(1) WASTE FEED	(2) TREATED SOIL	(3) DESORBER BURNER	(4) DESORBER OFFGAS	(5) OXIDIZER BURNER	(6) OXIDIZER OFFGAS	(7) QUENCHER OFFGAS	(8) STACK GAS	(9) DUST CONTROL	(10) MAKE UP WATER	(11) BLOW DOWN	(12) RECYCLE WATER	(13) QUENCHED SOIL
DRY GAS	LB/HR			67,816	53,749	95,121	141,374	141,374	141,374					
DRY SOLIDS	LB/HR	56,000	50,400											50,400
THERMAL CAPACITY	MM BTU/HR			38		99								
N2	LB/HR			42,237	42,237	69,716	111,953	111,953	111,953					
O2	LB/HR			25,579	8,308	20,824	10,473	10,473	10,473					
CO2	LB/HR				5,204		18,948	18,948	18,948					
H2O	LB/HR	14,000			21,011		28,508	108,184	116,603	15,000	103,095	94,676	79,676	10,200
HCL	LB/HR	0.038							.00038					
FUEL USAGE	LB/HR			1,735		4,581								
TEMPERATURE	°F	60	600	60	450		1,850	250	185					180
TOTAL MASS SOLID	LB/HR	70,000												
TOTAL GAS MASS	LB/HR			69,551	74,760	95,121	169,881	249,557	257,976					
TOTAL GAS VOLUME	ACFM				33,102		178,106	92,983	88,121					
Contaminants: (based on average concentration of BCEE in the soil)	LB/HR/1000	70	0.05		69.95		0.007	0.007	0.007					

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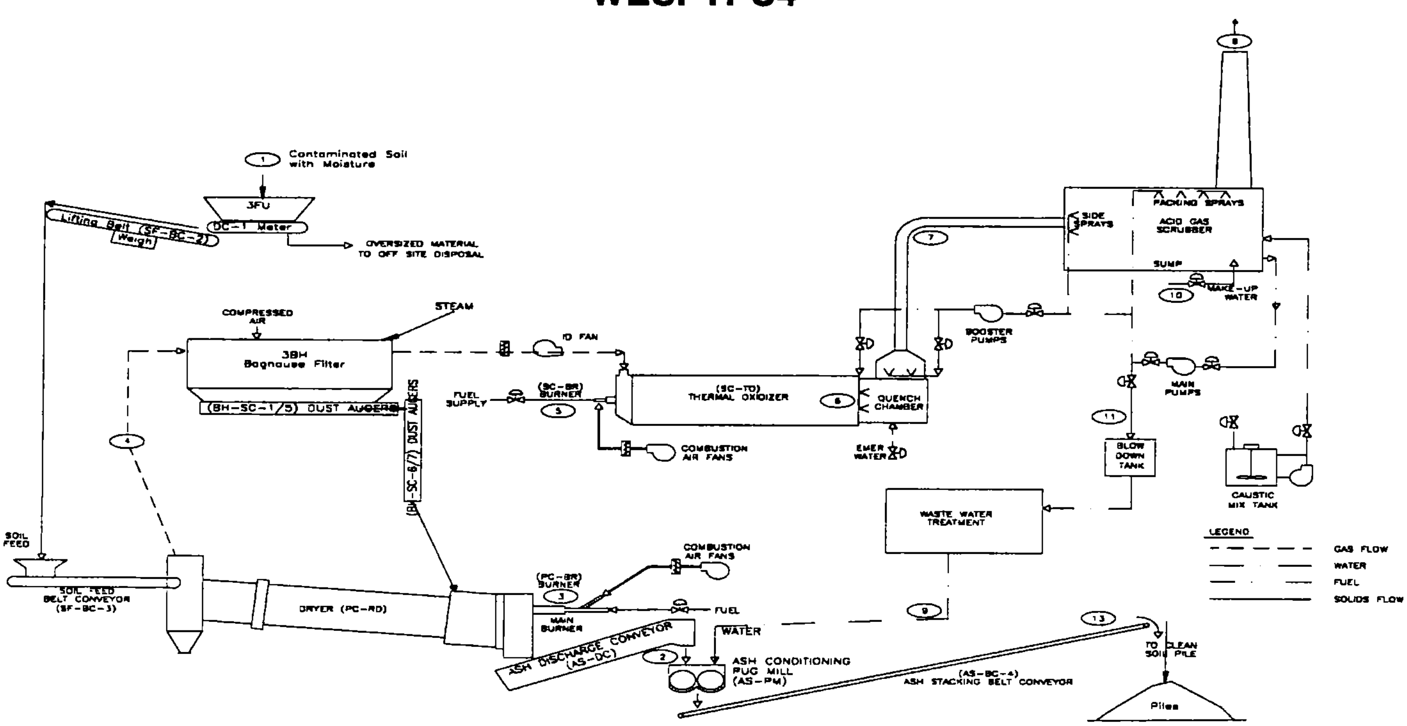
FIGURE NO. 3.7.2 TYPICAL HEAT AND MASS FLOW DIAGRAM FOR WESI*TPU4



from 4PFD-typ.DWG

Events Triggering Emergency Control System

ITEM	CONTROL ACTION
High quench tower outlet temperature Alarm at >200°F, VO>250°F	VO
High acid gas scrubber temperature or loss of water flow, alarm at >200°F, VO at 250°F	VO
Loss of water to quench tower	VO
Draft less than -0.01" w.c. in dryer for >15 seconds	AWFSO
Low scrubber pH, determined during Performance Test 2-minute rolling average	AWFSO
CO >100 ppm, 1 hour rolling average (7% O_2)	AWFSO
High dryer off-gas temperature >510°F	VO
Low dryer off-gas temperature <250°F	AWFSO
Dryer and thermal oxidizer burner system failure	AWFSO
Low thermal oxidizer temperature (determined by stack testing)	AWFSO
Low oxygen in the combustion gases (<3%)	AWFSO

NOTES:

1. VO = vent opening.
2. AWFSO = automatic waste feed shutoff.
3. In addition to automatic operation, both the AWFSO and VO can be activated manually at the operators' discretion in the event of an emergency.

SECTION 5

CONTROL & MONITORING

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5.1 CONTROL CONCEPTS

Control of WESI*TPU4 is from the Control Trailer (4CON). All motor starters and Start/Stop stations are in this trailer. Equipment is started and stopped with PUSH/PULL START/STOP buttons (push to start - pull to stop), located on the control panels.

Some electro-mechanical interlocks are utilized, but the majority of interlocks are accomplished electronically in the PLC (Programmable Logic Controller).

Electrical signals (4-20 mA) are fed into the PLC, where they are analyzed and compared to time status and other signals. Output signals are then sent to equipment switches and panel devices to start/stop the equipment and to display status messages and alarms.

Groups of motors are started in preset sequences.

The PLC uses programmed logic and decisions to accomplish equipment interlocks and to announce alarms.

WESI*TPU4 control details are presented diagrammatically in Process Instrumentation and Control Diagrams in this section. They are described in Section 5.7.4.

PLC alarms and interlocks and their logic are described in Section 5.7.

Process flow rates, process temperature and pressure points and process gas monitoring points with estimated alarm point settings, normal operating ranges and instrument ranges are tabulated in Tables 5.6.1 through 5.6.5.

See Section 3.7 for description of processes for WESI*TPU4.

CRITICAL CONTROL CONDITIONS

The control strategy for the WESI*TPU4 system is straight forward. The dryer exit gas temperature is controlled manually by the dryer fuel control valve to maintain the temperature less than 500°F. The thermal oxidizer exit temperature is automatically controlled by the burner fuel control valve to maintain temperature at the set point. The inlet gas temperature to the acid gas scrubber controls the quencher water control valve to maintain the scrubber inlet gas temperature.

AWFSO: Automatic Waste Feed Shut-off. This term describes a critical status that automatically stops the flow of soil materials into the system, by turning OFF the soil feed metering unit (SF-FU). The AWFSO can be triggered by several conditions; when any of the AWFSO conditions exist the soil feed metering unit is automatically shut down.

VSO: Vent Stack Opening. This term describes another critical status that automatically opens the air vent valves (BH-EV) to allow cool air to mix with the hot process gas, to reduce its temperature to a safe level. See Section 6.1.4 for Equipment Description. A high temperature (>500°F) of dryer off-gas will trigger an automatic vent stack opening (VSO). When VSO occurs, fuel and waste feed are stopped. The emergency vent stack will open with the following events:)

(1) Dryer Off-gas High Temperature - >500°F.
(2) Loss of compressed air.
(3) Loss of system electrical power.
(4) Manual override.

5.2 PLC PROGRAMMABLE LOGIC CONTROLLER

WESI*TPU4 uses an Allen Bradley programmable logic controller (PLC) to control all of the major start/stop sequencing, alarm annunciation, and interlocking functions. The PLC was chosen over a traditional relay system for its versatility and reliability. Since permit conditions change with each job, the PLC provides a means of incorporating these changes by software modifications, rather than changes in hardwiring. Major functions of the PLC include the following:

1. Ensures that the operator starts and stops the soil feed and discharge systems in the proper order, so as to prevent clogging.

2. Properly annunciates alarm status, and AWFSO or VSO if conditions are met, to the operator
3. Monitors all system motors and displays overload conditions when they exist.
4. Provides system interlocking functions to assure that all major systems on the unit are started and stopped in the proper order.

5.3 INTERLOCKS

The following conditions are used by the PLC to perform the interlock functions:

1. ID Fan Damper: Close damper before ID Fan is allowed to start
2. Emergency spray: Pressure switch must be closed before ID Fan is allowed to start

3P. PCC Burner: interlocks
 a.) ID Fan running
 b.) burner turbo fan running
 c.) burner combustion air flow switch closed
 d.) burner tertiary fan running
 e.) burner tertiary air pressure switch close
 f.) baghouse not at high temp
 g.) ID Fan air flow switch closed
 h.) PCC burner not greater than high temp setpoint
 i.) Ip pressure switch closed

3S. SCC Burner: interlocks
 a.) ID Fan running
 b.) burner turbo fan running
 c.) burner combustion air flow switch closed
 d.) burner tertiary fan running
 e.) burner tertiary air pressure switch close
 f.) baghouse not at high temp
 g.) ID Fan air flow switch closed
 h.) SCC burner not greater than high temp setpoint
 i.) Ip pressure switch closed

4. Soil Feed System: - Automatic
 a.) Discharge Ash
  1.) Stacking Conveyor
  2.) Left Pugmill - stacking conveyor must be running
  3.) Right Pugmill - left pugmill must be running

 *if right pugmill trips under overload condition it will also stop the left pugmill
  4.) Lifting Slat Conveyor - right pugmill must be running
 b.) Dryer Drive - lifting slat conveyor must be running
 c.) Feed Drive
  1.) Soil Feed Belt - dryer drive must be running
  2.) Soil Lifting Belt - soil feed belt must be running
 d.) Feed Metering Unit - soil lifting belt must be running.

5. Soil Feed System: - manual
 a.) Discharge Ash System, Dryer Drive, Feed Drive System, or Feed Metering Unit can be started or stopped in any sequence without affecting other motors. Baghouse auger interlocks will also be bypassed when in this mode. Therefore, any auger can be started or stopped without affecting other motors.

6. Baghouse Screws:
 a.) Outer Transfer Auger - stacking conveyor, left pugmill, right pugmill, and lifting slat conveyor must be running
 b.) Inner transfer Auger - outer transfer auger must be running
 c.) Lifting Auger - inner transfer auger must be running
 d.) Cross Auger - lifting auger must be running
 e.) Left Auger - cross auger must be running
 f.) Center Auger - cross auger must be running
 g.) Right Auger - cross auger must be running

*if left, right, or center auger trips - alarm only

Reversing:

If any auger is switched to reverse - there will be a 15 sec. delay before any forward interlocks become active and initiate their controlled shutdown.

7. Quench/Scrubber Water:
 a.) Front Sump Water Pumps can not start if front sump is at low-low level.
 b.) Rear Sump Water Pumps can not start if rear sump is at low-low level.
 c.) Emergency Sprays operate with loss of power <n.o. solenoid> or scrubber inlet temperature reaches high level setpoint
 d.) Emergency Spray Pressure Switch must be closed before ID Fans can start
 e.) Level Switches and Water Makeup Solenoids
  1.) Continuous Water Makeup

Master power on - valve energizes. Valve will remain energized until the water level reaches the high level switch plus time. At the end of the time period the solenoid will be deenergized. Any time the water l evel goes below the high level switch, the solenoid will be energized.

2.) Intermittent Water Makeup Solenoid energizes when water level goes below the low level switch and will remain on until the level reaches the high level switch.

f.) Booster Pumps Operation

1.) Pumps can not start unless manifold water pressure switch (PS 7332) is closed, indicating water pressure at the inlet of the pump.

2.) Operator will rotate the pumps in and out of service as needed to maintain consistent water flow to the quencher.

8. <u>VSO - Baghouse Control:</u>

a.) closes with power failure - valve arrangement

b.) PCC Exit Gas High Temp opens one vent

c.) PCC Exit Gas High High Temp opens the second vent

9. <u>ID Fans:</u>

When the fan pushbutton is pulled to start the fans, the ID Fan Damper must first be closed and the emergency sprays water pressure switch must be closed. The PLC controls a relay that is wired into the damper circuitry for closing the damper. Once the PLC receives a "Damper Closed" input the fans can start. When both fan motors are running, the relay will be deenergized allowing normal damper control. Until the damper closes and both fan motors are running, the ID Fan pushbutton indicating light will flash at a slow rate.

5.4 ALARMS

The following typical alarm conditions are established with their results. These alarm conditions may be modified from site to site depending on permit conditions.

	CONTROL ELEMENT CONDITION	RESULTS
1.	PCC Exit Gas High High Temp >500° F. (from burner controller)	AWFSO and Annunciator display of alarm message (VSO - done through baghouse controls)
2.	PCC Exit Gas High Temp: >450° F. (datalogger - 20 minute rolling average)	AWFSO and Annunciator display of alarm message
3.	PCC Exit Gas Low Temp <250° F. for longer than 1 minute, (from burner controller)	Annunciator display of alarm message
4.	SCC Exit Gas Low Temp <1800° F. (datalogger - 20 minute rolling average)	AWFSO and Annunciator display of alarm message
5.	PCC Burner Flame Failure (from burner system)	AWFSO and displays alarm message on Annunciator.
6.	SCC Burner Flame Failure (from burner system)	AWFSO and displays alarm message on Annunciator.
7.	Quench Outlet High Temp	For >200° F (from T1819)

Annunciator display of alarm message.

8.	Quench Outlet High High Temp. For >250° F (from T1819)	AWFSO and Annunciator display of alarm message
9.	Dryer Vacuum - For < 0.01" w.g. vacuum, 5 minutes after starting ID Fans and vacuum goes positive for 15 sec.	AWFSO and Annunciator display of alarm message
10.	Baghouse Delta P Less than 1" w.c.	AWFSO and Annunciator display of alarm message
11.	Front Sump pH - Less than 4.0 for longer than 5 minutes.	AWFSO and Annunciator display of alarm message
12.	Rear Sump pH - Less than 4.0 for longer than 5 minutes.	AWFSO and Annunciator display of alarm message
13.	Loss of water to Duct Quench - From (FI707)	AWFSO and Annunciator display of alarm message
14.	Loss of water to Main Quench - From (FI706)	AWFSO and Annunciator display of alarm message
15.	Acid Gas Scrubber Front High Temp For >200° F. (from TI8110)	Annunciator display of alarm message
16.	Acid Gas Scrubber Front High High Temp For >250° F. (from TI8110)	AWFSO and Annunciator display of alarm message
17.	Carbon Monoxide (CO): Greater than 100 ppm, corrected to 7% O2 (Datalogger - 1 hour rolling average)	AWFSO and Annunciator display of alarm message
18.	Loss of water flow to front scrubber (FI700)	AWFSO and Annunciator display of alarm message
19.	Loss of water flow to rear scrubber (FI701)	AWFSO and Annunciator display of alarm message
20.	Stacking Conveyor Speed Switch - check 3 sec after stacking conveyor is running	Annunciator display of alarm message.
21.	Discharge Soil Temperature Low: <500° F. from (TI112), 20 minute rolling average	AWFSO and Annunciator display of alarm message

22.	Discharge Soil High Temp >600° F. from (TI112), 20 minute rolling average	AWFSO and Annunciator display of alarm message
23.	BH Hopper Left Compartment High Level	Indicator light flash until acknowledged and then burn continuous
24.	BH Hopper Middle Compartment High Level	Indicator light flash until acknowledged and then burn continuous
25.	BH Hopper Right Compartment High Level	Indicator light flash until acknowledged and then burn continuous
26.	Compressed Air Pressure Low	Annunciator display of alarm message
27.	Baghouse Inlet High temp (TE 313 Baghouse controls)	Turns burners off and Annunciator display of alarm message
28.	Manifold water pressure switch (PS 7332) opens	Turns Booster Pumps off and displays alarm message on Annunciator.
29.	Thermal Oxidizer Oxygen Concentration Low: <4%	Annunciator display of alarm message
30.	Thermal Oxidizer Oxygen Concentration Low: <3%	AWFSO and Annunciator display of alarm message
31.	Soil Feed Rate High: >40 TPH, 60 minute rolling average	AWFSO and Annunciator display of alarm message
32.	ID Fan Failure: Loss of power to motor.	AWFSO and Annunciator display of alarm message
33.	Electric Power Failure: Loss of electrical power to unit.	AWFSO and Annunciator display of alarm message

34.
a.) alarm silence
b.) alarm tweeter
c.) soil feed system - auto/man
d.) discharge chute water - off/on
e.) id fan damper close limit switch
f.) id fan damper open limit switch
g.) front sump low-low level, low level, and high level
h.) rear sump low-low level, low level, and high level
i.) quench water spray water pressure switch (pe739)

35. AWFSO alarms
a.) Alarm tweeter continuous and displays alarm message on Annunciator./annunciator
b.) Depress silence pushbutton - alarm is silenced
c.) If alarm message is on display, start a 15 sec. timer
d.) At the end of the 15 sec., clear the display

36. Motor alarms and Misc. alarms
a.) Alarm tweeter on for 3-5 sec. and displays alarm message on Annunciator.
b.) Depress silence pushbutton
c.) Start 15 sec. timer
d.) At the end of the 15 sec., clear the display

5.5 CEM CONTINUOUS EMISSIONS MONITOR

5.6 OPERATING CONDITIONS

This section defines control and monitoring loops and states their Operating Ranges, Alarm Limit Settings and Device Ranges. The locations of these loop sensing points are shown in the Process Instrumentation and Controls Diagrams (P&ID) in Section 5.7. Soil conditions before and after processing are described in Section 5.6.1. Process flow rates are described in Section 5.6.2, equipment speeds are shown in Section 5.6.3, temperatures and pressures are shown in Section 5.6.4, and stack monitoring is shown in Section 5.6.5.

5.6.1 SOIL CONDITIONS

Typical parameters related to soils processed by WESI*TPU4 are described herein, including moisture content before and after processing, and flow rates thru the equipment.

Moisture Content, before	15-25%	Soil Btu value	Negligible
Soil Material Size	<2"	Soil Rewetting percent	12%

5.6.2 PROCESS FLOW RATES

The following flow parameters are monitored and controlled.

TABLE 5.6.2

INDICATOR NO.	FLOW ITEM DESCRIPTION	OPERATING FLOW RANGE	EQUIPMENT RANGE
WI-170	Dryer Feed Rate	25-50 TPH	135 TPH
PDI-232	Fuel rate to dryer burner	________	________.
PDI-435	Fuel rate to secondary burner	________	________
FI-729	Ash Cooling Water Controlled by manual proportional flow valve.	________	________GPM
AI-650	PCC Off-gas Oxygen	3 - 6%	
AI-851C	SCC Off-gas Oxygen	3 - 6%	
CALC	SCC Residence Time Based on Slope & RPM of Drum	2 seconds	1-3 seconds

5.6.3 EQUIPMENT SPEEDS & SETTINGS

Material through-put is regulated by the variable speed drive on the feeder. The feeder speed is controlled to maintain a reasonably constant contaminated soil feed rate for stable dryer operation. Rotational speed of the dryer is controllable by electric remote control of the variable belt gear reducer drive.

Increasing the rotational speed will decrease the residence time in the dryer. It also affects soil and off-gas temperatures. The feed rate and dryer speed are determined by the temperatures and pressures in the system and the ability to maintain draft. The position of the ID fan damper determines the overall system draft and is controlled manually to maintain a constant negative dryer pressure.

TABLE 5.6.3

EQUIP NO.	PARAMETER DESCRIPTION	OPERATING RANGE	EQUIPMENT RANGE
M-164	Belt Feeder Speed	25-50 TPH	0-100 TPH
SI-181	Dryer RPM Controlled by variable speed drum drive, manually	1.5 - 2.5 RPM desired	2.5-4.5 RPM
HIC-642	ID Fan Damper Controlled by Dryer Pres	0-100% (manual)	0-100% Open
Calc	Dryer Drum Slope Controlled by manual Jacks	1.5° - 2.5°	0-6.5°
Calc	Soil Residence Time	>30 minutes	15-60 minutes

5.6.4 TEMPERATURE & PRESSURE

Temperatures and pressures are set to maintain overall process gas-heat flow conditions throughout WESI*TPU4. These loops, manual and automatic, set and monitor the temperatures and pressures, that ultimately determine the production rate and thermal efficiency of the system.

Draft (dryer pressure) is controlled manually (via ID fan damper) to maintain a negative pressure at the burner end of the dryer. The dryer off-gas temperature (via fuel valve) is controlled manually to maintain a temperature less than 500°F. The secondary combustion chamber off-gas temperature is also controlled via fuel valve. The process pressure and temperature control loop characteristics are shown below.

TABLE 5.6.4

INDICATOR NO.	PARAMETER DESCRIPTION	ALARM SETTING	OPERATING RANGE	INSTRUMENT RANGE
TI-112	Soil Ash Temp	450° F (LOW) 1000° F (HIGH)	500-900°F	32-2100°F
TIC-310	Dryer Gas Exit Temp Type K T/C Controlled by Proportioning Fuel Flow Control Valves, (Manually)	250° F (LOW) 475° F (HIGH)	375-450° F	32-2100° F
TI-313	Baghouse Inlet Temp	450° F.	350-425° F.	32-2100° F.
PDIT-330	Dryer Pressure at burner end with 15 second delay Controlled by Damper Actuator via Controller	(-)0.01" w.g.	(-)0.1" to 0.15" w.g.	0" to (-)0.5" w.g.
TIC-518	Secondary Combust Off-gas Temperature Controlled by Proportioning Fuel Flow Control Valves, (Manually)	1400° F. (LOW) 2100° F. (HIGH)	1400-1800° F.	32-2100°F
PDI-634	Baghouse Pressure Differential		3"-4" w.g.	0-10" w.g.

PDI-637	ID Fan Differential		18"-22" w.g.	0-25" w.g.
PI-638	Compressed Air	80 psi (LOW)	90-110 psi	0-125 psi
Not Monitored	Soil Pile Temperature		200° F. max desired	
Design	ID Fan Static Pres. Controlled by drive speed		25" w.g. @ 425° F.	0-30" w.g.

5.6.5 STACK MONITORING

TABLE 5.6.5

INDICATOR NO.	ALARM DESCRIPTION	ALARM SETTING	OPERATING RANGE	INSTRUMENT RANGE
AI-851A	Carbon Monoxide 60 min. rolling avg.	100 ppm (HIGH)	0-100 ppm	0-100,0-500 ppm
Ai-851C	Stack Gas Oxygen	<3%	3-6%	0-25%
AI-851B	Carbon Dioxide	None	8-15%	0-20%
AI-851D	Total Hydrocarbons 60 min. rolling avg.	50 ppm (HIGH)	<20 ppm	0-100 ppm

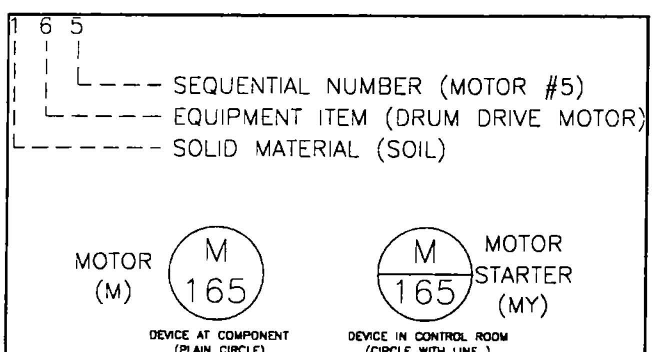
5.7 PROCESS CONTROL and INSTRUMENTATION DIAGRAMS (P&ID)

P&ID drawings are used to convey the relationships between control and monitoring elements of the entire system. They illustrate graphically how the control and monitoring philosophy is implemented.

Four main drawings are used to depict the entire P&ID for WESI*TPU4. Each major trailer system is shown separately: 4PCC, 4BH, 4SCC & 4ABS. The Quencher system is included with 4SCC, even though its components are physically divided between 4SCC and 4ABS.

Sub-systems are also shown as separate views of the complete system. Descriptions are provided to explain the operation and purpose of each element of each sub-system.

Descriptions of the P&ID items are tabulated in Section 5.7.8.



5.7.1 P&ID Identification System

Each element in the system is given a unique number symbol, so it can be identified and tracked. The number is placed inside a circle or square and attached to the equipment component or other control/monitor element.
Squares are used for PLC items and circles for everything else. A line across the middle means the item is located in

the Control Room; no line indicates the item is field mounted at the equipment itself.

The identifier is made up of an alpha character set on the top and a numerical number at the bottom.

The numerical segment describes the item being controlled or monitored. It is made up of three parts:

1st	Type of Stream
2nd	Type of Element
3rd	Sequencial Number

The alpha segment is a code for the device that does the controlling or monitoring, and it can represent the equipment component also.

5.7.2 Alpha Segment of P&ID Identifier:

The alpha segment is made up of standard code letters, standardized by ANSI/ISA, that stand for industrial devices. They are combined to form unique identification codes for specific pieces of equipment. The following list is used by WESI*TPU4:

AAH	Analytical Alarm, High
AAL	Analytical Alarm, Low
AE	Analytical Element
AI	Analytical Indicator
AIC	Analytical Indicator & Controller
AR	Analytical Recorder
AT	Analytical Transmitter
AWFSO	Automatic Waste Feed Shut Off
F	Fan or Blower
FE	Flow Sensor Element
FFA	Flame Failure Alarm
FI	Flow Indicator
FT	Flow Data Transmitter
HIC	Hand Indicating Controller
HS	Hand Switch
HSF	Hand Switch, Forward
HSR	Hand Switch, Reversing
I	Interlock
II	Current Indicator - Motor Amp Meter
LAH	Level Alarm, High
LAL	Level Alarm, Low
LE	Level Sensing Element
M	Motor
MY	Motor Starter
P	Pump
PAH	Pressure Alarm, High
PDA	Pressure Differential Alarm
PDI	Pressure Differential Indicator
PDR	Pressure Differential Recorder
PDT	Pressure Differential Transmitter
PE	Pressure Sensing Element
pH	pH
PI	Pressure Indicator
PR	Pressure Recorder
PS	Pressure Switch
PT	Pressure Transmitter
S	Solenoid Actuated Valve
SAL	Speed Alarm, Low
SI	Speed Indicator
ST	Speed Transmitter
TAH	Temperature Alarm, High
TAL	Temp Alarm, Low
TE	Thermocouple
TI	Temperature Indicator
TIC	Temperature Indicating Controller
TR	Temperature Recorder pen
TT	Temperature Transmitter
WE	Weight Sensor
WQI	Weight Indicator (rate & total)
WR	Weight Recorder
WT	Weight Transmitter
ZZ	Linked Actuator

5.7.3 Numerical Segment:

The numerical segment of the P&ID Identifier is made up of three parts:

1st: Describes what the electrical component is controlling, or what the sensor is monitoring..
2nd: Describes the electrical component or sensor.
3rd: Sequential number of like components.

COMPONENT NUMBERING SUMMARY

FIRST DIGIT

1	SOLID MATERIAL
2	FUEL PRIMARY COMBUSTION CHAMBER
3	FLUE GAS PCC
4	FUEL SECONDARY COMBUSTION CHAMBER
5	FLUE GAS SCC
6	FLUE GAS BAGHOUSE
7	LIQUID MATERIAL
8	FLUE GAS SCRUBBER/QUENCH

SECOND DIGIT

FLOW	0
TEMP	1
CURRENT	2
PRESSURE	3
POSITION	4
ANALYZER	5
EQUIP	6
WEIGHT	7
SPEED	8
FLAME	9

LAST DIGIT

CHRONOLOGICAL NUMBERING OF LIKE COMPONENTS

3PID-NOS.dwg

Three digits are combined into a single unique number that identifies the element.

The last number can be more than one digit, such as 65. Number 301 is made up of "3","0" & "1", where "3" = Flue Gas in the PCC, "0" = Flow of gas, and "1" = first in the sequence.

5.7.4 P&ID Drawings

P&ID drawings for WESI *TPU4 are included in the LTVS Work Plan.

SECTION 6

EQUIPMENT DESCRIPTIONS

TABLE OF CONTENTS

6.1 EQUIPMENT DESCRIPTION

This description is to be used with the WESI*TPU4 process flow diagram shown in section 3.7 and equipment drawings at the end of this section. The overall WESI*TPU4 system consists of soil processing units, dryer, ash handling equipment, emergency vent, baghouse, induced draft fan, thermal oxidizer, quencher, acid gas scrubber, stack, burner systems, and control room. The pollution control system is state-of-the-art, with a dust collector, thermal oxidizer and acid gas scrubber. The system is designed to treat 30-50 tons per hour of soil at 15-20% moisture content and meets the performance requirement for reducing organic contaminant levels from contaminated soil at most sites. The major components of the system are described below.

6.1.1 SOIL HANDLING EQUIPMENT

The Soil Handling Equipment consists of the optional Rock Crusher (SF-RC), optional Soil Prescreen Unit (SF-PS), Soil Metering Unit (SF-FU), Soil Lifting Belt Conveyor (SF-BC-2), and Soil Feed Belt Conveyor (SF-BC-3).

SOIL HANDLING

Soil material handling can often be the largest operational challenge in the thermal treatment process. Soils with high clay and moisture content are difficult to handle compared with sandy soils. The soil processing unit for the WESI*TPU4 system is specially designed and built to handle difficult clays. Operational parameters cannot always be modified to accommodate variable soil conditions, therefore, mixing or blending of waste feed material is sometimes required.

Handling of waste feed material is kept to a minimum to prevent entrainment of dust and vapors in the air. Therefore, Williams anticipates hauling untreated soils directly from the stockpiles to the treatment unit. Engineering controls are used to minimize fugitive dust emissions where applicable, such as on haul roads from stockpiles. Additionally, energy-intensive operations most likely to entrain dust and vapors, such as vibratory screening of oversize material, are performed only as needed because of their potential to create significant dust. It is not anticipated local exhaust ventilation will be required to meet the required levels of airborne concentrations of dust and vapors during the normal processing of soil material.

PRE-SCREENING

Contaminated soil can be pre-screened prior to thermal processing. Size screening enhances the efficiency of thermal treatment and protects the integrity of the feed and discharge systems of the unit. The material is initially screened to remove particles larger than three inches, as well as other large debris. The handling of oversized material is discussed in Section 3.6.1.

ROCK CRUSHING

Soil materials that are oversize can be crushed, so they can be processed through WESI*TPU4., rather than decontaminating them separately.

SOIL METERING

Prescreened soil is delivered to the soil hopper by a front-end loader. The soil is re-screened through a bar grate, then passes into the hopper of the Soil Metering Unit (SF-FU) and onto its soil lifting belt conveyor, where it passes over the weigh scale. Williams' material handling units are equipped with several different screen sizes. The screen size to be used during production operations is selected on the optimum unit performance prior to the performance test. The speed of the apron feeder is adjustable to control the soil feed flow rate.

LIFTING AND WEIGHING

The Soil Lifting Belt Conveyor (SF-BC-2) receives metered soil and lifts it up onto the Soil Feed Belt Conveyor. The soil is weighed as it travels up the Lifting Belt. Measurements from the weigh belt scale provide the pay basis for projects.

SOIL FEEDING TO DRYER

Soil materials received from the lifting belt are fed into the rotary dryer drum through the gas exit breeching, via the Feed Belt Conveyor.

6.1.2 ROTARY DRYER (4PCC)

4PCC is the primary combustion unit for TPU4. It is a 12' wide X 78' wide trailerized system consisting of a dryer drum and rotating mechanisms, burner and blowers, soil feed belt, power and control circuits, all mounted on an integral 3-axle trailer frame.

The rotary dryer is a thermal dryer, in that it uses heat to desorb (or volatize) contaminant hydrocarbons out of the soil and into the gas stream.

The dryer (PC-RD) consists of a rotary drum dryer with internal flights for lifting and showering the solids through the hot gas stream. The repeated spilling action veils the material through the hot gas stream, raising the soil temperature to approximately 600°F to 1000 F. The desired soil temperature depends on the physical characteristics of contamination and the cleanup levels required. Moisture is evaporated and hazardous waste constituents in the soil are volatized or desorbed.

Operation of the dryer is countercurrent, with heat supplied by a direct-fired burner (PC-BR). Retention time in the dryer varies based on dryer speed and the slope of the unit, and is typically between 15 to 20 minutes. Countercurrent flow of gas and solids gives greater heat transfer efficiency with a given inlet-gas temperature. The discharge end of the rotary dryer is constructed of stainless steel to withstand temperatures up to 1200°F. The system is flexible enough to process high moisture (up to 40%) and organic content (up to 10%) in the soil.

Heated air is provided to the dryer by a gas fired burner (PC-BR). This burner is located away from the dryer so that no direct oxidizing flame comes in contact with the soils. Combustion air for the burner is provided by separate blowers, but the overall draft is maintained by an I.D. fan (BH-ID) located after the baghouse. The pressure at the burner end of the dryer is monitored and the I.D. fan damper is regulated to maintain a negative pressure inside the dryer at all times.

Heat-treated soils exit the dryer from the discharge end breeching into the discharge dragslat conveyor (AS-DC).

Gases exit the rotary dryer through the transition ductwork above the feed input. The temperature of the off-gases is monitored to prevent any condensation of organic compounds in the duct and the baghouse.

Dust from the Baghouse is returned to the dryer for final heat treatment. It enters the Dobson Collar on the hot end of the dryer. It is a chute opening in the drum, allowing gravity to drop the dust materials into the inner end of the superheating zone. The dust mixes with the existing hot ash material. As the relatively small flow of material mixes with the hot material that progresses through the entire drum, it is heated through convection from the gas. While this is taking place, it is being heated by the radiant energy given off by the flame gases. In this portion of the drum, the material rolls on the surface of the hot drum and insulating flights. It gains most of its heat from this conduction process.

6.1.3 ASH HANDLING EQUIPMENT

The Ash Handling System handles heat-treated soils and consists of the Ash Discharge Conveyor (AS-DC), the Ash Conditioning Pugmill (AS-PM) and the Ash Stacking Belt Conveyor (AS-BC-4).

Processed soils are conveyed into the ash conditioning pug mill (AS-PM) where they are spray-quenched to cool the material and suppress fugitive dust emissions. The stacking conveyor (AS-BC-4) is used to generate temporary treated soil stockpiles which are then sampled for verification analyses.

ASH DISCHARGE CONVEYOR (AS-DC)

The Ash Discharge Conveyor is a drag slat conveyor that receives 600°-1000°F ash from the bottom of the Dryer Burner Breeching, and conveys it on an upward slope to its discharge point above the Pugmill.

ASH CONDITIONING PUGMILL (AS-PM)

The pugmill is a conventional 12' dual shaft counter-rotating mill with hardened hammer faces, all facing in the flow direction. Its sole purpose is to mix water thoroughly into the ash to convert it back to usable soil.
As the ash dust falls into the pugmill, it is sprayed with water for initial quenching. As it travels through the pugmill vessel, it is additionally cooled to below the boiling temperature with more water sprayed into the mixture created by the rotating arms.

Additional water is introduced to moisturize the ash to usable soil, usually 8% to 15% because dry soil does not compact well. Water spray is also used to prevent fugitive dust emission, by wetting airborne dust particles so they coagulate back into the mixture. Steam is generated during the quench and cooling processes. It is pulled by negative pressure out of the top outlet, through a small duct, and into the baghouse, where any airborne dust is trapped on the filter cake.

ASH STACKING BELT CONVEYOR (AS-BC-4)

The stacking conveyor receives damp soil from the pugmill and lifts it on its sloping belt, up high enough, to develop piles of processed soil. It is pivoted manually on pneumatic rubber tires to create multiple piles about 30 feet in diameter containing about 100 tons each. Removable covers are utilized to prevent wind from blowing the dust off the belt. The stacking conveyor is capable of producing treated soil piles in excess of 400 tons.

6.1.4 BAGHOUSE (4BH)

The Baghouse is the system dust collector and prime air mover, which consists of the Baghouse Dust Collector (BH-DC), Crossover Duct from 4PCC (PC/BH-D), Emergency Vent (BH-EV), Dust Discharge Screw Conveyors (BH-SC), Induced Draft Blower (BH-ID), Crossover Duct to 4SCC (BH/SC-D), and the Compressed Air System (BH-AC).

Off-gases from the dryer are processed to remove particulates. Particulates in the gas stream are filtered in the baghouse (BH-DC). The baghouse is designed to give optimum air to cloth ratio of 3.5:1 (5:1 max) and provides above 99% efficiency for removal of particulates. The filter media can withstand temperatures in the range of 500°F and has excellent resistance to corrosive atmospheres.

The baghouse cleans by pulse jets of compressed air that expand the flexible bags and dislodge the filter cakes. Baghouse dust is removed to the discharge auger system (BH-SC), where it is additionally heat-treated in the rotary dryer fines collar and mixed with dryer ash for ash treatment. This closes the solids loop in the treatment process.

BAGHOUSE DUST COLLECTOR (BH-DC)

The baghouse is a trailerized dust collector consisting of (1) a side entry (either side) drop-out chamber located near the front of the trailer, where the larger particles drop out of the air stream and fall into the bottom screw conveyors; and (2) the main filter box containing 9975 sq.ft. of special 18 oz. fine nap P-84, 6" diameter filter bags arranged in a unique pattern to allow free flow with minimum pressure loss. Dust laden air flows through the filter cake, depositing particles on the cake and allowing clean air into and upward through each bag and into the (3) outlet plenum chamber. Clean air flows up from the filter bags and then rearward through the outlet plenum, which becomes deeper as more bags contribute to the flow, and then downward toward the fan.

CROSSOVER DUCT FROM 4SCC (PC/BH-D)

Heat treated gas, containing water vapor and particulate matter and volatized hydrocarbons, flow from 4PCC to 4BH through a 36" diameter duct, which is connected on both ends with hi-temp rubber boots.

EMERGENCY VENT (BH- EV)

When temperature of the gas entering the baghouse exceeds the safe operating limit of the bag material, air is introduced to cool the gas mixture. This equipment is located in the duct from 4PCC to 4BH. It is a dual butterfly valve emergency vent, held in the closed position by air cylinders and moves to the fail-safe open position by self-contained springs, in the event of loss of electric power (see section 5.6 for triggering conditions). One valve opens at one temperature and both open at a higher temperature.

DUST DISCHARGE SCREW CONVEYORS (BH-SC)

Dust that has been removed from the air stream falls through a grating and into a hopper. The grating prevents filter bags and other large items from getting into the dust removal system. Three 12" diameter RH screw conveyors transfer the fallen dust from the hopper toward the rear of the trailer. It falls into the lifting Auger, which conveys the dust up over the axles and drops it beyond the end of the trailer. This falling dust travels through two counterbalanced trapdoor valves, to prevent air in leakage. The dust then travels through the two Dust Transfer Screw Conveyors (BH-SC-6/7) to the Fines Return Collar on 4PCC. See sections 3.3 and 3.5.

COMPRESSED AIR SYSTEM (BH-AC)

Two air compressors are mounted on the front trailer deck. They provide 120 psi air pressure for reverse pulse-jet cleaning of filter bags and for other air-operated devices.

6.1.5 INDUCED DRAFT FAN

An induced draft fan (BH-ID) provides the driving force for the movement of gases in the system. It maintains negative pressure in the dryer to prevent fugitive emissions.

The I.D. Fan is mounted on the rear end of 4BH trailer and pulls from 4PCC and 4BH and pushes it through 4SCC and 4ABS and out the stack. It uses 250 HP to move 35,000 acfm@ 425°F with 25" w.g. inlet suction and 10" exit pressure.

An inlet damper is located between the filter box and the fan to maintain proper pressures throughout the system and prevent overloading fan motors during cold startup conditions.

6.1.6 THERMAL OXIDIZER (4SCC)

The thermal oxidizer unit consist of a trailerized vessel with internal refractory, burner and combustion air fans.

The gases from the baghouse enter the oxidizer (SC-TO) where they are heated to the required temperature (permit condition) for about 2 seconds in a 4-6% oxygen rich atmosphere to assure complete oxidation of the organic contaminants. The destruction of the organics in the flue gas depends on the residence time, turbulence and temperature. The oxidizer is sized to provide sufficient residence time and is installed with a high intensity burner to provide the turbulence necessary to oxidize chlorinated compounds. Oxidization of organic compounds yields carbon dioxide, water vapor, and hydrochloric acid (chlorinated compounds).

$$C_xH_y + O_2 + N_2 \Rightarrow CO_2 + H_2O + O_2 + N_2$$
$$C_xH_yCl_z + O_2 + N_2 \Rightarrow CO_2 + H_2O + HCl + O_2 + N_2$$

The thermal oxidizer unit is fabricated of 7/16 inch carbon steel and is 12 feet in diameter and 87 feet long. The combustion chamber is insulated with a blanket of 6-inch thick center-mounted ceramic fiber Z block modules. Castable refractory is used at transitions and high wear locations. The burner (SC-BR), is center-mounted in the inlet end and has a rating of 97 million Btu/hr. Process gas from the baghouse enters the chamber from the end plenum, through ports located around the burner, traveling parallel to the flame.

The temperature of the gas can be raised as high as 2100°F in the thermal oxidizer to ensure complete oxidation and destruction of chlorinated hydrocarbons. The operating temperature for many typical wastes is maintained at about 1800°F. Gas residence time is greater than two seconds. Destruction and removal efficiency for principal organic hazardous constituents (POHCs) in the thermal oxidizer will meet or exceed 99.99%. Gases exit from the oxidizer directly into the quench unit (SC-QU).

6.1.7 QUENCHER (4SCQ)

The quench system consist of an alloy steel vessel in which dual spray nozzles provide initial quenching and side outlet duct nozzles provide final quenching to adiabatic saturation. Quench water is provided by two booster pumps and one in-line spare, mounted on front deck of 4ABS trailer, which increase water pressure to 150 psig, to obtain sufficient atomization in the nozzles to yield efficient cooling.

The quencher (QU-V) is designed to reduce the flue gas temperature prior to its introduction into the scrubber. The quencher is capable of removing more than 40 million Btu/hr from the flue gas stream by mixing with large quantities of water. It is designed to handle more than 200,000 ACFM at 1850°F and to reduce the flue gas temperature to approximately 185°F (the adiabatic saturation temperature). The spray nozzles spray approximately 650 gpm of recirculated water, of which about 180 gpm of fresh water is required for evaporation. The quencher is a horizontal modified venturi system with dual venturis, having single nozzles. Venturis are located in the end of the oxidizer vessel. The exit gas is approximately 48,000 acfm @ 185°F.

6.1.8 ACID GAS ABSORBER (SCRUBBER) (4ABS)

The scrubber consists of a vertical packed-bed scrubber, capable of removing 99% HCL acid, with 99.9% efficient mesh type demisters. Flows from the scrubber travel up the 70 foot high X 5 foot diameter FRP stack.

The acid gas scrubber (AB-SCR) is designed to neutralize any acids formed during the oxidation process. Particulates and acidic gases are effectively removed by the packed bed scrubber. The absorber has a design capacity of approximately 190,000 ACFM of saturated air. Caustic is used as the neutralizing solution and the efficiency of the scrubber is greater than 99% for gaseous HCl. The materials of construction are FRP for the vessel, with PPE, CPVC and 316 SS for packing, piping and fittings. Gases from the two scrubber chambers are discharged at adiabatic saturation temperature into a single FRP stack. The mist eliminator mounted in the scrubber discharge end removes the liquid carryover by the gas stream. Effluent from the WESI*TPU4 scrubber can be routed to aqueous phase carbon units. Water is purged from the system at about 12 gallons per minute. Blowdown is treated by the unit's wastewater treatment equipment prior to being reused in the process. Blowdown water from the scrubber can be used to quench the ash coming from the dryer. Any solid material collected in the liquid bag filters can be introduced into the wastefeed stockpile for further treatment.

6.2 EQUIPMENT SPECIFICATIONS

The following specifications are for WESI*TPU4. They describe each major component. Tag Numbers agree with identifiers on drawings. The first part of the Tag Number identifies the main system that item is used in, such as "SF" for Soil Feed, "PC" for Primary Combustion System, "AS" for Ash Handling Equipment, "BH" for Baghouse equipment, and "AB for Absorber equipment.

ITEM TAG NO.	SOIL FEED EQUIPMENT (4SOIL) ITEM NAME	DESCRIPTION
SF-FU	Soil Metering Unit	
	Feed Hopper:	8 cubic yard
	Apron Feeder:	36" belt, 100 tons/hr capacity
SF-BC-2	Lifting Belt Conveyor:	30" wide x 60' long
	Drive:	Variable speed 10 hp Electric
	Belt Weigh Scale: ton/h	Instantaneous and cumulative,
SF-BC-4	Soil Feed Belt	Located on 4PCC trailer
	Type:	Belt conveyor with receiving hopper
	Belt Width:	30" wide
	Drive:	8.9 hp electric, variable speed

ITEM TAG NO.	PRIMARY COMBUSTION EQUIPMENT (4PCC) ITEM NAME	DESCRIPTION
PC-RD	Dryer	
	Type:	Countercurrent rotary dryer
	Hot-end Material:	Stainless steel
	Nominal Feed Rate:	30-50 tons/hr
	Drum Dimensions:	8'-6" Diam. x 40'-0" Long
	Fines Collar:	10' Diam. mixes dust with ash
	Drum Speed:	1.5 to 2.5 rpm, remote variable
	Gear Drive:	100 hp electric, variable speed mechanical gear motor
	Drum Drive	wrap-around chain drive
	Gas Flow, Exit:	34,000 acfm @ 450° F.
	Drum Seals	Leaf type both ends
PC-BR	Rotary Dryer Burner	
	Manufacturer:	Hauck Powerstar model #SJP260
	Capacity:	49 mm BTU/Hr
	Fuel:	Propane (or natural gas)
	Blowers:	Hauck Turbo 50 hp @ 3500 scfm
		Hauck Tertiary 15 hp @ 8500 scfm
	Fuel Pump:	Blackmer #LGL1, 20 gpm, 3 hp, 1750 rpm

ITEM TAG NO.	PRIMARY COMBUSTION EQUIPMENT (4ASH) ITEM NAME	DESCRIPTION
ASH HANDLING EQUIPMENT		
AS-DC	Ash Discharge Conveyor	Transfers ash from dryer to pugmill.
	Type:	DRAGSLAT-conveyor
	Drive:	10 hp
AS-PM	Ash Conditioning Pug Mill	Cools ash and raises moisture content.
	Type:	Continuous Flow, Double Shaft
	Capacity:	50 - 100 TPH, 12' Length
	Drive:	Dual 30 Hp motors/reducers
	Dust Suppression:	Water injection
AS-BC-4	Stacking Conveyor	Distributes processed soil to piles.
	Type:	Enclosed belt conveyor
	Stacking Radius:	50'
	Belt Size:	30" wide x 60' long
	Drive:	10 hp electric
	Dust Control:	Covers

ITEM TAG NO.	BAGHOUSE EQUIPMENT (4BH) ITEM NAME	DESCRIPTION
PC/BH-D	Crossover Duct From PCC to BH	
	Size:	36" Diam.
	Connections:	Hi-Temp rubber flexible boots
BH-EV	Emergency Vent	
	Type:	double butterfly valves
	Actuation:	opened by springs upon loss of electric power
BH-DC	Baghouse Dust Collector	Removes particle matter
	Type:	Mobile pulse jet dust collector
	Design Flowrate:	35,000 acfm
	Filter Area:	9,975 square feet
	Filter Material:	P-84
	Maximum Temperature:	510°F
	Air to Cloth Ratio:	3.5:1 (design) 5:1 max.
	Pressure Differential:	3" - 4" w.g.
BH-SC-1/5	Baghouse Dust Discharge Conveyor System	
	Type:	12" screw conveyors (5)
	Drive:	5 hp electric each
BH-SC-6/7	Dust Transfer Conveyor	
	Type:	12" screw conveyors (2)
	Drive:	7.5 hp electric each
BH-ID	Induced Draft Blower	
	Type:	Industrial radial blade centrifugal
	Size:	29 inch inlet
	Horsepower:	250 (dual 125's)

	Nominal Flowrate:	35,000 acfm
	Design Conditions:	25" pres. @ 425° F
	Construction:	Carbon Steel
	Manufacturer and Model:	Northern Blower Exhaust Fan
	Damper:	Multi-louvered, on Inlet
BH-AC	Air Compressors (2)	
	Size:	25 HP
	Type:	rotary screw
BH/SC-D	Crossover Duct From BH to SCC	
	Shape & Velocity:	Rectangular, 3500 FPM

ITEM TAG NO.	SECONDARY COMBUSTION EQUIPMENT (4SCC) ITEM NAME	DESCRIPTION
SC-TO	Thermal Oxidizer	
	Size:	12' Diam. x 87' long
	Volume:	5,900 cubic feet
	Gas Flow, Inlet:	35,000 acfm @ 400° F
	Gas Flow, Exit:	190,000 acfm @ 1850° F
	Velocity:(cross sectional)	35 feet per second
	Residence Time:	1.9 seconds
	Refractory:	Carborundum 12"x12"x6" internal anchor C.F. modules
SC-BR	Thermal Oxidizer Burner	
	Manufacturer:	Hauck Powerstar model # SJP520
	Capacity:	97 MM BTU/hr
	Fuel:	Propane (or Natural Gas)
	Blowers:	Hauck Turbo, 100 hp, 7,300 scfm Hauck Tertiary, 60 hp, 12,100 scfm
	Fuel Pump:	Blackmer #LGL1, 20 gpm, 3 hp, 1750 rpm

ITEM TAG NO.	QUENCHING EQUIPMENT (4SCQ) ITEM NAME	DESCRIPTION
QU-V	Quencher Vessel	
	Type:	Horizontal venturi wetted elbow
	Inlet Temp:	1800°F
	Outlet Temp:	185°F
	Coolant:	400 gpm
	Gas Flow, Inlet:	20,000 acfm
	Gas Flow, Exit:	90,720 acfm
QU/AB-D	Duct From Quencher to Absorber	
	Size:	72" Diam into 48" Diam.
	Material:	FRP

ITEM TAG NO.	ACID ABSORBER EQUIPMENT (4ABS) ITEM NAME	DESCRIPTION
AB-SCR	Acid Absorber (Scrubber)	
	Type:	Vertical packed-bed
	Efficiency:	99% removal efficiency of HCL
	Capacity:	190,000 ACFM

	Mist Elimination:	Mesh-type 99% removal efficiency
	Materials:	FRP/PPE/SS
	Pumps:	20 hp (2+2 backup) 1000 gpm total flow
AB-ST	Stack	
	Material:	FRP
	Inside Diameter	60"
	Exit Height (from grade)	70 ft
	Test Ports:	Two sets, 10' apart
	Access:	Cage ladder to full circular platforms (2)

CONTROL HOUSE EQUIPMENT (4CON)

ITEM TAG NO.	ITEM NAME	DESCRIPTION
CH	Control House	
	Type:	Enclosed, trailer mounted, climate controlled
	Size:	8' wide x 48' long
	Motor Control Center:	On-board for all motors
	Work shop area	Located in rear
CEM	Continuous Emissions Monitoring System	
	Model:	HC500-2D
	Company:	Columbia Scientific Industries Corp.
	Parameters:	Carbon monoxide, oxygen, carbon dioxide & total hydrocarbons
	Analyzers:	FID, NDIR, Paramagnetic
PLC	Programmable Logic Controller	
	Model:	SLC 500
	Company:	Allen-Bradley Co.
	Type:	Modular Rack System
	Software:	Allen-Bradley Advanced Programming Software (APS)
	Application:	Provides start-up sequencing and system interlock control.

6.3 CONTROL & ELECTRIC EQUIPMENT DESCRIPTION

The control room for WESI*TPU4 is inside a mobile trailer. Control panels inside the trailer house all operating controls and monitoring instruments. Equipment is started and operated from these panels. All motor starters are located in the Motor Control Center. Continuous pen plotting of permanent data is done in the Recording Center.

6.3.1 CONTROL ROOM

Three sides of the control room are glass paneled so the chief operator can simultaneously monitor the process variables and view the operations outside the control room. The control room is insulated and can be heated or cooled as required. The pressure in the control room is kept positive to prevent dusting from outside.

6.3.2 CONTROL CONSOLES

Three floor consoles and two upper panels house all of the control and monitoring instruments, except for a few wall mounted instruments. Start/Stop stations and control indicators are mounted in sloping panels on the floor consoles. Other indicators and annunciators are located in overhead panels. Terminal strips, wiring, relays, and other equipment is located in side the cabinets. Swing out panels facilitate access to inside items.

AMMETERS

All 480 volt motors, except Propane Pumps, are monitored for current draw, with ammeters mounted in upper side panel. Current Transformers (CT) are used for remote sensing. No high voltage flows thru the panels. Most ammeters display the normal operating current near the middle of the scale. Ammeters provide feedback to the Operator that the motors are running. They indicate starting current, running current and, if out of range, indicate possible problems. No alarms are provided.

PANEL INDICATORS

The group of indicators in the upper right panel, display process temperatures, flow rates and pressures.

BAGHOUSE INSTRUMENTS

Instruments for monitoring and controlling the Baghouse are located in two places: one set in the lower left console panel, and one in the main panel on the Baghouse, itself. The console panel includes Power OFF/ON and the controller/indicator for BH Inlet Temperature (TE 313). Pulse Cleaning instruments are in the Baghouse panel.

6.3.3 ELECTRIC SERVICE ENTRANCE AND DISTRIBUTION

WESI*TPU4 requires 480 volt, 3 phase, 60 hertz, electrical power. Approximately 700 amps are used for normal feed rates, out of 1254 total connected amps. Total HP = 943, which relates to 1096 KVA and 772 KW.

POWER CONNECTION TERMINALS

Connection terminal blocks are provided on the Control Trailer for connecting electric service.

MAIN DISCONNECT BREAKER

The entire WESI*TPU4 system can be electrically isolated from the power source, with its Main Circuit Breaker. It normally carries a 1200 Amp Rating Plug for short-circuit protection.

120 VOLT DISTRIBUTION

480 volt 3-phase power is reduced to single phase power, for controls, lighting and other low voltage loads in the Office and Decontamination trailers. A 30 kva transformer, located in the MCC next to the Main Breaker, provides 120 volt power for Control Trailer.

CONTROL BREAKER PANEL			20 AMP Breakers
Circuit #143	1	2	Circuit # 10
Lights & Recep	3	4	Circuit #151
Circuit #140	5	6	Circuit # 142
Circuit #145	7	8	Circuit # 148
spare	9	10	spare
Circuit #141	11	12	spare
Circuit #149	13	14	Main Breaker
spare	15	16	Main Breaker
spare	17	18	Main Breaker

An additional 25 kva transformer, located in rear of the trailer, provides 120/240 volt power for lighting, receptacles, etc. for other trailers.

REAR LIGHTING BREAKER PANEL	AMP	
Main	20	MP1 PCC recep
Main	20	MP2 SCC recep
MP3 BH recep	20	MP4 ABS recep
MP5 PCC lights	20	MP6 PCC lights

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MP7 BH lights	20	MP9 BH lights
MP8 SCC lights	20	MP10 SCC lights
MP11 ABS lights	20	Maint Area Lights
Control recep	20	Control Lights
spare	20	spare
spare	20	spare
spare	20	spare
spare	20	Compr Unit
spare	20	Compr Unit
spare	20	Air Handler
spare	20	Air Handler

6.3.4 MOTOR CONTROL CENTER

All motor starters, overload protection and breakers are contained in the Square D Motor Control Center. Power cables carry power from the MCC to individual motors. Control wires stay inside the control trailer. All motors are monitored for current usage with ammeters located in an overhead panel.

6.3.5 RECORDING CENTER

The following data for process variables is continuously recorded: waste soil feed rate; temperature at the exit of the dryer, thermal oxidizer and quencher; differential pressure across the baghouse; dryer draft; dryer soil discharge end hood pressure; and stack gas carbon monoxide concentration. This data is recorded by two 12-pen recorders. In addition, stack gas flow rate is monitored and recorded through correlations to the ID fan amperage.

WESI*TPU4 uses a datalogger to provide alarm inputs to the PLC and two strip chart recorders to record various process data. In addition to recording information, the datalogger is also capable of math functions which allows the rolling average alarms, which are generally required on variables such as exit gas CO, CO_2, and THC.

6.3.6 PROGRAMMABLE LOGIC CONTROLLER (PLC)

6.4 CONTINUOUS EMISSIONS MONITOR

The Continuous Emission Monitoring (CEM) system is installed and certified prior to operation of the WESI*TPU4 system, to provide real time stack gas monitoring. The system monitors oxygen, carbon monoxide, carbon dioxide, and total hydrocarbons. The continuous monitoring instruments are integrated with the data management system. Monitoring data is interfaced with the waste feed cut-off system so that the WESI*TPU4 system is shutdown if emissions exceed the operational range established during the performance test.

6.5 ELECTRIC POWER REQUIREMENTS

MOTOR NUMBER	EQUIPMENT NAME	VOLTAGE	HP	FLA	REMARKS amps		
M-1	Prescreen Drive	480	50*	65*	ASH		
M-2	Soil Metering Belt	480	5	7.6	ASH		
M-3	Soil Lifting Belt	480	10	14	ASH		
M-4	Soil Feed Belt	480	5	7.6	ASH		
M-5	PCC Drum Drive for 2 RPM	480	60	77	PCC 1200		
	rpm motor not used(optional for 4-6 RPM) rpm motor		480		100*	124*	PCC 1800
M-5b	PCC Drum Speed	120			PCC		
M-6	PCC Turbo Fan	480	50	65	PCC		
M-7	PCC Tertiary Fan	480	15	21	PCC		
M-8	PCC Propane Pump	480	3	4.8	PCC		
M-9	Ash Lifting Slat	480	10	14	ASH		
M-10	Ash Pugmill, Left	480	30	40	ASH		
M-11	Ash Pugmill, Right	480	30	40	ASH		

M-12	Ash Stacking Belt	480	10	14	ASH	
M-13	not used					
M-14	BH Dust Auger, Left	480	5	7.6	BH	
M-15	BH Dust Auger, Center	480	5	7.6	BH	
M-16	BH Dust Auger, Right	480	5	7.6	BH	
M-17	BH Dust Auger, Cross	480	5	7.6	BH	
M-18	BH Dust Auger, Lifting	480	5	7.6	BH	
M-19	BH Dust Auger, Xfer In	480	7.5	11	BH	
M-20	BH Dust Auger, Xfer Out	480	7.5	11	BH	
M-21	Air Compressor, Right	480	25	34	BH	
M-22	ID Fan, Left	480	125	156	SCC	
M-23	ID Fan, Right	480	125	156	SCC	
M-24	SCC Turbo Fan	480	100	124	PCC	
M-25	SCC Tertiary Fan	480	60	77	PCC	
M-26	SCC Propane Pump	480	3	4.8	SCC	
M-27	Water Pump, Left Front	480	20	27	ABS	
M-28	Water Pump, Right Front	480	20	27	ABS	
M-29	Water Pump, Left Rear	480	20	27	ABS	
M-30	Water Pump, Right Rea	480	20	27	ABS	
M-31	Air Compressor, Left	480	25	34	BH	
M-32	Water Booster Pump,#1	480	50	65	ABS	
M-33	Water Booster Pump,#2	480	50	65	ABS	
M-34	Water Booster Pump,#3	480	50	65	ABS	
M-35	NaOH	120			ABS	
M-36	NaOH	120			ABS	
120 Volt Transformer		25 kva				Lighting
120 Volt Transformer		30 kva				Controls

TOTALS FOR

Total Connected Horsepower....(for 2 rpm drum)................ 943 hp
Total Connected Amps.. 1254 amps
System Ampere Rating.(total + 25% of largest)............................ 1293 amps
Estimated Current Consumption.. 700 amps approximately

KVA = 480 volts X 1254 amps X 1.73/1000 = 1041 + 25 + 30 = 1096 KVA
KW = 480 volts X 1254 amps X 0.65PF X 1.73/1000 = 677
+ 120 volts X 458 amps X 1.73/1000 = 95 = 772KW

Motors over 50 HP use SMC soft starters.

6.6 EQUIPMENT DRAWINGS

WESI drawings are normally provided in 11 x 17 format. Larger copies can be provided when requested. WESI drawings are numbered uniquely with a number that identifies the trailer unit (4ABS, etc.) and each system or sub-component. WESI Part Numbers match the corresponding WESI Drawing Number, ie: Part Number 4ABS-1XX would be shown on drawing 4ABS-1XX or related number.

A complete list of drawings is located at WESI's home office. It describes all available drawings, although some drawings are not provided for jobsite use, such as individual part drawings that were only needed for original manufacture. If additional drawings are needed in the field, request them from the Equipment Department.

SECTION 7

SITE PREPARATION

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Section 7 Site Preparation

7.1 SITE SELECTION

Site selection is not usually something with many choices. However, if possible, the following items should be considered:
1. Size: 200 ft. X 200 ft. is the minimum open area for WESI*TPU4 equipment. Additional space is needed for contaminated soil and processed soil storage and moving.

2. Level: A completely level space is desired, however, minor slopes can be easily accommodated with special support procedures.

7.2 PLANNING:

A considerable amount of advance planning is required for a WESI*TPU4 site. A comprehensive site plan is required to communicate all of the site preparation work to the various agencies and contractors that are involved. All of the items addressed in Section 6 should be shown, as well as the location of WESI*TPU4 equipment, soil handling equipment and soil storage locations.

7.3 GRADING:

Earthwork is one of the first site preparation steps to be performed. Smoothing and leveling the surface should be completed before equipment is moved onto the setup site. Most sites will need paved surfaces for water control and as support for equipment.

7.4 WATER SUPPLY:

Adequate water supply is extremely important for WESI*TPU4, for emergency quenching of hot gases and to replace water lost from the system by evaporation and purging.

Evaporation, Blowdown and Soil Quenching require about 250 gpm on a continuous basis while the unit is operating. Water supply and pipe sizes must be adequate to supply 30 psi at the unit.

Emergency cooling requires at least 500 gpm delivered to the unit for at least fifteen(15) minutes, at 50 psig. pressure.

Pipe lines must be of adequate size to prevent loss of pressure due to internal friction. They should be buried below the frost line in areas subject to freezing.

7.5 ELECTRICAL SERVICE:

3 phase, 480 volt, 60 cycle electrical service is required for WESI*TPU4. Power must be available at #4CON Control Trailer at it's power service entrance. A suitable disconnect should be included, unless wiring is connected directly to the trailer. All electrical work must comply with the National Electric Code or applicable regulatory codes. See Section 6.5 for complete electrical power requirements.

7.6 FUEL SUPPLY:
Liquid propane is the primary fuel used by WESI*TPU4. Two tanks should be located at least fifty (50) feet away from either burner.

7.7 UNDERGROUND PIPING:
Run piping underground before pouring concrete. Water lines should be buried to prevent freezing.

7.8 CONCRETE PADS & FOUNDATIONS:

Pads and foundations are specifically designed for each jobsite.

7.9 EQUIPMENT LAYOUT ON PAD:

Lines should be drawn on the finished surface, to indicate centerlines and ends of major pieces of equipment. Show location of stack and guy wire anchors and center lines for each trailer. Include locations for jack legs and axles to aid in initial placing of units. Use spray paint and 2x4 straight edge. Also show location of Power Pole and other significant items, if not already installed.

7.10 EQUIPMENT RENTAL:

Rental equipment should be planned for and ordered in advance. A 75 ton hydraulic crane is needed: Position ends of 4PCC, 4BH, 4SCC, 4ABS for final alignment; Install Quencher Vessel, Duct from 4PCC, Duct to 4SCC, Duct to 4ABS and the Stack (70' tall).

7.11 EQUIPMENT LAYDOWN AREA:

Space must be available for the process equipment during other site preparation activities. Space is needed for flatbed trailers waiting to be unloaded and for off-loading equipment from trailers. Off-loading should be planned so that the crane can reach equipment that it will be setting up.

7.12 DRAINAGE and STORM WATER CONTROL

Pads are specifically designed for each jobsite, to include required slopes, curbs, sumps, etc.

SECTION 8: PERMITS AND EQUIPMENT TRANSPORTATION

SECTION 8

NOT APPLICABLE

SECTION 9

SETUP & TEARDOWN PROCEDURES

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SECTION 9: EQUIPMENT SETUP FOR WESI*TPU4

9.1 EQUIPMENT SETUP

This section describes equipment setup. The following steps should be completed in the order shown.

9.1.1 SITE PREPARATION:

Preparation of the jobsite must be completed before Equipment Setup can begin. See Section 7. This includes initial planning, grading, concrete work and securing of utility services. Layout of lines on the pavement must be done (per 7.9) before placing any equipment in place.

INSPECTION: Verify that the pavement work is correct and properly cured. Check the layout lines' locations. Measure the locations of the Stack and its guy wire anchors, and curb locations, etc. Make sure the planned locations agree with drawing numbers.

9.1.2 TRANSPORT EQUIPMENT TO JOBSITE HOLDING AREA:

When the site is ready, WESI*TPU4 equipment should be shipped to the site and placed in the planned holding area.

9.1.3 PLACE EQUIPMENT IN APPROXIMATE POSITION:

After lines are drawn on the pavement to show the centerlines and end locations, each piece of equipment should be placed in its approximate position; and then adjusted to its final exact position.

9.1.4 CRANE REQUIREMENTS:

A hydraulic crane will be needed to lift and install equipment, probably 75 ton. The following lifts will need to be made:

Shift trailer ends sideways for final alignment, if needed: Dryer, Baghouse, Oxidizer, Scrubber

Remove from trailer to holding location, lift into erected position: Lifting Conveyor, Slat Conveyor, Pugmill, Ducting, Dust Augers, Quencher.

9.1.5 EQUIPMENT PLACEMENT PROCEDURES:

See Setup Drawing(s) for equipment location and spacing dimensions. The order of installation should be as shown. (⇒) symbol indicates sub-assemblies to be installed after the major items are set in final position.

1st 4PCC: Location should be based on the Stack location. Place 4PCC using measurements from the Stack. Be sure arrangement is parallel to final layout. The Stack position is the initial reference point because of the guy wire anchor footings. Adjust the slope of the drum before attaching 4BH or 4SOIL or 4ASH.

⇒ 4SOIL: Soil Metering Bin (SF-FU) and Soil Lifting Conveyor may be installed now, but should wait until the overall alignment scheme is finalized. Connect electrical cables to 4PCC.

⇒ 4ASH: Ash Discharge Slat Conveyor, Pug Mill and Stacking Conveyor may be installed now, but should wait until the overall alignment scheme is finalized. Connect electrical cables to 4PCC.

2nd 4BH: Place 4BH next to 4PCC. Adjust the distance between, and fore/aft positioning, as shown on the Setup Drawing. Use the "T-Square" alignment guide, mounted on the front right side of 4BH, Both ends must be spaced correctly, because they are attached at both ends: Cross-over duct at one end and dust augers at other end. Adjust the level of 4BH to match 4PCC.

⇒ PC/BH-D: Install duct from 4PCC to 4BH.

⇒ BH-SC-6/7: Install dust augers from 4BH to 4PCC.

⇒ STEAM DUCT: Install quench steam duct from pugmill to 4BH.

3rd 4SCC: Place 4SCC next to 4BH. Adjust the distance between and fore/aft positioning. Use the "T-Square" alignment guide, mounted on the side of 4BH. Both ends must be spaced correctly, because of the duct on one end and the relationship to 4ABS on the other end. Adjust the level of 4SCC to match 4BH.

⇒ CABLE HANGER: Remove the cover plate from the flanged end. Uncoil cables first.

⇒ BH/SC-D: Install duct from 4BH to 4SCC.

4th 4ABS: Place the Scrubber trailer in its proper relationship. Adjust the distance between and fore/aft positioning. Use the "T-Square" alignment guide mounted on 4SCC.

The two trailers should be parallel for duct connections to fit.

Adjust the level of 4ABS to match 4SCC.

⇒ WATER: Connect water source to 4ABS.

5th Mobilize crane equipment at this time. Set up in space where 4CON will be located.

6th 4SCQ: Place the trailer carrying the Quencher near the front end of 4BH. Lift off the Quench Unit and attach it to 4SCC. Install Stainless Piping on side of Scrubber. QU/AB-D: Install ducting from 4SCQ to 4ABS.

7th STACK: Place the stack base first. Connect duct to 4ABS. Assemble the upper Stack andplatforms and place on top of base. Hold it securely while the guy wires are connected.

8th 4CON: After crane has been moved, place Control trailer in correct position. Place Cable Trays on ground between trailers. Place cables in trays and connect terminals/plugs.
Level 4CON and install stairs.

9TH TOOL TRAILER

10TH DECON TRAILER:

9.1.6 FINAL ALIGNMENT:

After all major items are in general alignment, measure locations, and make final adjustments. Use fork lift or crane to move items. Lift one end at a time of major units.

9.1.7 SUPPORTING TRAILERS:

Be sure trailer wheels are chocked and that supports are solid and safe. Raise and lower trailers with hydraulic jacks, one on each side, to reach desired heights. Then adjust landing legs to hold trailer in final position. Landing leg cranks are not for lifting, just for holding.

All landing legs should be supporting the load. Use wood dunnage under them if their travel is insufficient, or if more surface area is needed to prevent sinking. Most jacks have large landing pads that extend all across the unit. These should always be used to spread the load.

9.1.8 LEVELING TRAILERS:

Most trailers are designed to operate in a level attitude. This should be checked with a 48" level on a portion of the trailer that is straight and flat.

They also have to be level with each other, so ducts will fit properly. Wheels may not touch the pavement when the trailers are properly leveled. This is okay; they can hang free.

9.1.9 DRUM SLOPE FOR 4PCC:

The Dryer drum must slope to cause the soil to flow thru it. It slopes downward in the direction of soil flow. The drum is built parallel to the frame. Therefore, to adjust the slope, the entire frame must be tilted.

4PCC should be sloped about 1.5° to 2.5°. Use the following conversion data to measure slope with a level:

level:	For 12" Length				For 36" Level				For 48" Level			
Slope in Degrees	1.5	2.5	3.5	4.5	1.5	2.5	3.5	4.5	1.5	2.5	3.5	4.5
Slope in Inches	5/16"	1/2"	3/4"	1"	1"	1.5"	2.25"	3.75"	1.25"	2"	3"	3.75

9.1.10 ELECTRICAL:CONNECTIONS:

Install ground cable trays from 4CON to each trailer.

Connect cablesfor 480 volt circuits, 120 volt circuits, controls, and thermocouples, from 4CON to each trailer: 4PCC, 4BH, 4SCC and 4ABS; and to 4SOIL and 4ASH equipment.

Setup lights and test.

The main power must be connected from the power pole to the Service Entrance box on the Control Trailer. Do not turn power ON until all cables are connected to trailers.

9.1.11 FUEL SERVICE:

Install pipe line from Propane tank(s) to burners on 4PCC and 4SCC. Use schedule 80 pipe and fittings suitable for 350 psi service. Verify that spare bottle(s) of propane are on hand, to start the burner pilots.

9.1.12 AIR SUPPLY:

Connect air lines from 4BH to Emergency Vent air cylinders.

9.1.13 WATER SUPPLY:
Install water pipe from source to 4ABS and to Pugmill areas. Bury it for freeze protection.

9.1.14 PRESSURE HOSE CONNECTIONS:
Connect pressure tubing from 4BH and 4PCC to 4CON.

9.1.15 ASH QUENCH STEAM LINE
Install hose from Pugmill to 4BH.

9.1.16 LADDERS AND STAIRS:
Install stairs to all doors and ladders to other trailer decks: 3BH side and ends, 3ABS ends and top.

9.2 EQUIPMENT TESTING

This section describes tests to be performed after the equipment has been mechanically connected and power is available. The purpose is to verify that everything works as intended. A Test Report is included for documentation purposes. A completed copy should be sent to the Equipment Department.

9.2.1 MOTORS

Each motor should be tested separately, in Manual mode, without burners operating and without any soil feed, with normal equipment connected. The inspector should verify the following:

1. Motors operate when the appropriate switch is energized.
2. Motor rotation directions are correct.
3. Motors are running free, without dragging, and should sound normal.
4. Amp draw for unloaded condition should be normal, and should be recorded.

9.2.2 EQUIPMENT

Each piece of equipment should be operated separately, if possible, The following should be verified:

1. Components operate properly when energized, without binding.
2. Movement is in the correct direction.
3. Augers should reverse direction okay.

9.2.3 CONTROLS

Each control device should be tested, if possible, to verify correct operation and proper control.

9.2.4 120 VOLT CIRCUITS

Each receptacle should be tested with a polarity meter to verify that power exists at the receptacle, and to verify correct polarity and grounding. Problems should be corrected immediately. Lights should be plugged in and tested.

SETUP TESTING REPORT FOR WESI*TPU4

Jobsite: ______________ Date: __________ Tests Performed by: ______________________

ITEM No. — OKAY BY:

SOIL METERING UNIT
M-2 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Belt: Runs True? __________ Quiet? ________ Speed Adjustment? ________ ___

SOIL LIFTING BELT
M-3 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Belt: Runs True? __________ Quiet? ________ ______________________ ___

SOIL FEED BELT
M-4 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Belt: Runs True? __________ Quiet? ________ ______________________ ___

DRUM DRIVE
M-5 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Drum: Runs True? ________ Quiet? ________ ___
Speed: Min. ______rpm Max. ______rpm, Control? ________ ___

PCC TURBO FAN
M-6 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Fan Sounds OK? ________ Damper Operates OK? ________ ____________ ___

PCC TERTIARY FAN
M-7 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Fan Sounds OK? ________ Damper Operates OK? ________ ____________ ___

PCC PROPANE PUMP
M-8 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Pump: Max. shutoff pres ______psi ambient temp ________ Leaks? ________ ___

ASH LIFTING SLAT
M-9 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Conveyor: Sounds OK? ________ ___

ASH PUGMILL
M-10 Left Motor: Correct rotation? ________ Free Running? ______ Amps? ________ ___
M-11 Right Motor: Correct rotation? ________ Free Running? ______ Amps? ________ ___
Pugmill: Free Running? ________ Sounds OK? ________

ASH STACKING BELT
M-12 Motor: Correct rotation? ________ Free Running? ________ Amps? ________ ___
Belt: Runs True? __________ Quiet? ________ ______________________ ___

BH DUST AUGERS
M-14 Left Motor: Correct rotation? _______ Free Running? ______ Amps? ________ ___
M-15 Center Motor: Correct rotation? _______ Free Running? ______ Amps? ________ ___
M-16 Right Motor: Correct rotation? _______ Free Running? ______ Amps? ________ ___
M-17 Cross Motor: Correct rotation? _______ Free Running? ______ Amps? ________ ___

M-18 Lifting Motor: Correct rotation? _______ Free Running? ______ Amps? ________ ___
M-19 Xfer In Motor: Correct rotation? _______ Free Running? ______ Amps? ________ ___

SETUP TESTING REPORT FOR WESI*TPU4

M-20 Xfer Out Motor: Correct rotation? ______ Free Running? _____ Amps? ________ ____

AIR COMPRESSORS

M-21 Right Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Compressor: Sounds OK? ______ Pres. Cutoff OK? ______ ____
M-31 Left Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Compressor: Sounds OK? ______ Pres. Cutoff OK? ______ ____

ID FAN

M-22 Left Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
M-23 Right Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Fan: Sounds OK? ______ ____________________ ____

SCC TURBO FAN

M-24 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Fan Sounds OK? ______ Damper Operates OK? ______ ________ ____

SCC TERTIARY FAN

M-25 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Fan Sounds OK? ______ Damper Operates OK? ______ ________ ____

SCC PROPANE PUMP (IF USED)

M-26 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Pump: Shutoff pres ______psi ambient temp ______ Leaks? ________ ____

WATER PUMPS

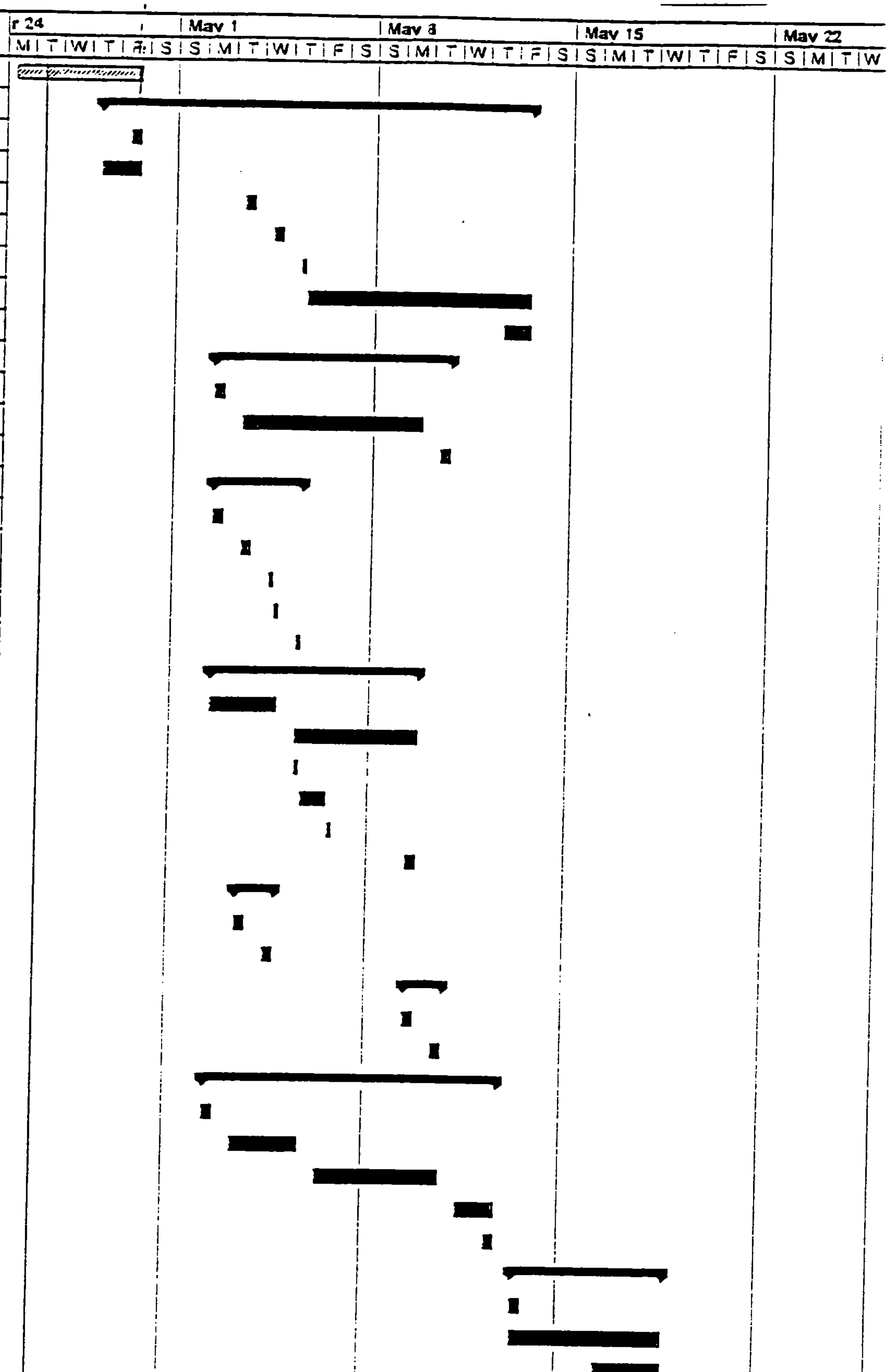
M-27 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Pump: Shutoff pres? ______psi, Sounds OK? ______ Leaks? ________ ____
M-28 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Pump: Shutoff pres? ______psi, Sounds OK? ______ Leaks? ________ ____
M-29 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Pump: Shutoff pres? ______psi, Sounds OK? ______ Leaks? ________ ____
M-30 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Pump: Shutoff pres? ______psi, Sounds OK? ______ Leaks? ________ ____

BOOSTER PUMPS

M-32 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Pump: Shutoff pres? ______psi, Sounds OK? ______ Leaks? ________ ____
M-33 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Pump: Shutoff pres? ______psi, Sounds OK? ______ Leaks? ________ ____
M-34 Motor: Correct rotation? ______ Free Running? ______ Amps? ________ ____
Pump: Shutoff pres? ______psi, Sounds OK? ______ Leaks? ________ ____

SECTION 9.3: TYPICAL SETUP SCHEDULE FOR WESI*TPU4

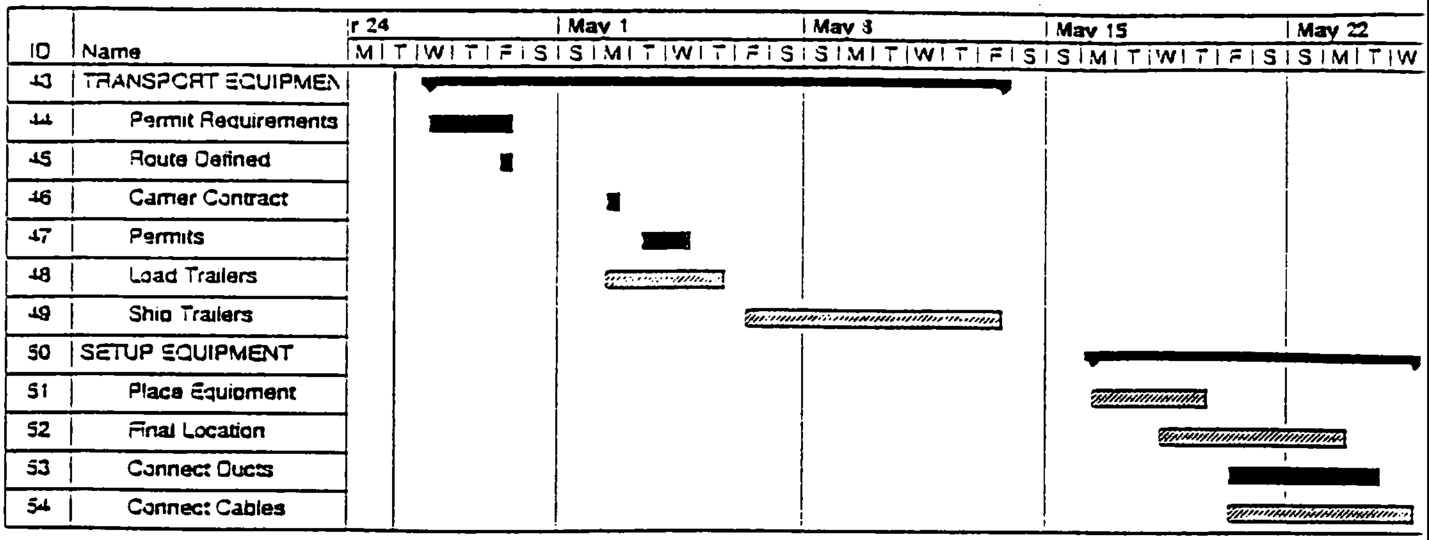
ID	Name
1	DECISION: WOODS
2	CONCRETE PAD
3	Review Site Plan
4	Contract
5	Survey Locations
6	Grading & Forms
7	Pour Concrete
8	Cure Concrete
9	Inspect & Layout Line
10	ELECTRIC SERVICE
11	Order Power
12	Install Power
13	Connect Control Trail
14	WATER SERVICE
15	Underground Trench
16	Install Piping
17	Pressure Test
18	Connect 3ABS
19	Connect Pugmill
20	PROPANE
21	Deliver Tanks
22	Fill Tanks
23	Underground Trench
24	Install Piping
25	Pressure Test
26	Connect Burners
27	RENTAL EQUIPMENT
28	Order Crane
29	Crane on site
30	EQUIP HOLDING AREA
31	Identify Area
32	Move Equipment Into
33	PERSONNEL
34	Determine Needs
35	Identify Crew
36	Commit Personnel
37	Travel to Job
38	Motel
39	OFFICE FACILITY
40	Trailer
41	Telephone
42	Connect Electricity



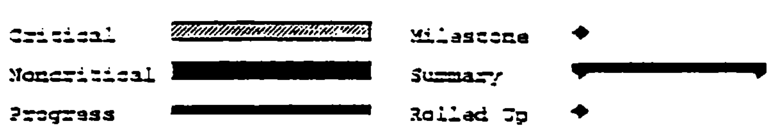
Critical — Noncritical — Progress — Milestone ◆ — Summary — Rolled Up ◆

Project:
Date: 4/26/94

SECTION 9.3: TYPICAL SETUP SCHEDULE FOR WESI*TPU4



Project:
Date: 4/26/94



COMBUSTION PROCESS

$$C + (O_2 + N_2) = CO_2 + N_2 + O_2 + HEAT$$

CARBON + AIR = CARBON DIOXIDE, NITROGEN, OXYGEN, HEAT

$$H_2 + (O_2 + N_2) = H_2O + N_2 + O_2 + HEAT$$

HYDROGEN + AIR = WATER, NITROGEN, OXYGEN, HEAT

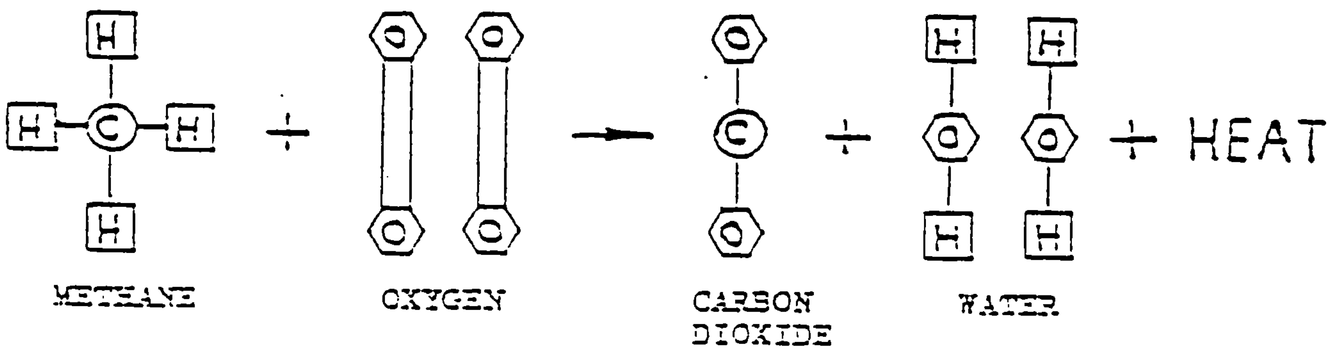
$$CH_4 + (O_2 + N_2) = CO_2 + H_2O + N_2 + O_2 + HEAT$$

METHANE + AIR = CARBON DIOXIDE, WATER, NITROGEN, OXYGEN, HEAT

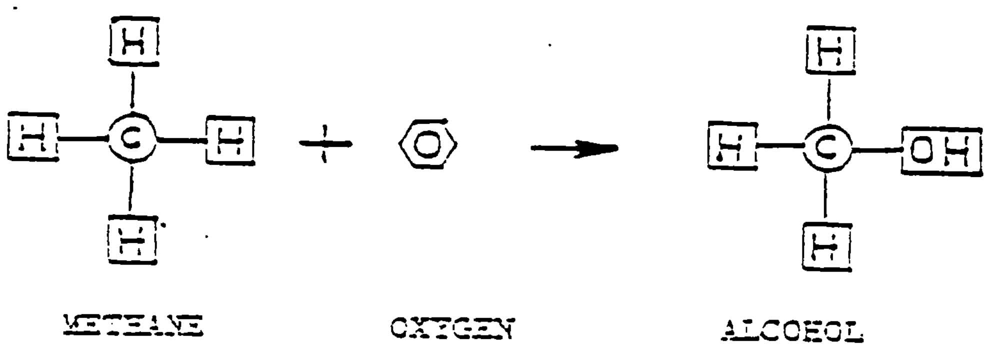
2

VIII. GAS COMBUSTION PHASES

Referring back to the natural gas combustion reaction, that is, the mechanical and chemical reaction of methane and oxygen, further investigation shows that the reaction passes through several intermediate stages before the reaction is completed. The initial and final reactants and products are:

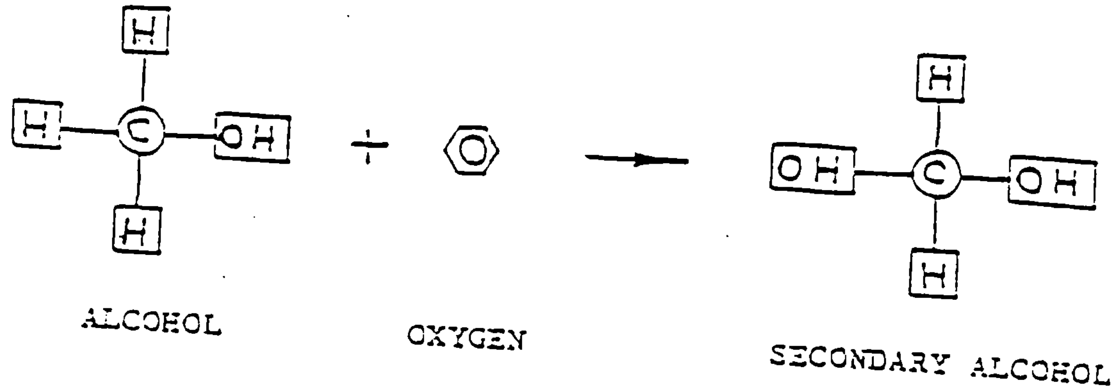


But actually the first action taking place is:

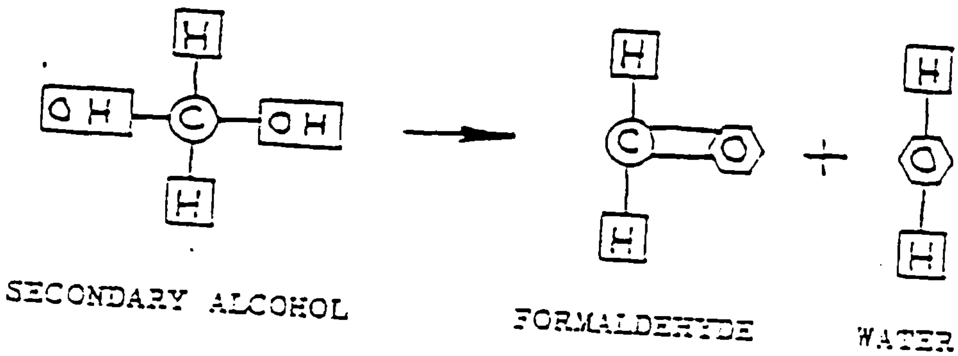


Or methane plus oxygen equals an alcohol. The collision force actually drives the oxygen atom into methane molecule. The opening of the chemical linkages holding the atoms releases the energy of these linkages raising the temperature of the molecule. The second phase is:

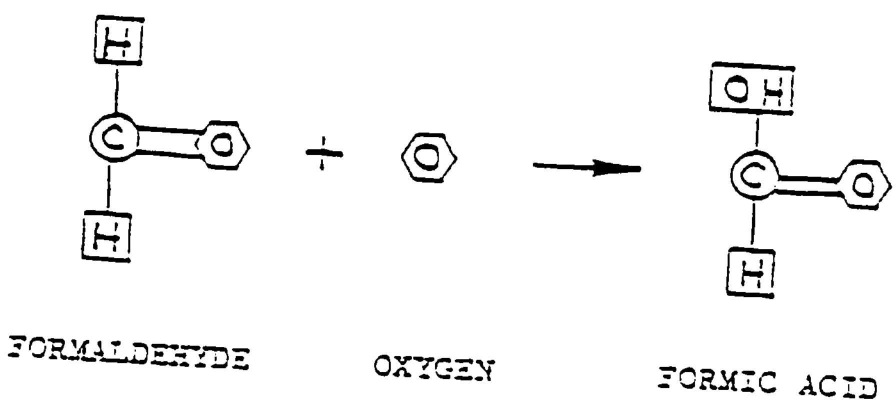
(3)



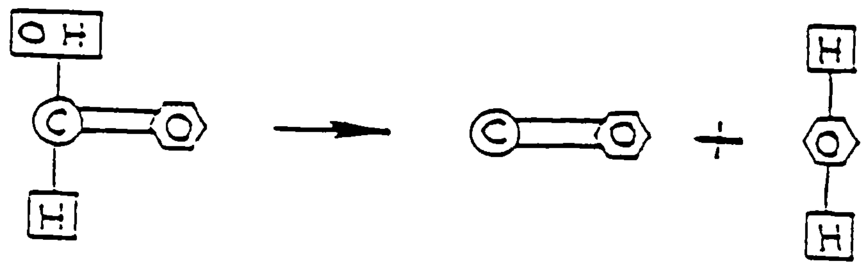
The alcohol unites with another oxygen to form a secondary alcohol. This alcohol is very unstable and breaks down almost immediately to formaldehyde and water vapor.



The formaldehyde has a high affinity for oxygen and when another oxygen is added an acid is formed.

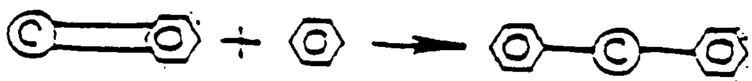


The step by step reaction is proceeding with increasing releases of energy and a constantly rising temperature level. In this high energy state, formic acid is unstable and breaks down with the oxygen to form carbon monoxide and the second water molecule is released.



FORMIC ACID CARBON MONOXIDE WATER

The carbon monoxide then combines with the last oxygen atom available to form carbon dioxide and complete the reaction.

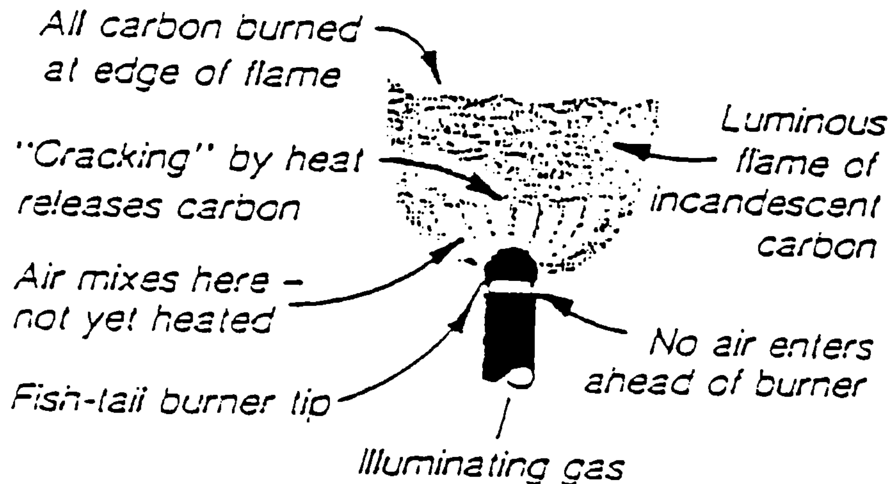


CARBON MONOXIDE OXYGEN CARBON DIOXIDE

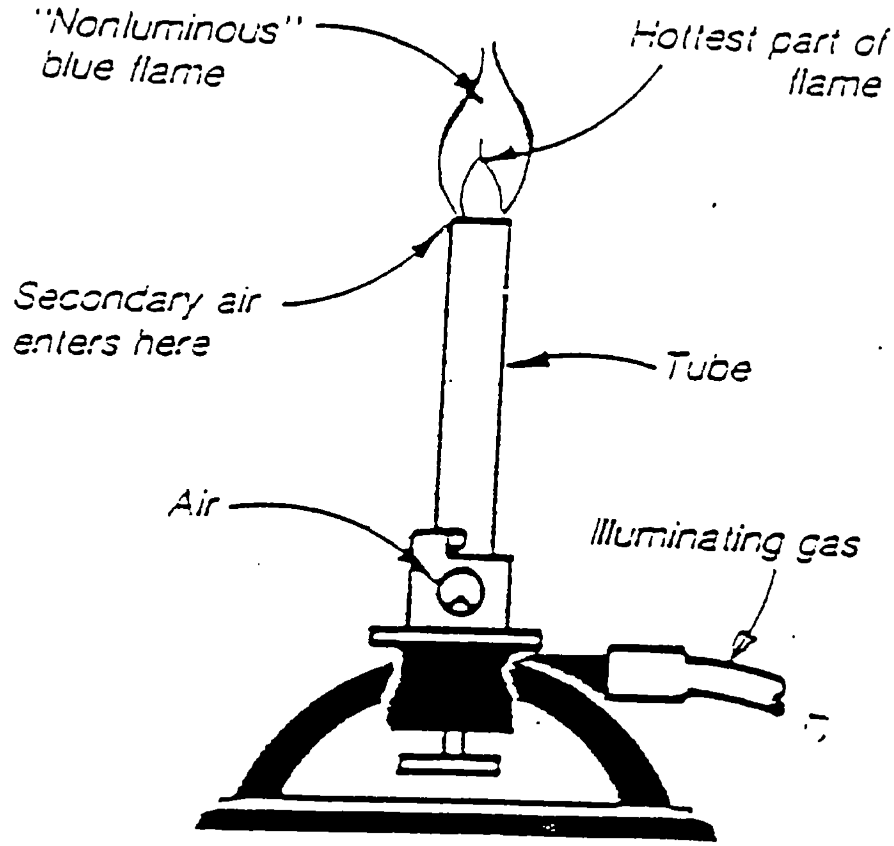
These reactions all take place at extremely high energy levels, progress almost instantaneously and at very high temperatures, approaching 5000°F. internal molecular temperature.

The combustion phases indicated occur with a characteristic blue flame when oxygen is intimately mixed with the gas and readily available to add to the methane molecule.

5)



THERMAL DECOMPOSITION of gas to a fishtail burner yields yellow flame



GAS AND AIR mix before reaching flame in Bunsen burner, producing a blue color

X. FLAME QUENCHING

If during the multiphase reaction the temperature of the molecules dropped drastically from some external causes, the reaction would cease and the reactants would be isolated in their various stages of formation. When this occurs the flame is quenched. A burning gas flame contains all of the partial reacted compounds at the same time in their various states of transformation. Should a refrigerating medium be brought in contact with any part of the flame and reduce the temperature of that part below 1200°F., the flame will be arrested or quenched and combustion will be halted in any stage of completion When this occurs, there are present alcohols, aldehydes, formic acid, higher order acids, and carbon monoxide as well as carbon dioxide and water vapor.

In actual practice, flame quenching is a possibility on lower temperature industrial processes, especially air heaters. In a case where recirculated air is being heated by mixing with hot flue gases, the air itself might become the refrigerating medium if it impinged into the flame. Long, unprotected flames from a burner firing into a high velocity air stream may permit the air to quench the edge of the flame and produce the aldehydes and the other undesirable flue products. Arrested or quenched combustion conditions can be detected, even in small quantities, by the acrid odor of the products.

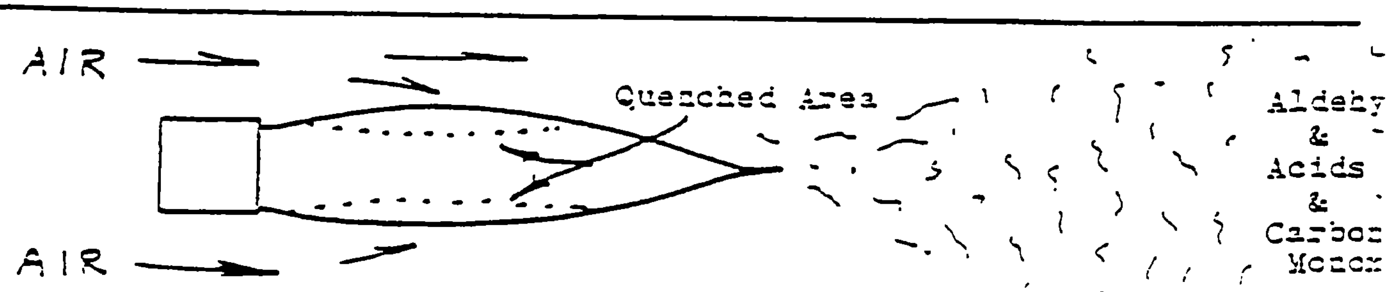


Table 1 Combustion Constants

No.	Substance	Formula	Molecular Weight	Lb per Cu Ft	Cu Ft per Lb	Sp Gr Air = 1.0000	Heat of Combustion: Btu per Cu Ft Gross (High)	Btu per Cu Ft Net (Low)	Btu per Lb Gross (High)	Btu per Lb Net (Low)	For 100% Total Air, Moles per mole of Combustible or Cu Ft per Cu Ft of Combustible: Required for Combustion O_2	N_2	Air	Flue Products CO_2	H_2O	N_2	For 100% Total Air, Lb per Lb of Combustible: Required for Combustion O_2	N_2	Air	Flue Products CO_2	H_2O	N_2
1	Carbon*	C	12.01	—	—	—	—	—	14,093	14,093	1.0	3.76	4.76	1.0	—	3.76	2.66	8.86	11.53	3.66	—	8.86
2	Hydrogen	H_2	2.016	0.0053	187.723	0.0696	325	275	61,095	51,623	0.5	1.88	2.38	—	1.0	1.88	7.94	26.41	34.34	—	8.94	26.41
3	Oxygen	O_2	32.00	0.0846	11.819	1.1053	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	Nitrogen (atm)	N_2	28.01	0.0744	13.443	0.9718	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	Carbon monoxide	CO	28.01	0.0740	13.506	0.9672	321	321	4,347	4,347	0.5	1.88	2.38	1.0	—	1.88	0.57	1.90	2.47	1.57	—	1.90
6	Carbon dioxide	CO_2	44.01	0.1170	8.548	1.5282	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Paraffin series																					
7	Methane	CH_4	16.04	0.0425	23.552	0.5543	1012	911	23,875	21,495	2.0	7.53	9.53	1.0	2.0	7.53	3.99	13.28	17.27	2.74	2.25	13.28
8	Ethane	C_2H_6	30.07	0.0803	12.455	1.0488	1773	1622	22,323	20,418	3.5	13.18	16.68	2.0	3.0	13.18	3.73	12.39	16.12	2.93	1.80	12.39
9	Propane	C_3H_8	44.09	0.1196	8.365	1.5617	2524	2322	21,669	19,937	5.0	18.82	23.82	3.0	4.0	18.82	3.63	12.07	15.70	2.99	1.63	12.07
10	n-Butane	C_4H_{10}	58.12	0.1582	6.321	2.0665	3271	3018	21,321	19,678	6.5	24.47	30.97	4.0	5.0	24.47	3.58	11.91	15.49	3.03	1.55	11.91
11	Isobutane	C_4H_{10}	58.12	0.1582	6.321	2.0665	3261	3009	21,271	19,628	6.5	24.47	30.97	4.0	5.0	24.47	3.58	11.91	15.49	3.03	1.55	11.91
12	n-Pentane	C_5H_{12}	72.15	0.1904	5.252	2.4872	4020	3717	21,095	19,507	8.0	30.11	38.11	5.0	6.0	30.11	3.55	11.81	15.35	3.05	1.50	11.81
13	Isopentane	C_5H_{12}	72.15	0.1904	5.252	2.4872	4011	3708	21,047	19,459	8.0	30.11	38.11	5.0	6.0	30.11	3.55	11.81	15.35	3.05	1.50	11.81
14	Neopentane	C_5H_{12}	72.15	0.1904	5.252	2.4872	3994	3692	20,978	19,390	8.0	30.11	38.11	5.0	6.0	30.11	3.55	11.81	15.35	3.05	1.50	11.81
15	n-Hexane	C_6H_{14}	86.17	0.2274	4.398	2.9704	4768	4415	20,966	19,415	9.5	35.76	45.26	6.0	7.0	35.76	3.53	11.74	15.27	3.06	1.46	11.74
	Olefin series																					
16	Ethylene	C_2H_4	28.05	0.0742	13.475	0.9740	1604	1503	21,636	20,275	3.0	11.29	14.29	2.0	2.0	11.29	3.42	11.39	14.81	3.14	1.29	11.39
17	Propylene	C_3H_6	42.08	0.1110	9.007	1.4504	2340	2188	21,048	19,687	4.5	16.94	21.44	3.0	3.0	16.94	3.42	11.39	14.81	3.14	1.29	11.39
18	n-Butene	C_4H_8	56.10	0.1480	6.756	1.9336	3084	2885	20,854	19,493	6.0	22.59	28.59	4.0	4.0	22.59	3.42	11.39	14.81	3.14	1.29	11.39
19	Isobutene	C_4H_8	56.10	0.1480	6.756	1.9336	3069	2868	20,737	19,376	6.0	22.59	28.59	4.0	4.0	22.59	3.42	11.39	14.81	3.14	1.29	11.39
20	n-Pentene	C_5H_{10}	70.13	0.1852	5.400	2.4190	3837	3585	20,720	19,359	7.5	28.23	35.73	5.0	5.0	28.23	3.42	11.39	14.81	3.14	1.29	11.39
	Aromatic series																					
21	Benzene	C_6H_6	78.11	0.2060	4.852	2.6920	3752	3601	18,184	17,451	7.5	28.23	35.73	6.0	3.0	28.23	3.07	10.22	13.30	3.38	0.69	10.22
22	Toluene	C_7H_8	92.13	0.2431	4.113	3.1760	4486	4285	18,501	17,672	9.0	33.88	42.88	7.0	4.0	33.88	3.13	10.40	13.53	3.34	0.78	10.40
23	Xylene	C_8H_{10}	106.16	0.2803	3.567	3.6618	5230	4980	18,650	17,760	10.5	39.52	50.02	8.0	5.0	39.52	3.17	10.53	13.70	3.32	0.85	10.53
	Miscellaneous gases																					
24	Acetylene	C_2H_2	26.04	0.0697	14.344	0.9107	1477	1426	21,502	20,769	2.5	9.41	11.91	2.0	1.0	9.41	3.07	10.22	13.30	3.38	0.69	10.22
25	Naphthalene	$C_{10}H_8$	128.16	0.3384	2.955	4.4208	5854	5654	17,303	16,708	12.0	45.17	57.17	10.0	4.0	45.17	3.00	9.97	12.96	3.43	0.56	9.97
26	Methyl alcohol	CH_3OH	32.04	0.0846	11.820	1.1052	868	767	10,258	9,066	1.5	5.65	7.15	1.0	2.0	5.65	1.50	4.98	6.48	1.37	1.13	4.98
27	Ethyl alcohol	C_2H_5OH	46.07	0.1216	8.221	1.5890	1600	1449	13,161	11,917	3.0	11.29	14.29	2.0	3.0	11.29	2.08	6.93	9.02	1.92	1.17	6.93
28	Ammonia	NH_3	17.03	0.0456	21.914	0.5961	441	364	9,667	7,985	0.75	2.82	3.57	—	1.5	3.32	1.41	4.69	6.10	—	1.59	5.51
														SO_2						SO_2		
29	Sulfur*	S	32.06	—	—	—	—	—	3,980	3,980	1.0	3.76	4.76	1.0	—	3.76	1.00	3.29	4.29	2.00	—	3.29
30	Hydrogen sulfide	H_2S	34.08	0.0911	10.979	1.1898	646	595	7,097	6,537	1.5	5.65	7.15	1.0	1.0	5.65	1.41	4.69	6.10	1.88	0.53	4.69
31	Sulfur dioxide	SO_2	64.06	0.1733	5.770	2.2640	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	Water vapor	H_2O	18.02	0.0476	21.017	0.6215	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33	Air	—	—	0.0766	13.063	1.0000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

*Carbon and sulfur are considered as gases for molal calculations only.

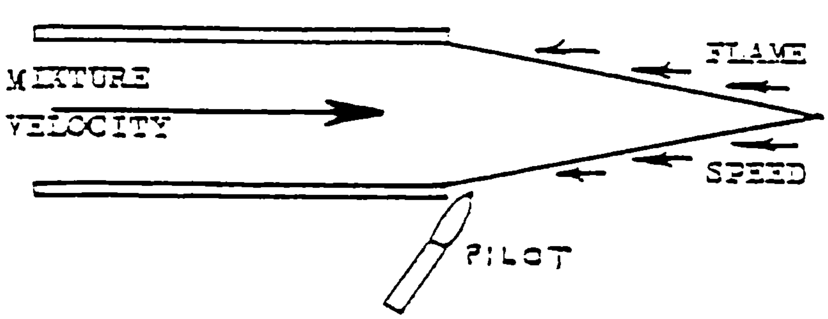
All gas volumes corrected to 60 F and 30 in. Hg dry.

Note: This table is included by courtesy of the American Gas Association and the Industrial Press. The format and data are taken principally from "Fuel Flue Gases," 1941 Edition, American Gas Association, with modifications [illegible]

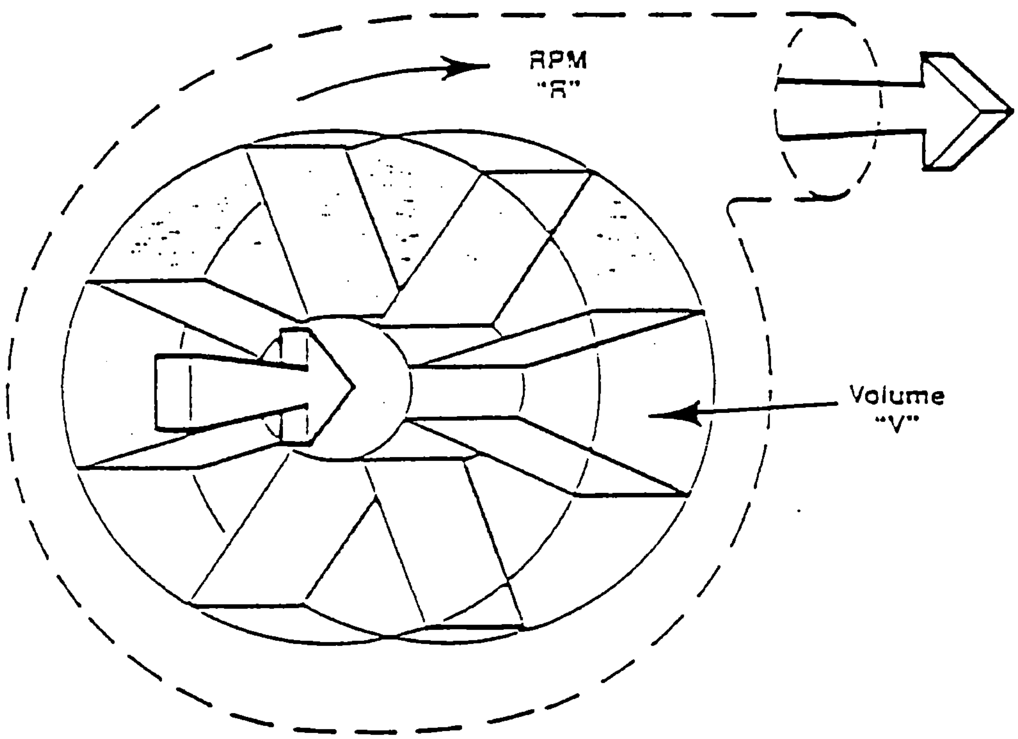
To illustrate this, 100% primary air would have a sharp, pale blue flame since all of the air for combustion is mixed with the gas, and ready to ignite as soon as it reaches the nozzle. A flame burning with 75% primary aeration would be characterized by a double blue cone and be a little longer since 25% of the gas molecules need time to find some oxygen from the secondary air so they can burn. At 50% primary aeration, the flame becomes still longer and softer with some orange tips. At 25% only a slight amount of blue remains at the nozzle and the flame becomes still longer and yellow is the predominating color. A 0% primary aeration is a raw gas flame, long and yellow. All of the air to complete combustion has to be supplied as secondary air. The percent aeration affects the flame length because the gas molecules require more time to find free oxygen since there is less oxygen available in the lower percentages of primary air.

V. FLAME GEOMETRY

With a 100% aerated air-gas mixture expelled from an open pipe, and a source of ignition applied on the edge of the pipe, a flame will be produced when the escape velocity of the air-gas mixture is the same as the flame speed.



CHAPTER 2 – FAN LAWS & BLOWER APPLICATION ENGINEERING



For blower wheel with eight segments. Theoretical Flow = 3 x V x R

Combustion air blowers are normally rated in terms of standard cubic feet (scf) of air: that is, 70°F air at Sea Level (29.92" Hg) barometric pressure. Density of this air is 0.075 lb/cu ft. and its specific gravity is 1.0.

Although fuel/air ratios are usually stated in cubic feet of air per cubic foot or gallon of fuel, it's the weight of air per weight of fuel that's important. As long as air temperature and pressure are close to standard conditions, blower and burner sizing charts can be used without correction. However, if air temperature, gauge pressure or altitude change the density of air by any significant amount, blower ratings have to be corrected from actual cubic feet (acf) to standard cubic feet to insure the proper weight flow of air reaches the burner.

Centrifugal fans are basically constant volume devices: at a given rotational speed, they will deliver the same volume of air regardless of its density.

If, for example, a blower has a wheel made up of eight segments, each with a volume V, and the wheel is rotating at R rpm, the theoretical flow rating of the blower will be 3 x V x R, because each fan wheel segment fills with air and empties itself once each revolution.

The actual volume delivered is strictly a function of the carrying capacity of the wheel and its speed. Cfm, whether it is standard (scfm) or actual (acfm) is the same. Consequently, if the density of air is reduced by temperature, pressure, or both, the blower will deliver a lower weight flow of air, even though the measured volume hasn't changed.

Air density also affects the pressure developed by the blower and its power consumption. Because air density is related to temperature, pressure, and altitude (barometric pressure) – see pages 2.3 and 2.4 – it is possible to relate blower performance to these factors with a set of relationships known as *fan laws*.

10

100 Btu/FT^3 RULE

"TYPICAL" HYDROCARBO[NS]

- METHANE (NAT. GAS) $1\,ft^3\ CH_4 = \frac{1013\ Btu/ft^3}{~~fuel~~} \times \frac{ft^3}{9.5\,ft^3}$

$\approx 106\ Btu/ft^3$

- PROPANE $1\,ft^3\ C_3H_8 = \frac{2500\ Btu}{ft^3\ fuel} \times \frac{ft^3\ fuel}{25\ ft^3}$

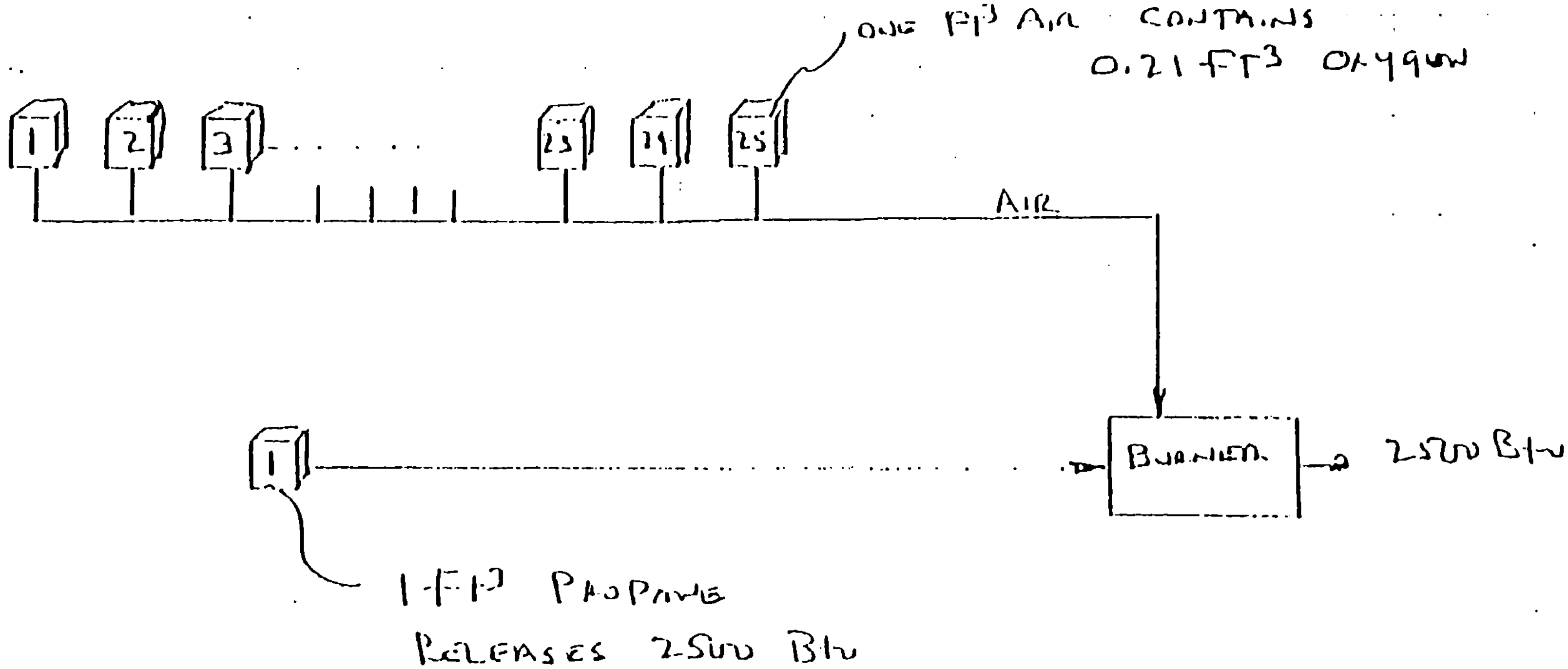
$\approx 100\ Btu/ft^3$

TOLUENE $1\,ft^3\ C_7H_8 = \frac{4484\ Btu}{ft^3\ FUEL} \times \frac{ft^3\ fuel}{42.88\ ft^3}$

$\approx 105\ Btu/ft^3$

-

* HEATING VALUES FROM GAS CONSTANTS.



REACTION:

$$C_3H_8 + 5\,O_2 + 20\,N_2 \longrightarrow 3\,CO_2 + 4\,H_2O + 20\,N_2 + 2500\ \text{Btu}$$

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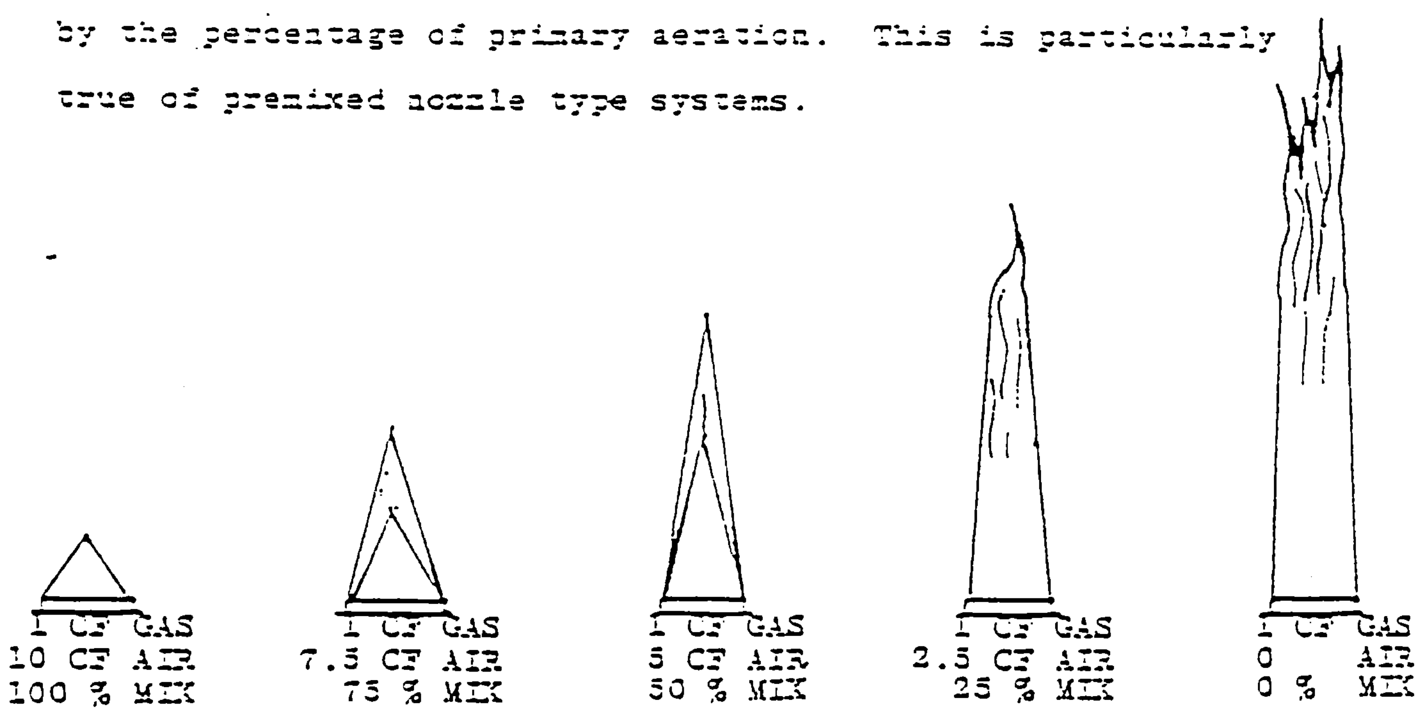
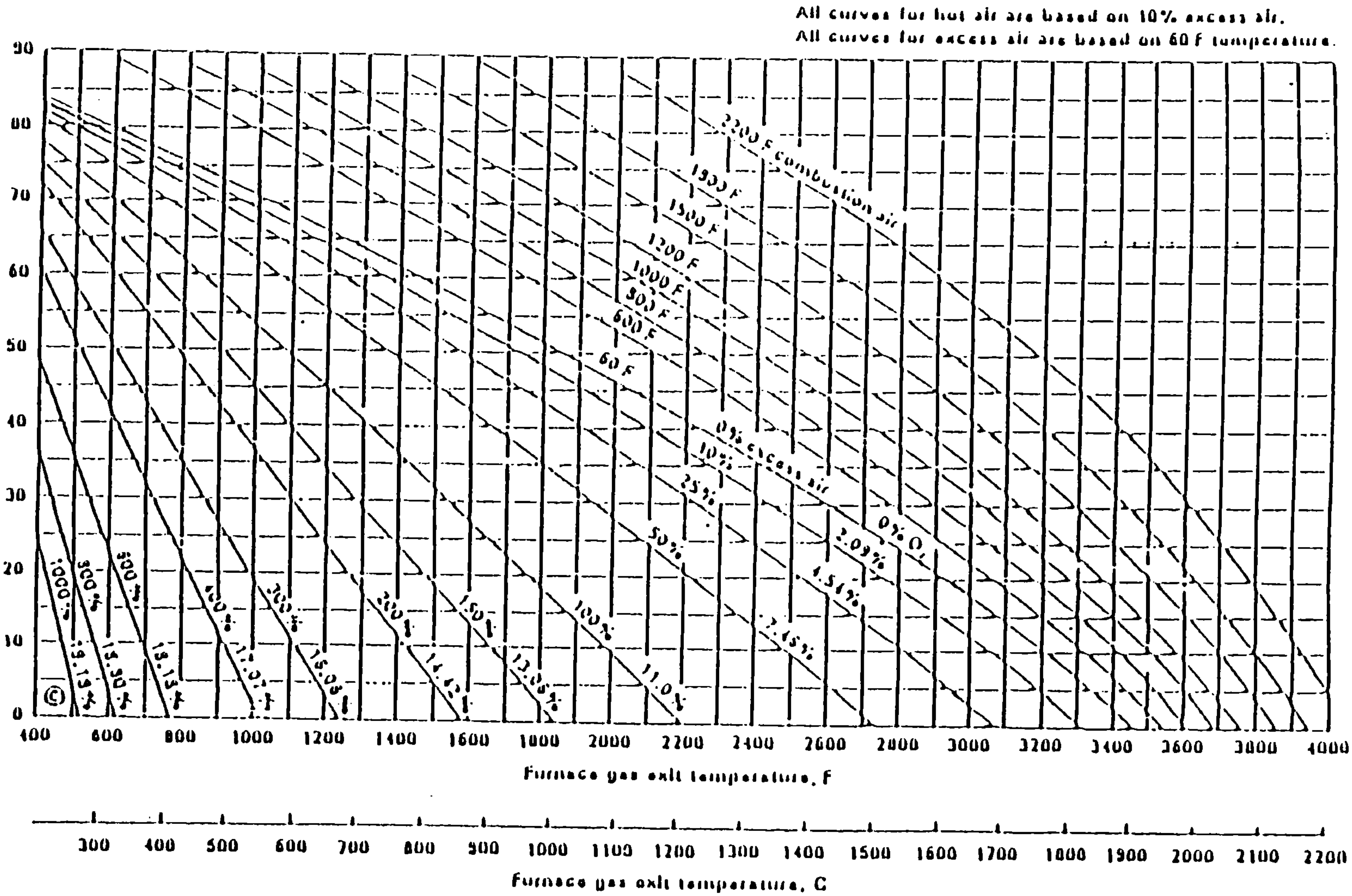
an air quantity requirement of 10 ft.[3] for each 1000 BTU/hr., once the air piping is sized, any fuel can be used to produce the same total heat release when the gas adjustor or the adjustable fuel orifice is set for the proper fuel flow. For example, a 1,000,000 BTU/hr. system will require 10,000 cu. ft./hr. of air and 1000 cu. ft./hr. of natural gas or 400 cu. ft./hr. of propane or approximately 8 gallons of #2 fuel oil. All fuels in this system will then give the same heat release.

Many combustion systems mix or introduce the air to a burner before combustion. This air is primary air. If all of the air required is not supplied before combustion, then the air mixed after ignition is secondary air. The amount of primary air is normally expressed as a percent of the total theoretical air required. For example, a 70% primary air mixture would have 7 cu. ft. of air mixed with 1 cu. ft. of natural gas. The balance of the air required to complete combustion or 3 cu. ft. would then be secondary air.

To a great extent the geometry of a flame is controlled by the percentage of primary aeration. This is particularly true of premixed nozzle type systems.



(3)



Natural Gas - 1000 Btu/C.F.

(14)

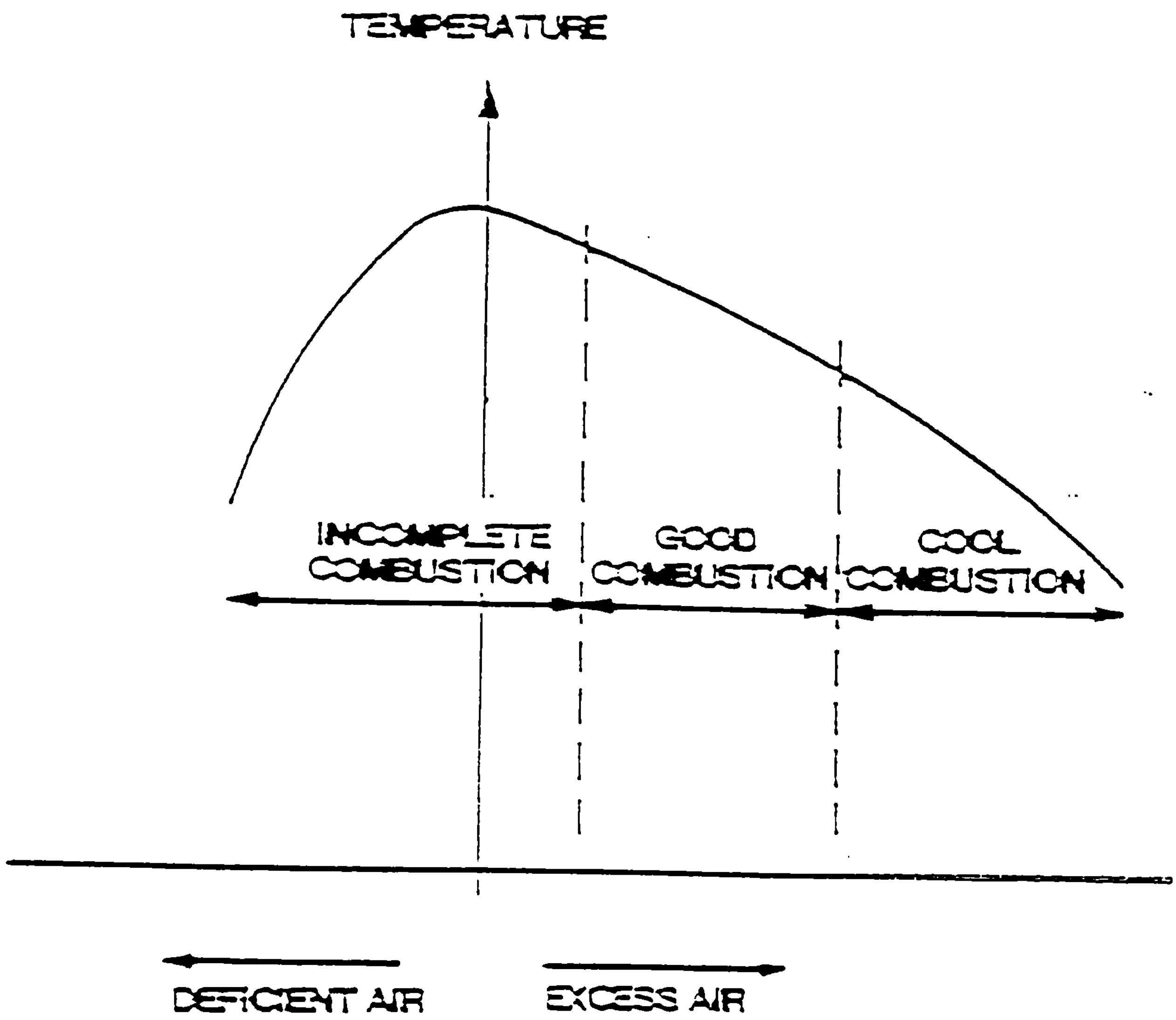

TEMPERATURE
INCOMPLETE COMBUSTION
GOOD COMBUSTION
COOL COMBUSTION
DEFICIENT AIR
EXCESS AIR

Table 16-1. *(Continued)*

Gas or Vapor	Lower Limit, % by volume	Upper Limit, % by volume	Closed Cup Flash Point, °F
Gasoline (variable)	1.4-1.5	7.4-7.6	-50
Heptane	1.0	6.0	25
Hexane	1.2	6.9	-15
Hydrogen cyanide	5.6	40.0	–
Hydrogen	4.0	74.2	–
Hydrogen sulfide	4.3	45.5	–
Illuminating gas (coal gas)	5.3	33.0	–
Isobutyl alcohol	1.7	–	82
Isopentane	1.3	–	–
Isopropyl acetate	1.8	7.8	43
Isopropyl alcohol	2.0	–	53
Kerosene	0.7	5	100
Linseed oil	–	–	432
Methane	5.0	15.0	–
Methyl acetate	3.1	15.5	14
Methyl alcohol	6.7	36.5	52
Methyl bromide	13.5	14.5	–
Methyl butyl ketone	1.2	8.0	–
Methyl chloride	8.2	18.7	–
Methyl cyclohexane	1.1	–	25
Methyl ether	3.4	18	–
Methyl ethyl ether	2.0	10.1	-35
Methyl ethyl ketone	1.8	9.5	30
Methyl formate	5.0	22.7	- 2
Methyl propyl ketone	1.5	8.2	–
Mineral spirits No. 10	0.8	–	104
Naphthalene	0.9	–	176
Nitrobenzene	1.8	–	190
Nitroethane	4.0	–	87
Nitromethane	7.3	–	95
Nonane	0.83	2.9	88
Octane	0.95	3.2	56
Paraldehyde	1.3	–	–
Paraffin oil	–	–	444
Pentane	1.4	7.8	–
Propane	2.1	10.1	–
Propyl acetate	1.8	8.0	58
Propyl alcohol	2.1	13.5	59
Propylene	2.0	11.1	–
Propylene dichloride	3.4	14.5	60
Propylene oxide	2.0	22.0	–
Pyridine	1.8	12.4	74
Rosin oil	–	–	266
Toluene (toluol)	1.3	7.0	40
Turpentine	0.8	–	95
Vinyl ether	1.7	27.0	–
Vinyl chloride	4.0	21.7	–
Water gas (variable)	6.0	70	–
Xylene (xylol)	1.0	6.0	63

Source: Ref. 15-5.

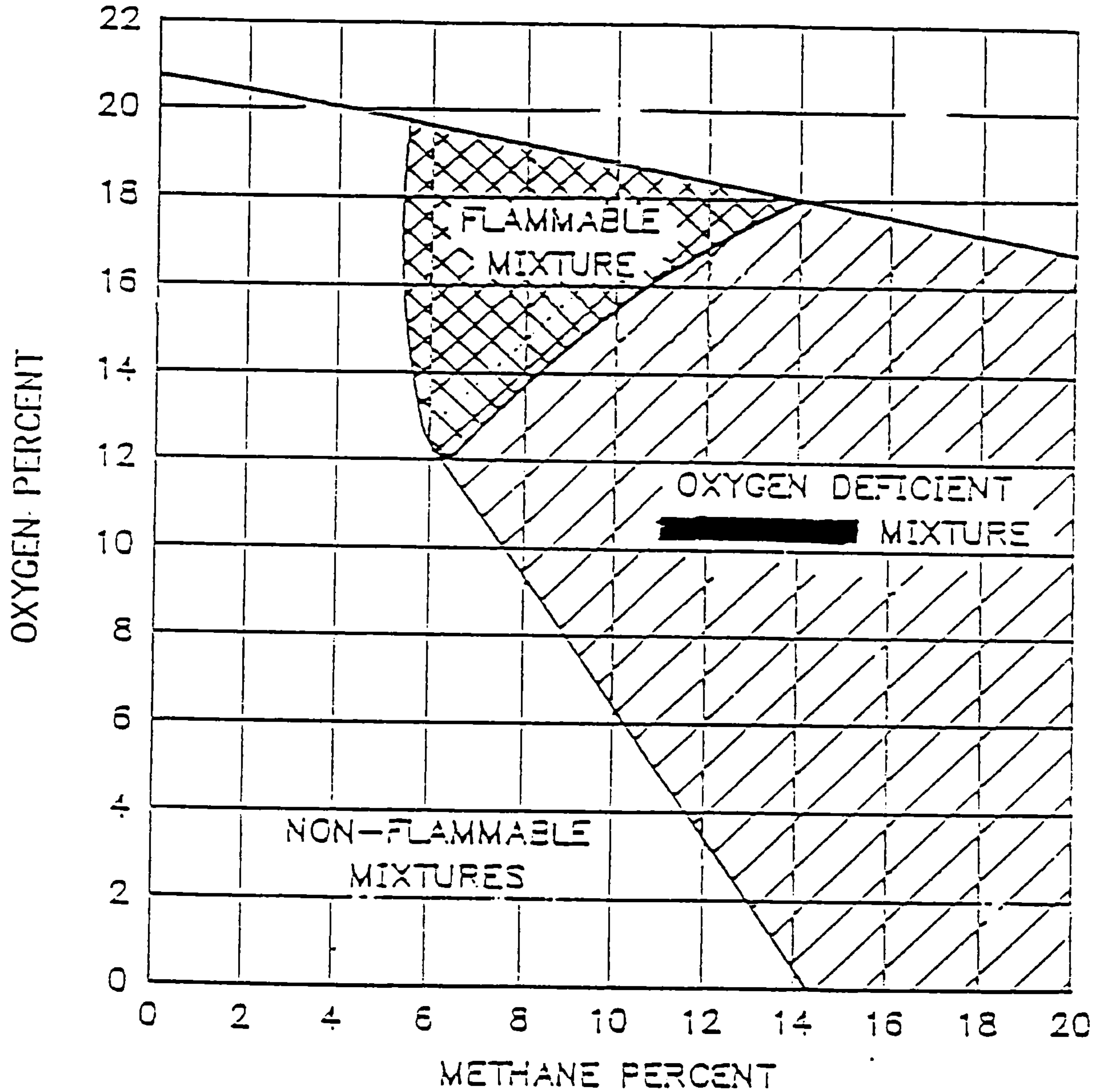
Table 16-2. Autoignition Temperature of Some Common Organic Compounds.

Compound	Temperature, °F	Compound	Temperature, °F
Acetone	1000	Hydrogen	1076
Ammonia	1200	Hydrogen cyanide	1000
Benzene	1075	Hydrogen sulfide	500
Butadiene	840	Kerosene	490
Butyl alcohol	693	Maleic anhydride	890
Carbon disulfide	257	Methane	999
Carbon monoxide	1205	Methyl alcohol	878
Chlorobenzene	1245	Dichloromethane	1185
Cresol	1038	Methyl ethyl ketone	960
Cyclohexane	514	Mineral spirits	475
Dibutyl phthalate	760	Petroleum naphtha	475
Ethyl ether	366	Nitrobenzene	924
Methyl ether	662	Oleic acid	685
Ethane	950	Phenol	1319
Ethyl acetate	907	Phthalic anhydride	1084
Ethyl alcohol	799	Propane	874
Ethyl benzene	870	Propylene	940
Ethyl chloride	965	Styrene	915
Ethylene dichloride	775	Sulfur	450
Ethylene glycol	775	Toluene	1026
Ethylene oxide	804	Turpentine	488
Furfural	739	Vinyl acetate	800
Furfural alcohol	915	Xylene	924
Glycerin	739		

Source: Ref. 15-6.

16

LIMITS OF INDIVIDUAL GASES AND VAPORS

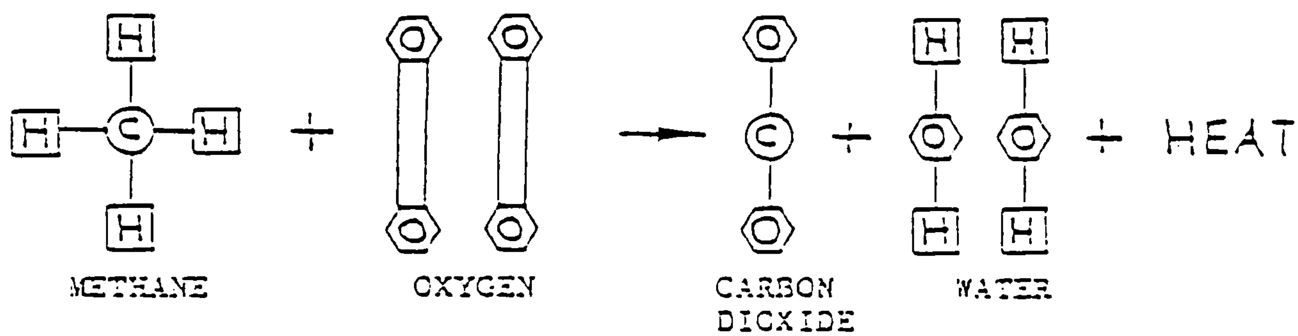


BASELINE METHANE MIXTURE RELATIONSHIP
FIGURE 1

AUTO IGNITION TEMPERATURE

FUEL	MAXIMUM TEMPERATURE (°F)	(°C)
NATURAL GAS	1300	704
PROPANE	940	504
BUTANE	810	432
NO. 2 FUEL OIL	500	260
NO. 6 FUEL OIL	1000	538
BENZENE	1050	566
TOLUENE	1000	538
ACETYLENE	570	299

collision would not be sufficient to break the bonds of the hydrogen and carbon or oxygen molecules, and allow the oxygen to be added to the carbon or hydrogen. As the temperature of the molecules is raised, the velocity of the molecules increases and more energy is liberated upon impact.



At about 1200°F. enough velocity and energy has been imparted to molecules so that the collision occurs with enough force to break the double oxygen bond and the hydrogen linking to the carbon center of the methane molecule. At this time, the situation is very unstable. The carbon has a high affinity for oxygen and so does hydrogen. Combustion begins. As soon as this reaction takes place, heat is released in the immediate vicinity of the collision and the molecule is at a temperature approaching 5200°F. This heat is radiated to the next adjoining molecules and a chain reaction begins. In other words, the heat liberated from one molecular reaction heats up the adjoining molecules and transmits them to a higher energy level, and they react. In most applications there is an air and gas mixture and the associated nitrogen molecules. The nitrogen impedes the progression of the heat transfer from methane to oxygen and absorbs heat. The theoretical flame temperature is about 3500°F. with natural gas and air mixtures.

H. COMPONENT IDENTIFICATION

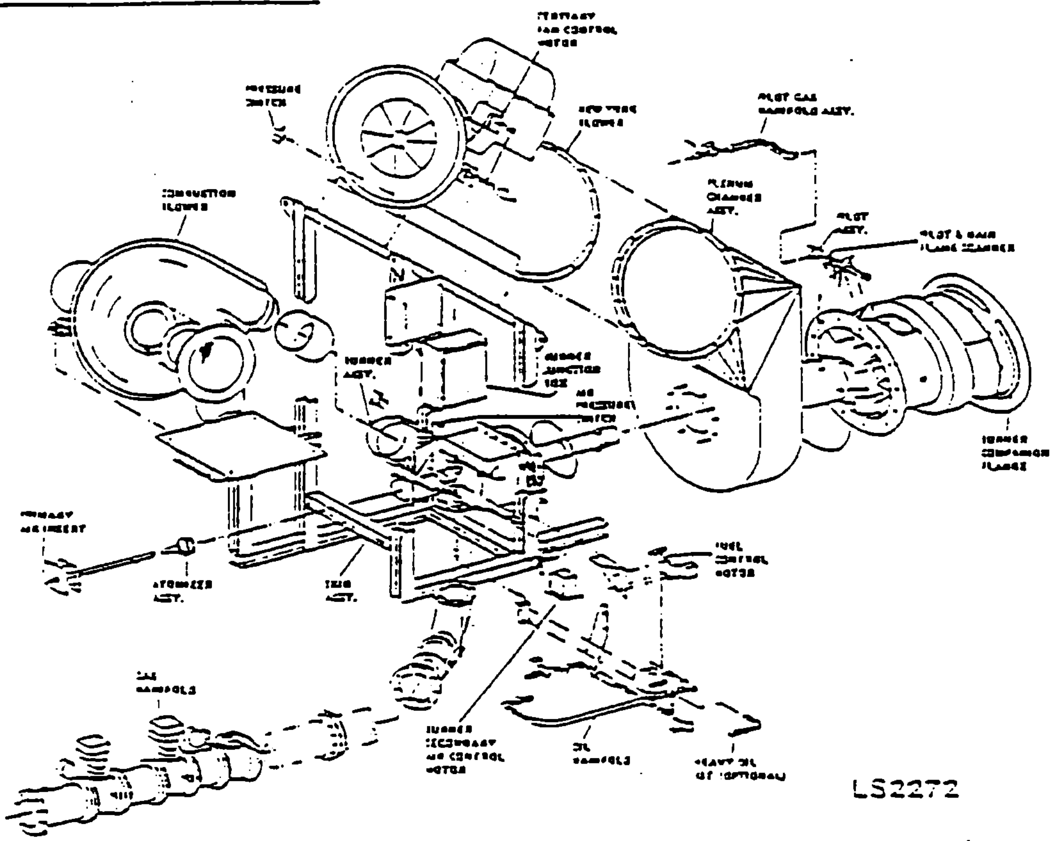


Fig. 2 - Hauck PowerStar Burner Unit (SJP075 - SJP980)

I. DIMENSIONS

PowerStar dimensional drawings are located in the Appendix.

J. RECEIVING AND INSPECTION

Upon receipt, check each item on the bill of lading and/or invoice to determine that all equipment has been received. A careful examination of all parts should be made to ascertain if there has been any damage in shipment.

IMPORTANT

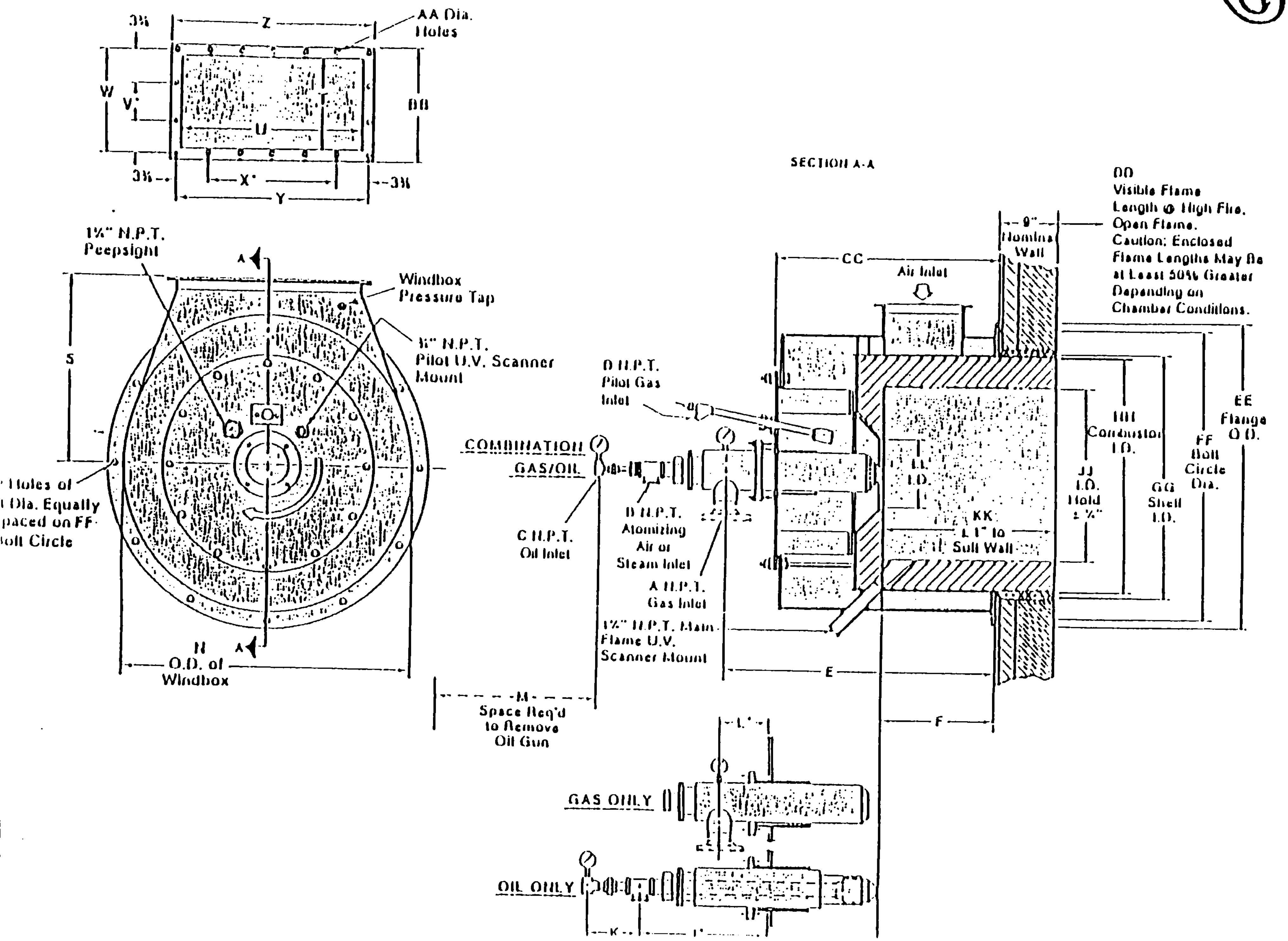
If installation is delayed and equipment is stored outside, provide adequate protection as dictated by climate and period of exposure. Special care should be given to all motors and bearings, if applicable, to protect them from rain or excessive moisture.

K. MOUNTING BURNER

1. The burner should be mounted on the drum centerline at the same pitch as the drum. Install a structure to support the burner's skid. The skid support structure should provide a minimum of plus or minus 4" along the drum centerline. Burner repositioning may be required for final burner adjustment. Refer to drawing CY4256 for burner skid dimensions.

2. The burner comes complete with a companion flange. If the drum opening is greater than drawing CY4256 "A" dimension, it will be necessary to close the opening with an adapter ring of 1/4 inch thick mild steel. The

DIMENSIC



3⅜
Z
AA Dia. Holes
W
V*
U
BB
X*
Y
SECTION A-A
1¼" N.P.T. Peepsight
Windbox Pressure Tap
½" N.P.T. Pilot U.V. Scanner Mount
5
Holes of Dia. Equally Spaced on FF Bolt Circle
N O.D. of Windbox
A
D N.P.T. Pilot Gas Inlet
COMBINATION GAS/OIL
C N.P.T. Oil Inlet
B N.P.T. Atomizing Air or Steam Inlet
A N.P.T. Gas Inlet
1¼" N.P.T. Main Flame U.V. Scanner Mount
M Space Req'd to Remove Oil Gun
CC
Air Inlet
9" Nominal Wall
DD Visible Flame Length @ High Fire, Open Flame. Caution: Enclosed Flame Lengths May Be at Least 50% Greater Depending on Chamber Conditions.
EE Flange O.D.
FF Bolt Circle Dia.
GG Shell I.D.
HH Combustor I.D.
JJ I.D. Hold ± ¼"
KK
LL I.D.
L 1" to Soft Wall
E
F
GAS ONLY
OIL ONLY
K
L*

Constant gas pressures ranging from 10 psig minimum to 25 psig maximum must be available at the inlet of the Hauck gas pilot manifold.

4. Complete the initial adjustment of the air shutter in the following manner:
   a. Loosen, but do not remove, the locking thumbscrew.
   b. Adjust the air shutter to approximately 1/4" opening.
   c. Securely tighten the locking thumbscrew.
   d. Open the gas flow valve slowly and light the pilot by means of electric ignition.

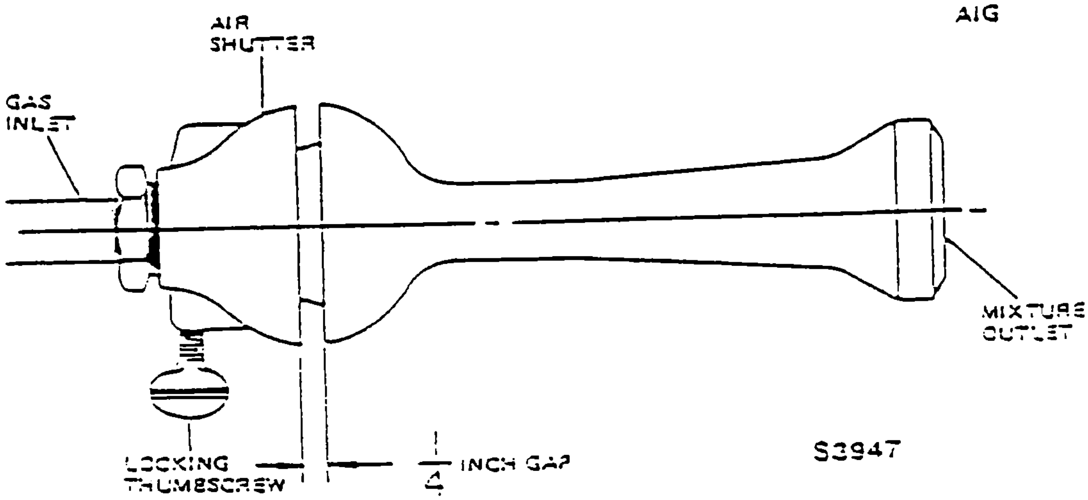


Fig. 4 - PowerStar AIG Pilot System

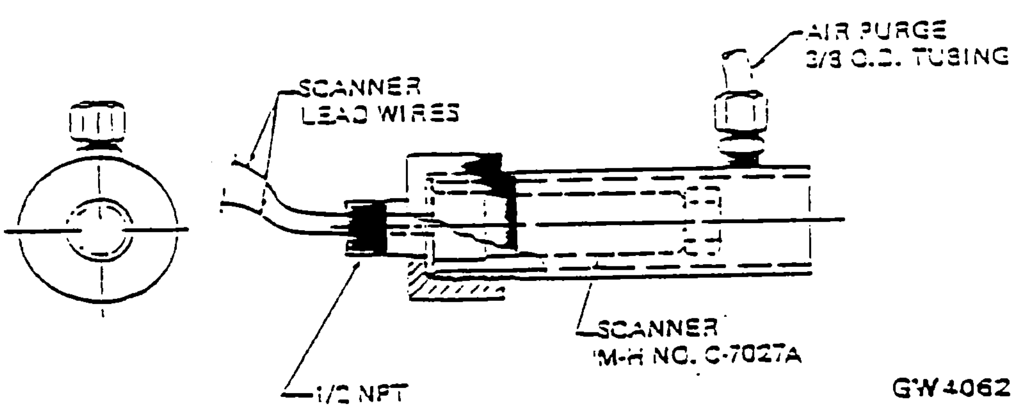
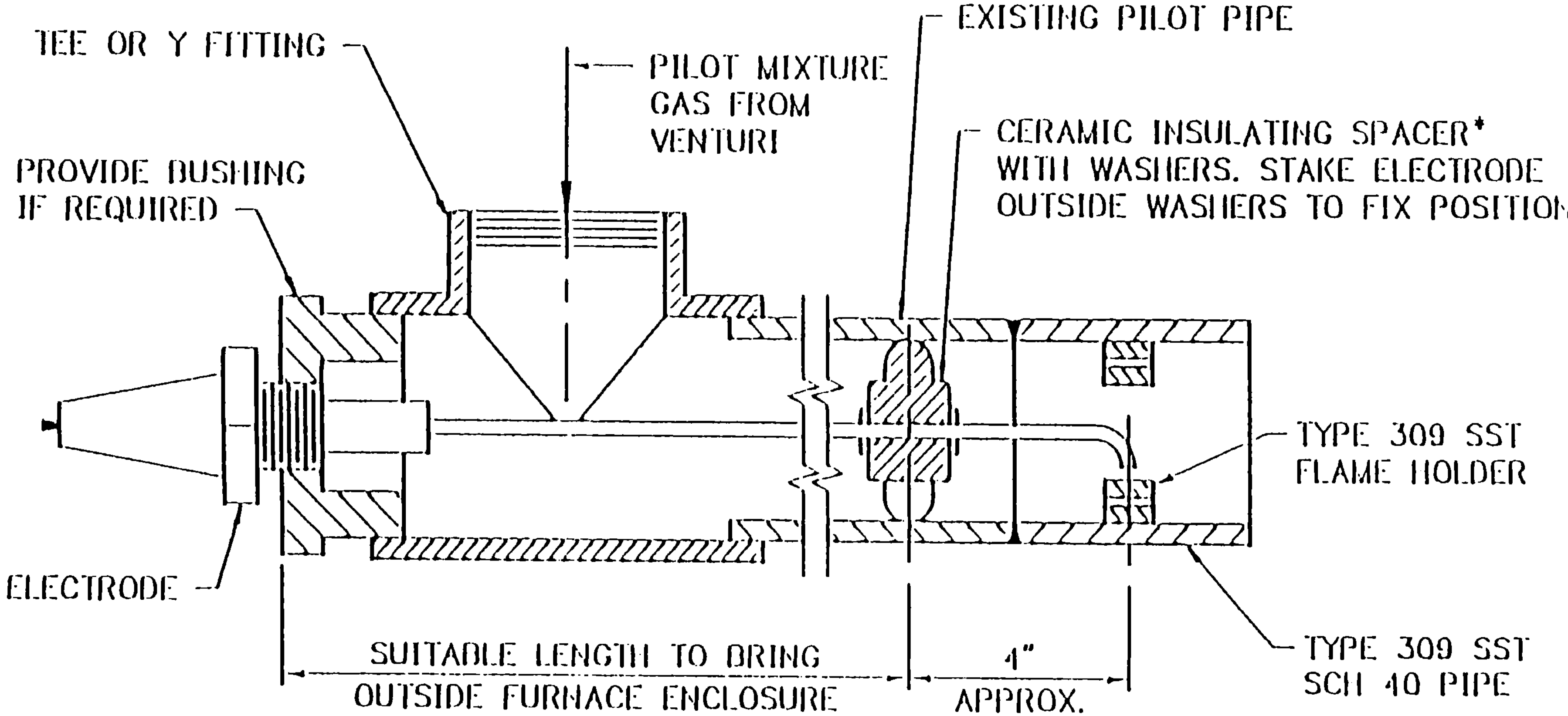


Fig. 5 - Pilot Scanner, Adapter

21A



* PROVIDE 1 CERAMIC SPACER FOR EVERY 24" OF LENGTH

FIGURE 8 – CARBURETING PILOT DESIGN

21 B

PILOT FUEL

NATURAL GAS

PROPANE

NO. 2 FUEL OIL

KEROSENE

21C

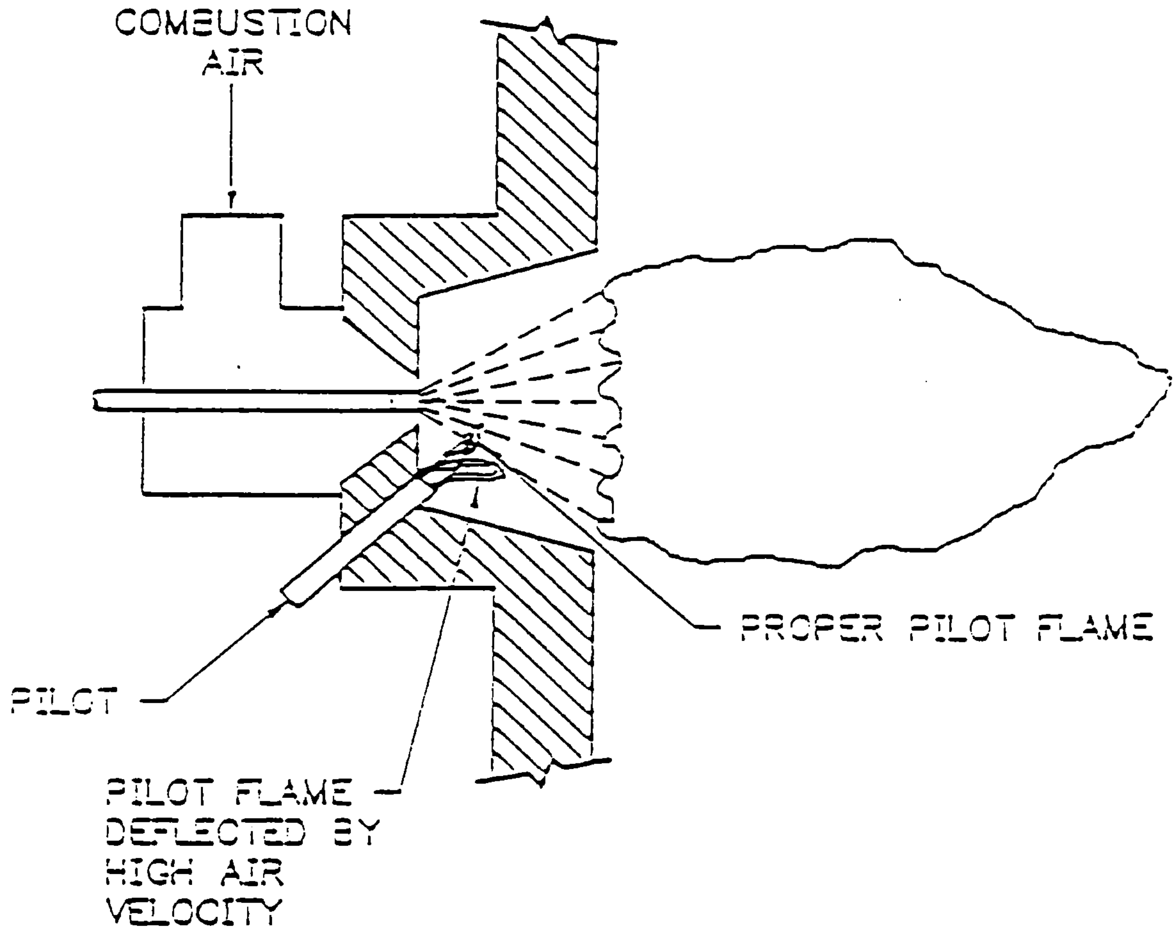


FIGURE 7 — PILOT FLAME LOCATION

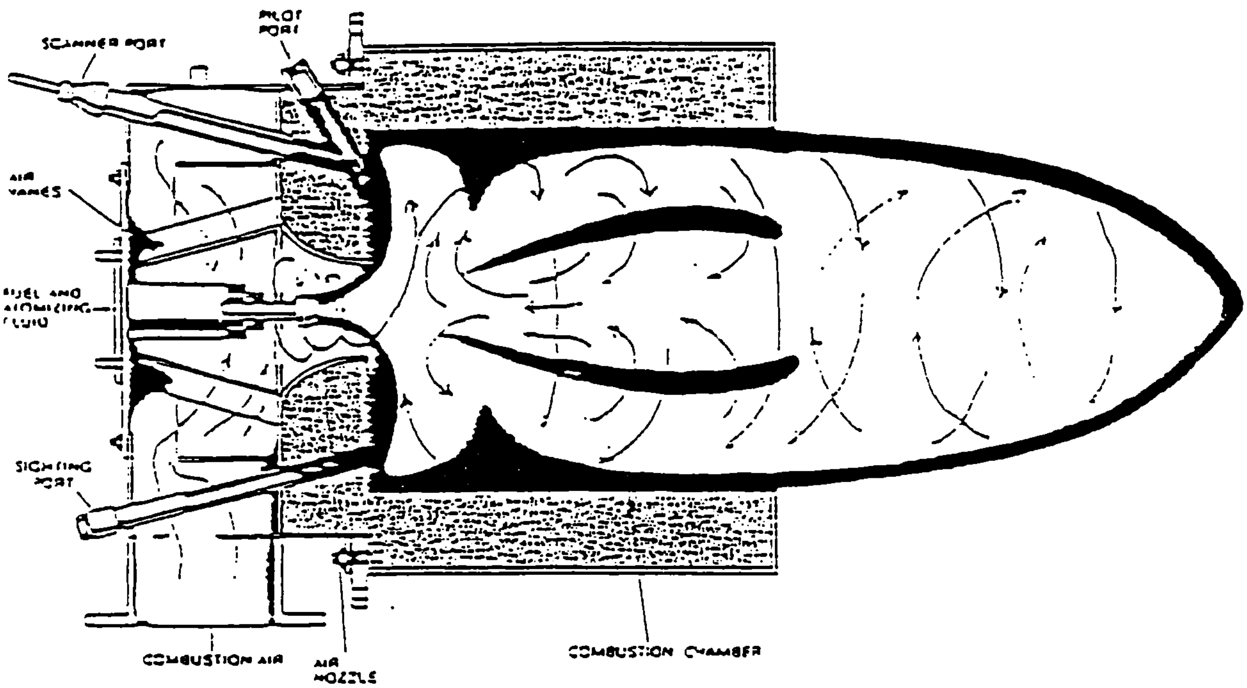
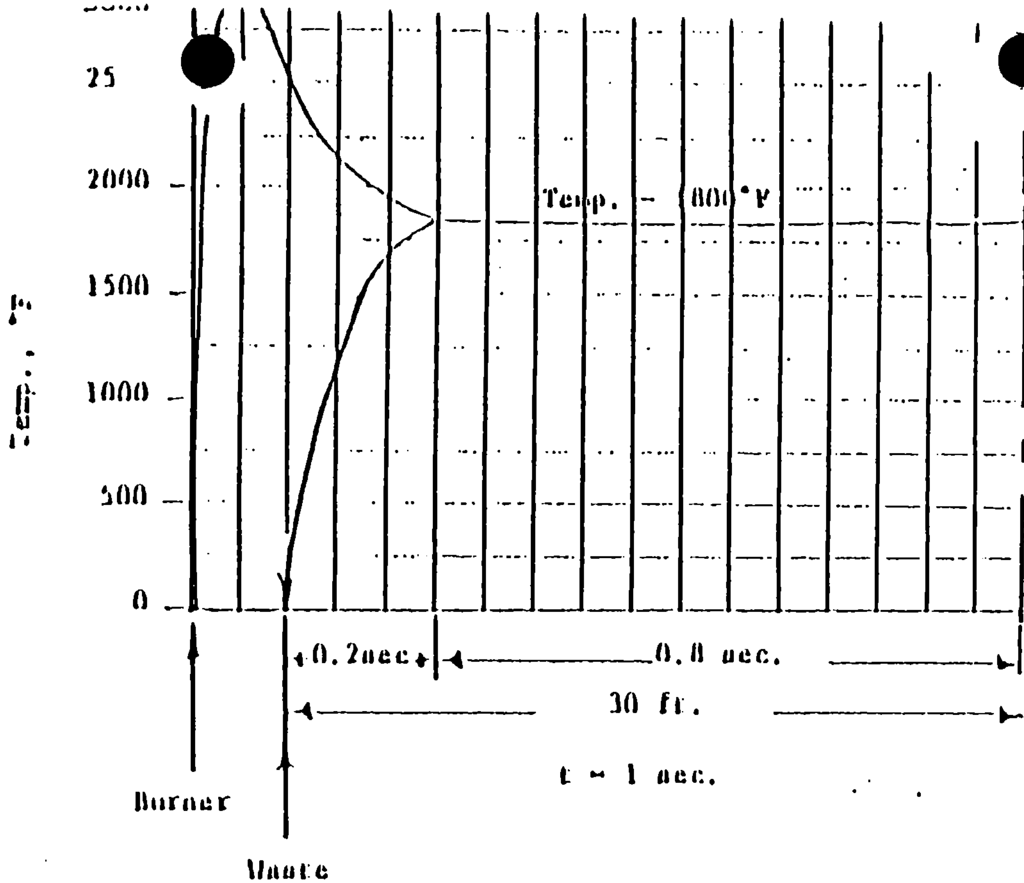


FIG. 2
TRANE THERMAL VORTEX BURNER

22A

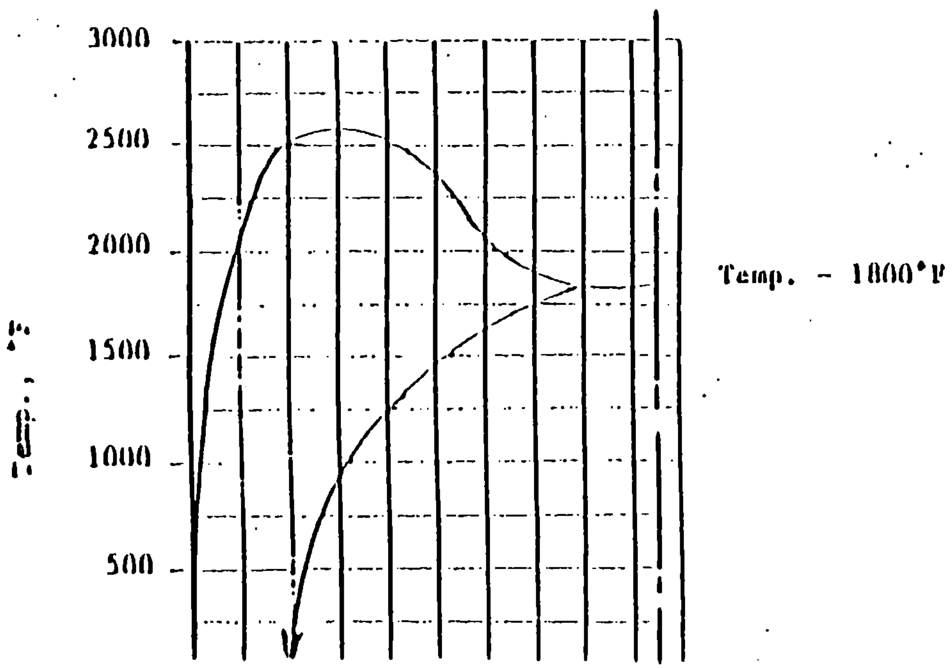
TEMP. PROFILE

INCINERATOR NO. 2



TEMP. PROFILE

INCINERATOR NO. 1



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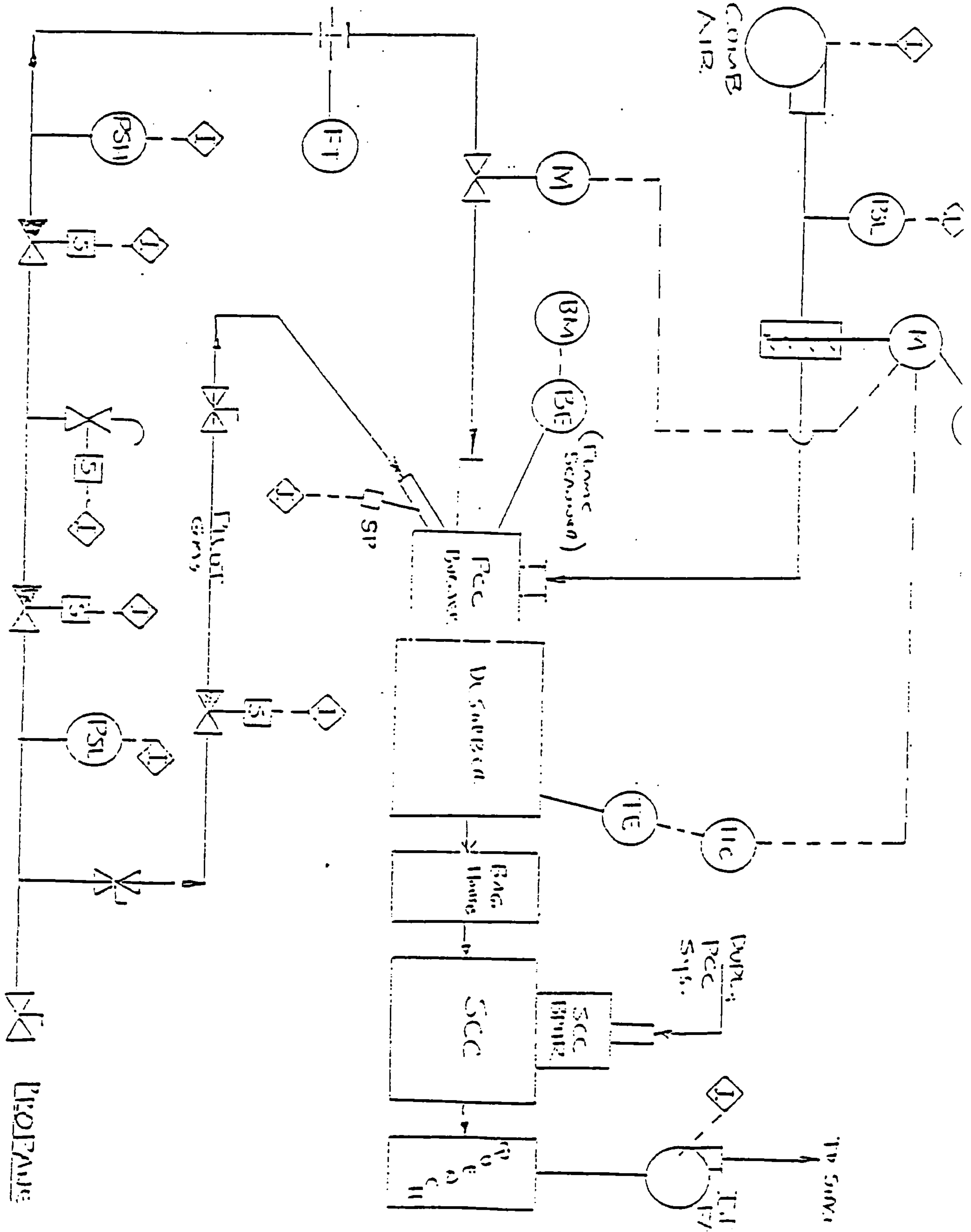
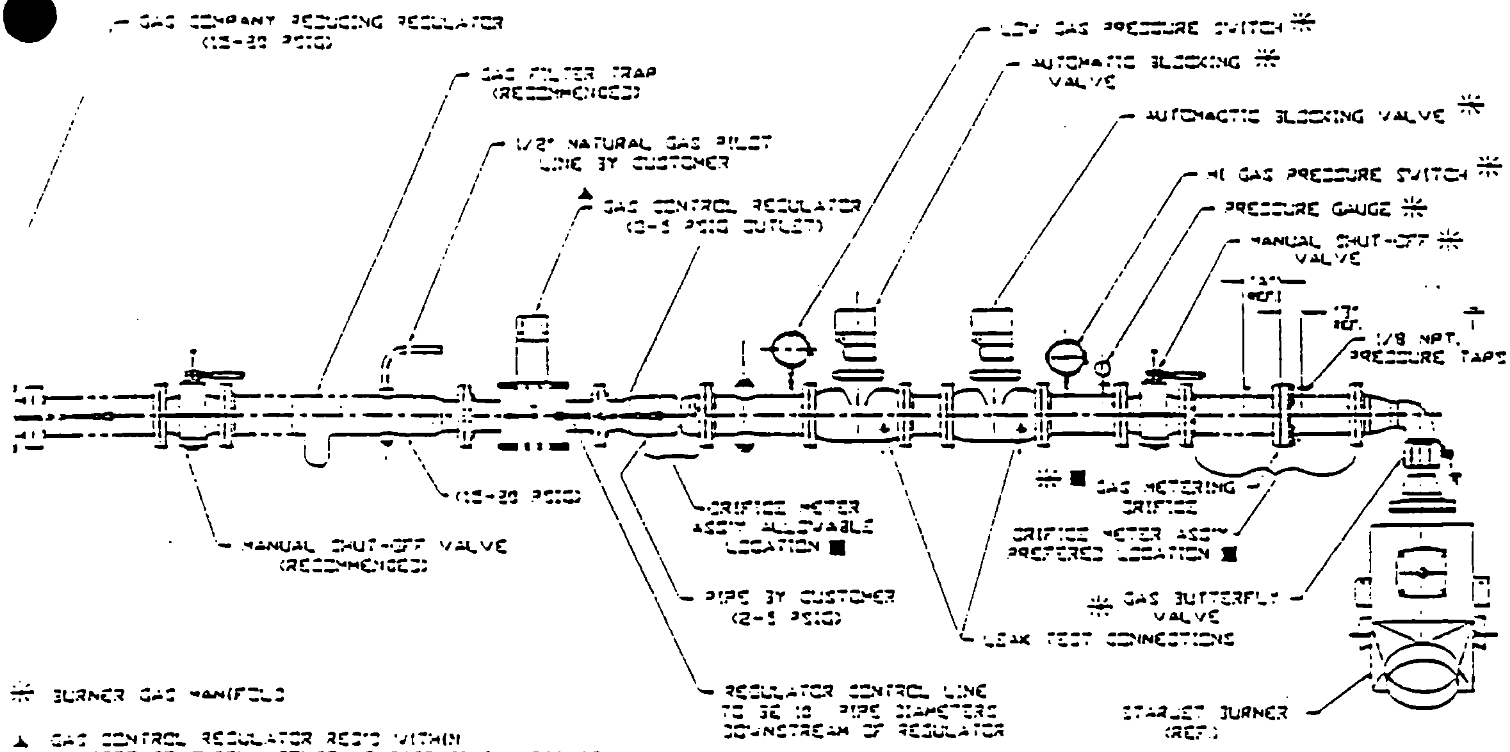


23A



BURNER GAS MANIFOLD

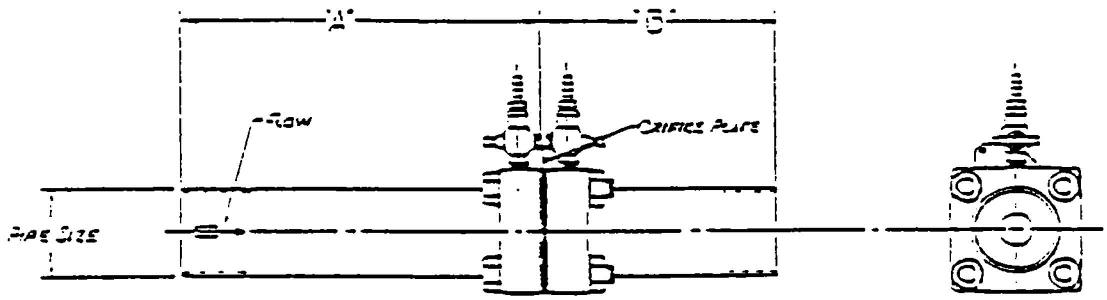
GAS CONTROL REGULATOR REQ'D WITHIN 25 FEET TO SUPPLY CONSTANT OPERATING PRESSURE. INLET GAS PRESSURE TO CONTROL REGULATOR SHOULD BE 15-20 PSIG. REQ'D OUTLET GAS PRESSURE 2-5 PSIG.

GAS METERING PLATE MUST HAVE A MIN. OF ... PIPE DIAMETERS UPSTREAM & MIN. 2 PIPE DIAMETERS ...STREAM IN STRAIGHT UNOBSTRUCTED LENGTHS. (PREFERED LOCATION & ALLOWABLE LOCATION)

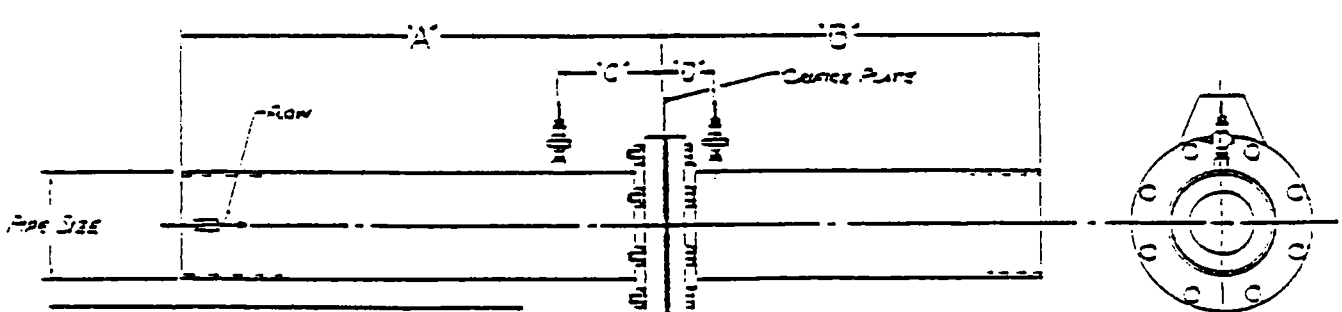
150 - 260 PRESSURE TAPS LOCATED ON ORIFICE FLANGES

MODEL NO.	"A"	"B"
150 - 260	N/A*	N/A*
360 - 580	5 1/16	2 3/4
750 - 980	8 1/16	3 5/8

CY4220



SJ-SJP GTT to 260



SJ-SJP 360 to 980

MODEL SJ-SJP	PIPE SIZE	"A"	"B"	"C"	"D"
GTT	2½"	12"	8"	—	—
150,200,260	4"	20"	14"	—	—
360,580,750	6"	28"	22"	6 7/16"	2 1/16"
750,980	8"	36"	28"	8 7/16"	1 1/8"

GX4845

Fig. 5 - Schematic representation of the burner gas manifold and dimensions for gas orifice meter

FLAME SENSOR TYPES

FLAME ROD SENSOR

INFRA-RED DETECTOR

ULTRA-VIOLET DETECTOR

PRESSURE-DIFFERENTIAL DETECTOR

25

PILOT TYPE OPERATING

CONTINUOUS

INTERMITTENT

INTERRUPTED

PURGING INCINERATORS

MINIMUM – 4 VOLUME CHANGES

100% AIR FLOW.

ALTERNATE – 8 VOLUME CHANGES

25% AIR FLOW

METHOD

– FORCED DRAFT

– NATURAL DRAFT

POST PURGE

27

INTERLOCKS

COMBUSTION AIR PRESSURE

NATURAL GAS PRESSURE (LOW, HIGH)

OXYGEN ANALYZER

CARBON MONOXIDE ANALYZER

PRESENCE OF FLAME

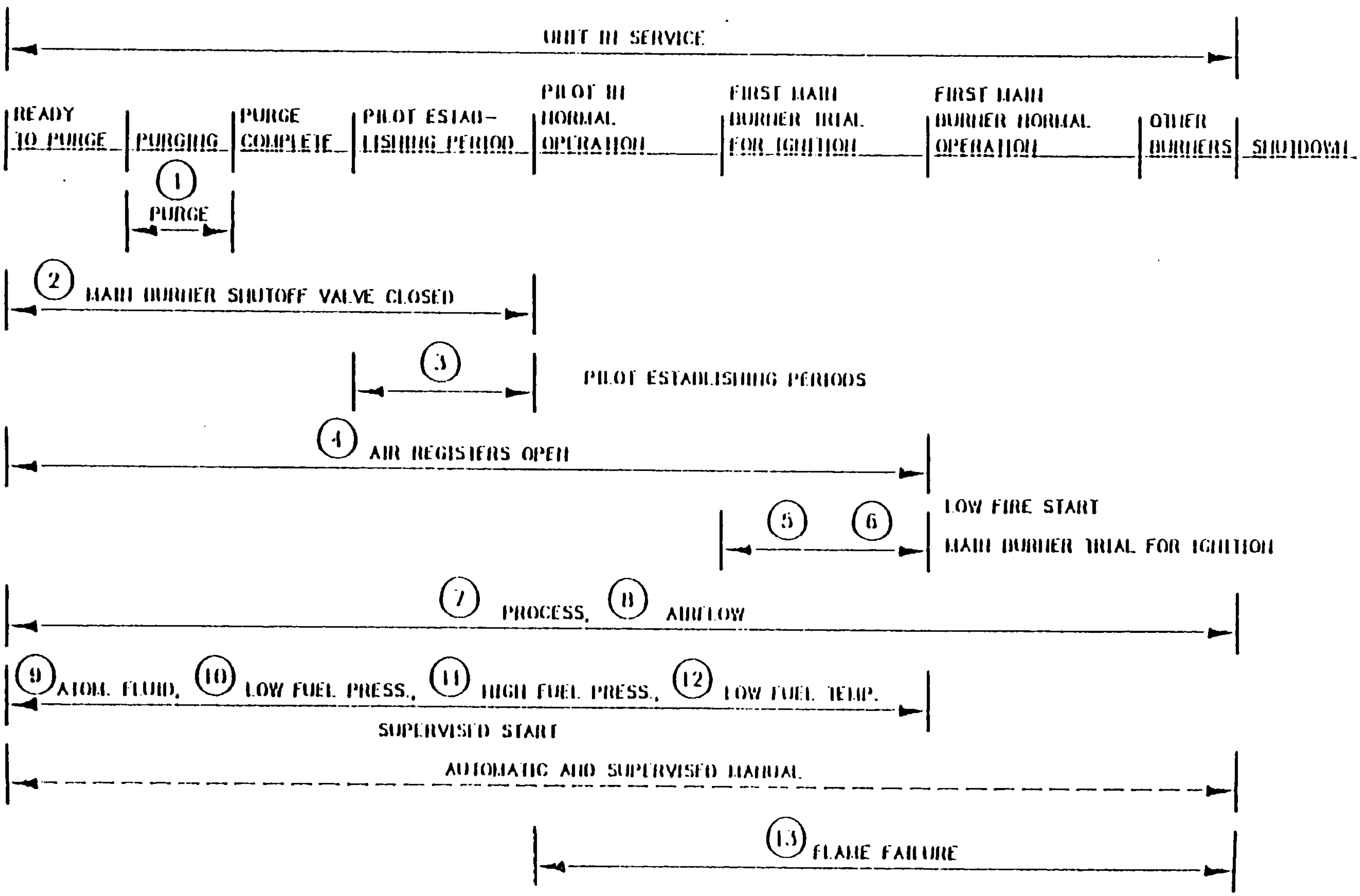
PURGING (AIRFLOW)

PURGE COMPLETE (TIME DELAY)

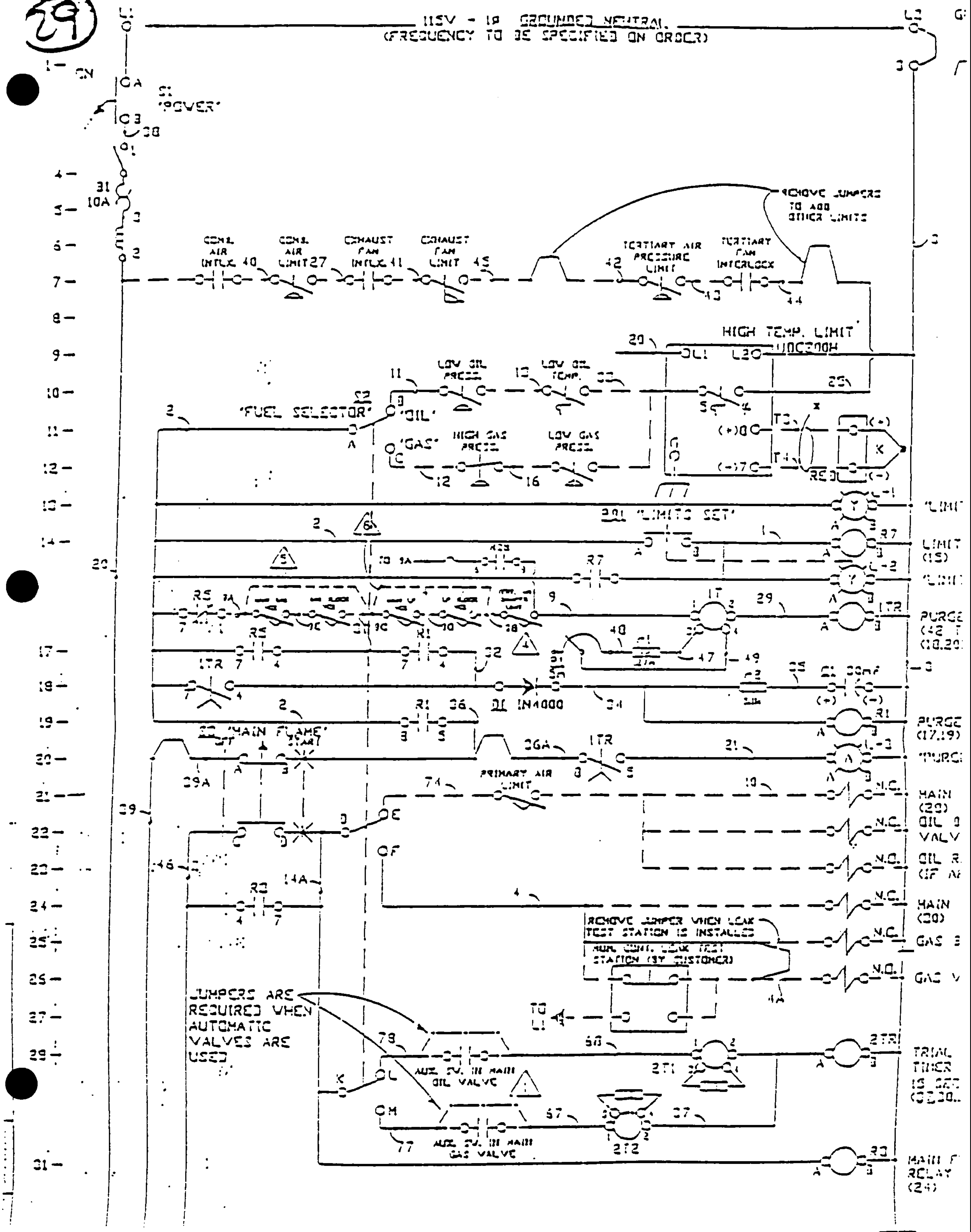
PILOT IGNITION TRIAL

MAIN FLAME IGNITION TRIAL

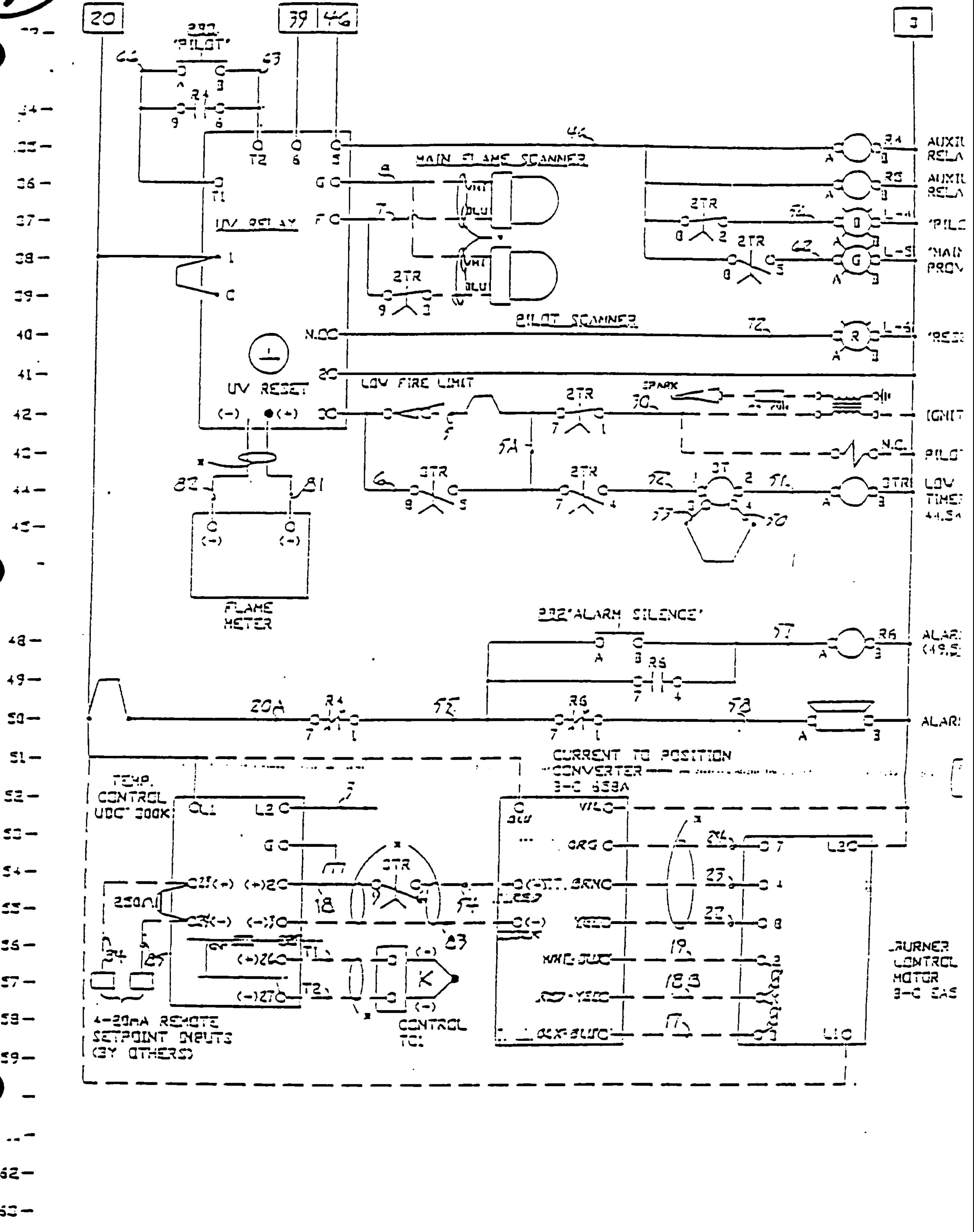
FIGURE 15 – START UP SEQUENCE



29


115V - 1Ø GROUNDED NEUTRAL
(FREQUENCY TO BE SPECIFIED ON ORDER)
L1
L2
ON
S1
'POWER'
31
10A
COMB. AIR INTLK.
COMB. AIR LIMIT
EXHAUST FAN INTLK.
EXHAUST FAN LIMIT
TERTIARY AIR PRESSURE LIMIT
TERTIARY FAN INTERLOCK
REMOVE JUMPERS TO ADD OTHER LIMITS
HIGH TEMP. LIMIT
LOW OIL PRESS.
LOW OIL TEMP.
'FUEL SELECTOR'
'OIL'
'GAS'
HIGH GAS PRESS.
LOW GAS PRESS.
'LIMITS SET'
LIMIT
PURGE
IN4000
PURGE
'MAIN FLAME'
START
PRIMARY AIR LIMIT
MAIN
OIL
VALV
N.C.
N.O.
GAS
REMOVE JUMPER WHEN LEAK TEST STATION IS INSTALLED
AUX. CONT. LEAK TEST STATION (BY CUSTOMER)
JUMPERS ARE REQUIRED WHEN AUTOMATIC VALVES ARE USED
AUX. SW. IN MAIN OIL VALVE
AUX. SW. IN MAIN GAS VALVE
TRIAL TIMER
MAIN F
RELAY

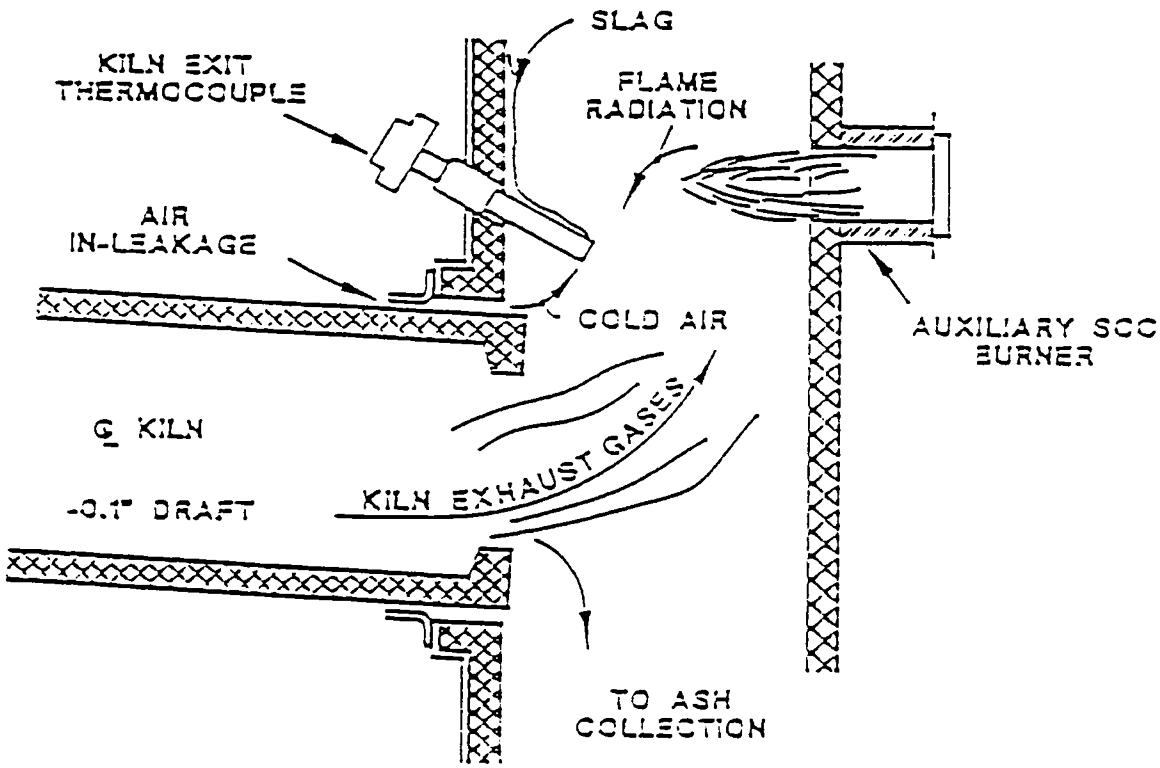
30



20
39
46
3
"PILOT"
R4
AUXIL RELA
MAIN FLAME SCANNER
2TR
UV RELAY
PILOT SCANNER
UV RESET
LOW FIRE LIMIT
SPARK
IGNIT
PILOT
LOW TIMER
FLAME METER
"ALARM SILENCE"
R6
R5
ALARM
CURRENT TO POSITION CONVERTER
TEMP. CONTROL UDC 300K
250Ω
4-20mA REMOTE SETPOINT INPUTS (BY OTHERS)
CONTROL TC1
BURNER CONTROL MOTOR

MISC

98C273



THERMOCOUPLE LOCATION
ERRORS IN MONITOR OUTPUT
OF PCC TEMPERATURE

Fig.3

Misc

Combustion
Miscellaneous Rules of Thumb

(1) Higher Heating Value (HHV) of Fuel

$HHV = \#O_2$ REQ'D × 6000 =

= ___X___ Btu/#

---

(2) LEL for Typ. Hydrocarbons in Air @ 60°F.

52 Btu/ft³ = LEL
13 Btu/ft³ = 25% LEL

---

(3) Temp Rise – VOC in Air Stream

25°F Rise for each 1% LEL

---

(4) 100 Btu/ft3 Rule

SECTION 11

TROUBLE SHOOTING GUIDE

TABLE OF CONTENTS

No.	PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
1	Dryer Pressure at burner end low. (low draft) pressure tap	ID fan damper control will not control.	Check instrument LP #330 Check separate line for plugged Check electrical power. Check mechanical performance.
		Burner firing rate high.	Check operating conditions.
		Dryer off-gas temperature high.	Reduce dryer burner fuel –and/or– increase feed rate.
		Dryer off-gas oxygen high.	Prevent air leakage or adjust the excess air in primary burner.
		Gas flow obstruction.	
-		-Baghouse diff. pressure high.	Check baghouse performance. See TSG #10.
–		ID fan not delivering flow.	Check operating conditions. Inspect fan and damper. Check diff. pressure across ID fan.
		Gage not functioning Excess air leakage	
2	Dryer off-gas oxygen low (<3%)		Oxygen analyzer malfunction. Check oxygen probe.
		Dryer draft low.	Raise dryer DE pressure by controlling ID fan damper. –or– By correcting air to fuel ratio in primary burner.
3	Dryer off-gas oxygen high (>10%)		Oxygen analyzer malfunction. Check oxygen probe.
		Air leakage.	Reduce the air leakage into the dryer.
		Incorrect air/fuel ratio.	Correct the setting for proper air/fuel ratio.
		High draft.	Reduce DE pressure by controlling ID fan damper.
4	Dryer off-gas temperature low (less than 350°F)	Dryer draft high. (-)0.1" w.g.	Lower DE pressure to
		Air leakage.	Prevent excessive air leakages.
		Dryer burner fuel input low.	Increase fuel flow.

NO.	PROBLEM	CAUSE	REMEDY
		Temperature erratic or no temperature reading.	Check instrument LP #310. Check for defective thermocouple
		Dryer low.	Increase dryer.
		Retention time too low	
5	Dryer off-gas temperature high		Burner fuel input high.
		Low feed rate.	Increase feed rate.
		Incorrect air/fuel ratio (low O_2)	Increase DE pressure. —or— Adjust air to fuel ratio in primary burner.
		Temperature erratic.	Check instrument LP # 310. Check for defective thermocouple.
6	Dryer drive motor amps high	Dryer rotation too fast.	Check dryer RPM. Reduce, as required.
		Dryer discharge chute plug.	Inspect and verify.
		Mechanical problem.	Check all drive components.
		Electrical problem.	Check meter circuit. Check drive motor circuit.
		Dryer loading too high. Retention time too high	Check feed rate and dryer. Increase drum slope
7	Dryer discharge end temperature high.		Burner overfiring.
		Material agglomerating.	Check feed rate. Increase to normal.
		Incorrect air distribution.	Check flights in the dryer.
8	Soil temperature high.	Low feed rate/high residence time.	Increase feed rate or reduce dryer RPM.
9	Soil temperature low.	High feed rate/low residence time.	Reduce feed rate or reduce dryer RPM.
10	Baghouse differential pressure high.		Excessive gas flows. Decrease gas flows.
		Pulsing system failure.	Check operation of solenoid valves. Check air compressor. Check for open air line. Check lines for restriction. Check compressed air for moisture or oil.

NO.	PROBLEM	CAUSE	REMEDY
			Check timing sequence (off-time/on-time). Check setpoint & differential pressure gauge.
		Cleaning cycle sequence problem.	Check for proper operation.
		Bags blinded.	<u>If dust is dry.</u> (1) Air flow too high. If the dryer air flow is too high to allow dust to drop off of the filter bags, an excessive pressure drop across the dust collector will result and dust will build up in the system. (2) Particle size and dust load. If possible, compare the dust particle size and loading with the original design specifications. (3) Bags too tight. Bags that have shrunk on their cages may not flex sufficiently during the compressed air pulse to loosen caked dust. <u>If dust is wet.</u> (4) Condensation. If moisture has been condensing inside the collector, check the dew point temperature of the incoming air stream, and compressed air.
		Instrument loop problem.	Checked instrument LP # 631. Checked the differential pressure gauge.. (above 450°F)
11	Baghouse differential pressure low.		Ductwork, dampers. from the dust collector for air leaks or blockage. Make sure that any dampers in the system are correctly positioned to allow air to flow through the dust collector.
		Leaks in the housing.	Check the tube sheets and the

NO.	PROBLEM	CAUSE	REMEDY
			dust collector housing for holes, cracks or loose gasketing that would permit air to bypass the dust collector of filter bags.
		Bag failure.	Inspect and replace bad bags.
-		Due to over-heating.	Do not operate above 500°F.
-		Holes in the filter bags or	Inspect the filter bags assemblies for holes, rips, tears, or excessive wear. Check the tube sheets for holes, cracks, or loose bolts that would permit dusty air to by-pass the filter bags.
-		Bags incorrectly installed.	
			Check instrument LP #631. Check differential pressure gauge.
12	ID Fan Motor Amps High.	Gas flow excessive.	Check operating conditions. Reduce primary burner fuel and/or feed rate.
-		Low gas temperature.	See TSG #4.
-		Air leak problem.	Inspect the system & correct.
		Electrical problem.	Check amp motor circuit. Check drive motor circuit.
		Mechanical problem.	Inspect fan and motor.
13	SCC Off-gas Oxygen Low.	High concentration of hydro-carbons in the feed.	Alter feed rate (short term solution). Check also CO reading. If it is persistently high (CO>100 ppm) then adjust air to fuel ratio.
		Incorrect air/fuel ratio.	Correct the setting for proper air/fuel ratio.
		Oxygen analyzer malfunction.	Check instrument LP #552.
14	SCC Off-gas Oxygen High.	High air to fuel ratio in SCC burner.	Adjust burner air fan damper to correct the ratio.
		Air leakage.	Check for air leak.
		Oxygen analyzer malfunction.	Check instrument LP #552.
15	SCC Off-gas temperature Low. low.		SCC Burner firing rate setpoint Raise setpoint to 1600°F.

NO.	PROBLEM	CAUSE	REMEDY
		Temperature erratic or no temperature reading.	Check instrument LP #516. Check for defective thermocouple.
17	Stack Gas CO High (>100 ppm, 1 hr. rolling avg.)	SCC low temperature.	Increase the SCC temperature.
		SCC off-gas low O_2.	Decrease the feed rate <u>or</u> Increase air to fuel ratio in SCC burner.
18	Stack Gas Hydrocarbon High (>50 ppm, 1 hr. rolling avg.)	SCC low temperature.	Increase the SCC temperature.
		SCC off gas low O_2	Decrease the feed rate <u>or</u> Increase the air to fuel ratio in SCC burner

SECTION 12

MAINTENANCE RESOURCES

TABLE OF CONTENTS

12.0 HOW TO LOCATE INFORMATION

If you need information about a part or system, follow these instructions:

YOU KNOW SUPPLIER'S NAME:

If you know the name of the supplier that furnished the item, then look in Appendix 12.4.1 "POs by Supplier " and look thru the Index or thru the POs to find information about the order. Manufacturer's catalog sheets are included as attachments with most POs for reference.

If you just want the Supplier's phone number or contact's name, look in Appendix 12.3 "Suppliers List".

YOU KNOW MANUFACTURER'S NAME:

If you know the name of the manufacturer that made the part originally, then look in Appendix 12.5 "Catalog Sheets & Instructions" Book #1 (A thru H) or #2 (I thru Z). Search for specific manufacturer or supplier or item desired in different sorted lists.
If the Manufacturer's name is the same as the Supplier's name, follow instructions above.

YOU KNOW PURCHASE ORDER NUMBER ONLY:

If you only know the number of the purchase order that the item was bought under, then look in Appendix 12.4.1, in the index of POs.

YOU KNOW SYSTEM PART IS FROM

If you know the WESI-assigned Part Number, then look in Appendix 12.1 "Parts List". Look in the section for the specific Trailer Unit. Scan down the column "System" to find the desired item. Read the Supplier Name and PO#.

Drawing numbers for parts have the same number as the Parts Number, or a similar number. See Appendix 12.2 for Drawing List.

YOU KNOW DRAWING NUMBER OF PART:

If you know the drawing number that shows the item, then the System number is very similar. Follow above instructions for "System".

12.1 MANUFACTURING PARTS LISTS

This section includes lists of parts used on WESI*TPU3 (~~see Appendix #12~~.1). They are separated by trailer systems (3PCC, 3ABS, etc.) and include tables of information arranged by WESI Part Number. This section is provided as an index to WESI parts and drawings and includes detail information.

12.2 DRAWINGS OF EQUIPMENT

Copies of all drawings prepared by WESI are located in the Drawing Binder ~~Appendix 6.6~~. WESI drawings are normally provided in 11 x 17 format. Larger copies can be provided when requested. The following drawing list describes all available drawings. Some drawings are not provided for jobsite use, such as individual part drawings that were only needed for original manufacture. If additional drawings are needed in the field, request them from the Equipment Department.
WESI drawings are numbered uniquely with a number that identifies the trailer unit (3ABS, etc.) and each system or sub-component. WESI Part Numbers match the corresponding WESI Drawing Number, ie: Part Number 3ABS-1XX would be shown on drawing 3ABS-1XX or related number.

12.3 SUPPLIERS LIST: Names, Phones, PO #s.

This list includes all suppliers of systems, components, services, etc. for WESI*TPU3 original manufacture (see Appendix 12.3). It includes company names, phones, contacts, locations, and items furnished, as well as names of original manufacturers of items purchased thru these sources. It is arranged alphabetically by supplier name.

12.4 PURCHASE ORDERS: Alphabetical & numerical.

available at WESI's home office

Copies of purchase orders for manufacture of WESI*TPU#3 are ~~provided in Appendix 12.4~~. Two copies are included in different sorted sets. One arranged alphabetically by supplier name, and one numerically by PO numbers. An index is also included, sorted by Unit, then, Supplier, then PO#.

12.4.1 PURCHASE ORDERS BY SUPPLIER NAME

This copy of purchase orders was made from the goldenrod copy maintained by the Equipment Department. It should have complete prices and accurate quantities and descriptions, as well as any hand-written about the order. This copy of the PO has attachments that relate to the order, such as sketches, catalog sheets etc. These attachments are placed loosely behind their related PO, rather than stapled to it. They should be kept in order when handling. They are marked in upper right corner with Supplier Name and PO number.

An index list is included in front of the POs. It is sorted by Trailer Unit, then Supplier Name, and then PO#. It includes Quan and Description of items ordered, as well as the WESI Part Number. The Item Number is a cross reference to the row number in the Parts Listings of Section 12.1.

12.4.2 PURCHASE ORDERS BY PO NUMBER

This copy of purchase orders was made from the white copy of the original PO. It may not have complete or final prices. If the information desired is not shown, the alphabetical PO copy should be referenced.

12.4.3 ADDITIONAL ORDERS PLACED AFTER ORIGINAL MANUFACTURE

Purchase orders for replacement or new items should be kept in these files. Job personnel or home office purchasers should send copies of all new POs for the Job File and for Equipment Dept. files.

12.5 MANUFACTURER'S CATALOG SHEETS & INSTRUCTIONS

Two separate manuals are provided for the manufacturer's catalog sheets for purchased items. ~~They are provided in Appendix 12.5.~~ One is for names beginning with A thru H; the other is for I thru Z. They are photocopies of supplier information relating to items used in original manufacture of WESI*TPU#3. Additional copies may be provided in Section 12.4.1 with the POs. They are arranged alphabetically by original manufacturer. They may include instructions, catalogs, drawings, parts lists, price lists or sketches. They may be hand labeled in upper right corner, if manufacturer's name is not otherwise shown. The related PO number may also be added.

The catalog sheet information is cross-referenced in three ways: sorted by Manufacturer, Supplier and by Item description.

12.6 PHOTOGRAPHS OF EQUIPMENT

Photographs are available of equipment, made during construction. Copies of selected photographs are included in Appendix #12.6. Request other copies, as needed, from the Equipment Department.

12.4 PURCHASE ORDERS: Alphabetical & numerical.

Copies of purchase orders for manufacture of WESI*TPU3 are ~~provided in Appendix 12.4~~ [maintained at WESI's home office]. Two copies ar included in different sorted sets. One arranged alphabetically by supplier name, and one numerically by P(numbers. An index is also included, sorted by Unit, then, Supplier, then PO#.

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This section has not been reviewed for TPU3.
Reports shown are from original TPU2.
They do NOT reflect what is being used now!

SECTION 13

delete

MANAGEMENT REPORTS

TABLE OF CONTENTS

REPORTS

Written reports shall be made to management on a regularly scheduled basis as follows:

HOURLY INSPECTION REPORT

Rates, speeds, temperatures, pressures, settings, and other readings for each operating hour of each shift of each day, including downtime reasons and times.

SHIFT INSPECTION REPORT

Results of inspections of all operating systems for each operating shift of each day.

SHIFT INSPECTION SUMMARY REPORT

Summary of SHIFT INSPECTION REPORT for each shift, by operating system.

DAILY PRODUCTION STATUS REPORT

Comparison of status of each shift with daily total and daily requirements, including problems, personnel process rate and total, plant hours, labor hours downtime hours, fuel use, and evaluation calculations of above for management review.

DOWNTIME LOG

Chronological list of downtime incidents, including duration and reason, for each operating shift.

MAINTENANCE REPORT

Maintenance correction and prevention actions taken, plus schedule of planned activities.

Certification of maintenance for each operating system on each unit, including action taken, when, by whom, and inspection report.

INSTRUCTION MANUAL
WESI*TPU3

Copies of this manual were sent to the following people:

Williams Environmental Services Inc.:

Dr. Taylor- President
Mark Fleri- Operations Manager
Brett Burgess- Project Development Manager
Tom Basler - Equipment Coordinator
John Port- Project Engineer
Wesi Shop

Benchmark Engineering:

Greg Powell- Electrical Engineer
Allen Tucker- Mechanical Engineer

Higgins Technical Services:

Mikie Walding- Electrical Contractor

Williams Environmental Services, Inc.
2075 West Park Place, Suite G
Stone Mountain, Georgia 3008

M

APPENDIX M

CSI OPERATIONS MANUAL

CONTINUOUS EMISSIONS MONITORING SYSTEM

COLUMBIA SCIENTIFIC INDUSTRIES CORPORATION

11950 Jollyville Road
P.O. Box 203190
Austin, Texas 78720
Phone: (512) 258-5191

CHECK OUT SHEET
EQUIPMENT SUPPLY COMPANY
08/06/91

I. ANALYZERS

A. CSI HC500-2D Analyzer Serial Number 14722

1. Sample Flow Rate	200 cc/min (MM)
2. H_2 Flow Rate	140 cc/min (MM)
3. Exhaust Line Temperature	108 °C
4. Burner Block Temperature	115 °C
5. Zero Pot Setting	9.60
6. Span Pot Setting	3.20

B. Milton Roy (ACS) Model 3300 CO Analyzer Serial Number N/A5202T

1. Sample Flow Rate	1 l/min
2. Purge Air Flow Rate	1 l/min approximately
3. Dual Range	a) 500 ppm
	b) 1000 ppm
4. Electronic Span	92 % Full Scale Low Range

C. Milton Roy (ACS) Model 3300 CO_2 Analyzer Serial Number N/A5211T

1. Sample Flow Rate	1 l/min
2. Purge Air Flow Rate	1 l/min approximately
3. Dual Range	a) 10 %
	b) 20 %
4. Electronic Span	88 % Full Scale Low Range

D. Servomex Model 1420B O_2 Analyzer Serial Number 01420/B/701/543

1. Sample Flow Rate	1 l/min
2. Range	#1 0-25 %
	#2 0-25 %
3. High Level Alarm	disabled
Low Level Alarm	disabled

CHECK OUT SHEET
EQUIPMENT SUPPLY COMPANY
08/06/91

II. CM10-1D SYSTEM CONTROL MODULE - SERIAL NUMBER 14724

A. Zero Air Pressure	30 psi
B. Diluted Sample Flow Rate	.2 l/min
C. Undiluted Sample Flow Rate	3.25 l/min
D. Sample Vent Flow Rate	.3 l/min
E. Dilution Air Pressure Set At to Achieve 50:1 Dilution Ratio	31.5 psi

III. HD10 AIR MODULE 14603

A. Purge Air Flow Rate	10 l/min
B. Dryer Air Pressure	90 psi
C. Eductor Air Pressure	40 psi

CALIBRATION PROCEDURE FOR CEM SYSTEM
EQUIPMENT SUPPLY COMPANY
August 16, 1991

Due to the low oxygen content in the stack gas the HC500-2D will need to be calibrated with nitrogen. The gases needed for calibration will be:

1) Propane in N_2 approximately 450 ppm; and
2) Carbon Monoxide and carbon dioxide mix in nitrogen approximately 900 ppm CO, 18% CO_2.

Step #1 Switch span source isolator to CO/CO_2 position. Switch CM10-1D Run/Cal switch to Cal position. Switch CM10-1D inside/outside switch to inside.

Step #2 Verify that all rotometers are reading correctly (approximately mid scale on all rotometer, adjust as necessary).

Step #3 Adjust for correct zero reading on HC500-2D and oxygen analyzer plus correct span values on the CO and CO_2 analyzers.

Step #4 Switch span source isolator to C_3H_8 position.

Step #5 Adjust for correct span reading on the HC500-2D and check for correct zero reading on the CO and CO_2 analyzers.
NOTE: If adjustments are necessary on the CO and CO_2 analyzers, Step #3 will need to be repeated.

Step #6 Switch CM10-1D from span mode to zero mode for the span adjustment on the O_2 analyzer (20.95%).

Step #7 Switch CM10-1D from inside to outside cal repeat steps 2 through 5 no further adjustments to the analyzer should be required and calibration points should repeat within 1 to 1.5%.

Step #8 Return span source isolator switch to OFF position, on the CM10-1D switch Run/Cal switch to Run, and Span/Zero switch to middle position.

CONTINUOUS EMISSIONS MONITORING SYSTEM

Operation, Maintenance and Parts Manual
Model CM6000-32

P/N 751-9032

For:

Equipment Supply Company
TPU#2
2076 West Park Place
Stone Mountain, Georgia 30087

By:

COLUMBIA SCIENTIFIC INDUSTRIES CORPORATION
11950 Jollyville Road
P.O. Box 203190
Austin, Texas 78720
Phone: (512) 258-5191

August 1991
Rev --

TABLE OF CONTENTS

APPENDED MANUALS

APPENDED MANUALS (cont'd.)

CSI MODEL HC500-2D	Total Hydrocarbons Analyzer
GENERAL CABLE	P-100-303-1 Heatless Dryer and CO_2 Extractor
MISCELLANEOUS	E to I Converter; AC Arrester; Shaded Pole Blower; 737-41 Aadco Methane Reactor; SOLA Constant Voltage Transformer; Vent Fan and Filter

LIST OF FIGURES

1. INTRODUCTION

The Columbia Scientific Industries (CSI) Corporation series CM6000 Continuous Emissions Monitoring (CEM) system utilizes the latest in technology to provide reliable, low maintenance, accurate emissions analysis. Each system is designed to the customer's specific requirements. The general description of a standard CM6000 system follows.

(1) Sample Probe – The material and length of each probe is determined by the application. A mounting hub with locking feature is provided for easy installation to the desired depth.

(2) Heat Traced Umbilical – Provides the pneumatic interface between the sample probe and sample conditioner. This umbilical is heated to insure no condensation occurs in the sample stream prior to conditioning.

(3) Sample Conditioner – Performs the following functions at the stack or duct: (a) creates the vacuum level necessary for sample extraction through the probe and heat traced umbilical; (b) provides secondary sample filtration to 0.5 micron; (c) provides blowback of clean air through the heat traced umbilical and probe for in-stack filter clean out; (d) maintains the sample temperature at 185 to 215 deg. F, well above dewpoint, until dried; (e) achieves permeation drying of the sample to be analyzed by a process utilizing a special ion exchange membrane, thus lowering the sample dewpoint well below ambient to allow unheated transport to the analyzers; and (f) allows for the introduction of calibration gas through the conditioning and transport interface per EPA guidelines.

(4) Umbilical – Provides the pneumatic interconnect between the sample conditioner and sample control module contained in the instrument enclosure. The umbilical contains at least four tubes providing the following: (a) eductor clean air; (b) permeation dryer, clean, dry purge air; (c) sample gas transport; (d) calibration gas delivery. The length, material and size of each tube is determined by the application.

(5) Clean Air Supply – Provides the clean, dry air necessary for continuous system operation. Air from the user's supply is delivered to the instrument enclosure. This air then passes through the Clean Air Supply package which includes the HD10 regulation and control panel. Clean, dry air is sent to the eductor and permeation dryer in the Sample Conditioner. Zero air is also supplied to the Sample Control Module to provide analyzer "zero" samples.

(6) Sample Control Module – Provides controls necessary for remote operation of the sample conditioner. This unit maintains blowback through the probe whenever the sample conditioner is not within its specified operating temperature range. Calibration, or sample distribution to the analyzers is controlled by valves contained in the control module.

(7) Analysis System - Provides analysis for the component gases of the emission source specified by the customer. Typical gases analyzed include sulfur dioxide, nitrogen oxides, ammonia, total sulfur, reduced sulfur compounds, oxygen, carbon dioxide, carbon monoxide, methane, total hydrocarbons, and non-methane, organic compounds. Various types of detectors are used, including ultraviolet, flame photometric (FPD), chemiluminescent, non-dispersive infrared (NDIR), paramagnetic resonance and flame ionization (FID). One advantage of this system concept allows use of EPA designated ambient air monitors that have been established as stable and reliable.

(8) Data Acquisition and Control - To be provided by the customer.

(9) Accessories - A complete package is provided, specific to the customer's needs. Items included are: (a) electrical: constant voltage systems, circuit breakers, interfacing cables, digital displays, etc.; (b) pneumatic: air purification and drying systems, pressure regulation, pumps, exhaust manifolds, interface lines, etc.; (c) enclosures: NEMA 12, NEMA 4, rack-mount enclosures, shelters and temperature controlled environments.

The major components used in the CM6000 system are given in the next section. System description, operation, maintenance, warranty and spare parts are given in following sections. Specific information about the analyzer(s), controller, conditioner and major accessories is given in their respective manuals included herein.

2. SPECIFICATIONS AND DESCRIPTION

This section contains specifications and detailed descriptions of the CM6000–32 Continuous Emissions Monitoring (CEM) system supplied to Equipment Supply Company, Stone Mountain, Georgia.

2.1 Specifications

(1) Site Requirements:

Electrical Requirements:	115 ± 10 Vac, 30 amps (suggested breaker size) 60 Hz, single phase.
Air Supply Requirements:	90 ± 10 psig, 3 SCFM Maximum; Free from particulates, oil and water (dewpoint –40°F).
Environmental Requirements:	Temperature 20–30°C (68–86°F) Minimal dust; Relative humidity 5 to 95%.
Special Requirements:	(a) Exhaust line of 1.25 in. diameter and 24 ft (max) length, to exhaust all gases from enclosure site, is furnished. (b) Clearance of 1 ft. on each side of enclosure to provide sufficient air flow for ventilation intake and exhaust. (c) Heatless dryer is inside enclosure.

(2) System Specifications (enclosure only):

(a)	RITTAL Model EL:	(PS4608–2700)
	Style:	Upright cabinet with rear door and plexiglass front door.
	Size:	Height – 84.75" (215 cm.) Depth – 31.89" (81 cm.) Width – 23.88" (61 cm.)
	Type:	NEMA 12
	Weight:	375 lbs. (170Kg) (enclosure without analyzer) 525 lbs. (238Kg)(with analyzers and controller).

System Response Time:	Approximately 2 to 4 minutes maximum (depends on umbilical lengths).
Electrical Power:	Maximum 1000 VA (see site requirements).
Air Requirement:	3 SCFM regulated to 60 psig, oil and dirt free; dewpoint -40°C (-40°F).
System Protection:	30 amp circuit breaker to miscellaneous outlet power strip and 20 amp circuit breaker to instrument power strips via the 1000VA supply. (Note: Both sides of each service line are breakered). Additional circuit protection is provided by an AC arrester installed at the breaker box. This device limits surge voltages caused by lightning or other unwanted transients.

(b) Sample Conditioner:

Manufacturer:	CSI
Model:	SC-10D
Options/Features:	Single probe. Local or remote operation.
Specifications:	See unit manual, appended.

(c) Sample Control Module:

Manufacturer:	CSI
Model:	CM10-1D
Options/Features:	Single probe. All excess sample gas collected for safe exhaust.
Specifications:	See unit manual, appended.

(d) Total Hydrocarbon Analyzer:

Manufacturer:	CSI

Model: HC500-2D

Options/Features: Utilizes flame ionization (FID).

Specifications: See unit manual, appended.

(e) Oxygen Gas Analyzer:

Manufacturer: Servomex

Model: 1420B

Options/Features: Output range 0–25%. Utilizes paramagnetic susceptibility technique. Has internal 4–20mA output signal.

Specifications: See unit manual, appended.

(f) Carbon Monoxide Gas Analyzer:

Manufacturer: Milton Roy (formerly ACS).

Model: 3300 (CO)

Options/Features: Utilizes nondispersive infrared (NDIR) technique. Ranges 500 amd 1000 ppm.

Specifications: See unit manual, appended.

(g) Carbon Dioxide Gas Analyzer:

Manufacturer: Milton Roy (formerly ACS).

Model: 3300 (CO_2)

Options/Features: Utilizes nondispersive infrared (NDIR) technique. Ranges 10 and 20%.

Specifications: See unit manual, appended.

(h) Heatless Dryer and CO_2 Extractor:

Manufacturer:	General Cable
Model:	P-100-303-1
Specifications:	See unit manual, appended.

(i) Methane Reactor:

Manufacturer:	Aadco
Model:	737-41
Options/Features:	CO to CO_2 conversion.
Specifications:	See data sheets, appended.

(3) Miscellaneous:

(a) Enclosure Fan:

Manufacturer:	RITTAL
Model:	SK3168
Options/Features:	260 CFM, particulate filter at inlet, low noise.
Specifications:	0.2 Amps, 18 W
Dimensions (filter):	Length 12.72" (32.3 cm) Width 12.72" (32.3 cm)
Replacement Filter Mat:	SK3173 (inlet and outlet filters).
Replacement Gasket:	SK3193

(b) Outlet Filter (Enclosure)

Manufacturer:	RITTAL
Model:	SK3163
Dimensions:	Length 12.72" (32.3 cm) Width 12.72" (32.3 cm)

(c) Instrument Power strip (six outlet) with on/off switch and 15 amp circuit breaker.

(d) Power Strip (six outlet) - miscellaneous supply.

(e) Exhaust port (1.25 in. OD x 24 ft. long) to vent all system gases.

(f) Lock on each door of enclosure.

(g) System Probe Assembly:

Manufacturer:	CSI
Model:	D-TP (High Temperature).
Specifications:	Length 36"
Material:	RA446

(h) Umbilical:

Manufacturer:	Technical Heaters
Length:	To be determined.
Diameter:	1.125 in.
Options/Features:	See Figure 3.7, 970-3106.

2.2 CM6000-32 System Description

The CM6000-32 CEM System will provide total hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO_2) and oxygen (O_2) emission concentration levels. This system consists of one high temperature D-TP Sample Probe, one SC-10D Sample Conditioner, CM10-1D Sample Control Module, Model HC500-2D HC Analyzer, Model 3300 CO Analyzer, Model 3300 CO_2 Analyzer and Model 1420B O_2 Analyzer.

Control and analysis hardware is assembled in a NEMA 12, 19 inch rack mount enclosure, while the probe and conditioner are installed at the sample extraction site. The system may be operated manually at the enclosure front panels or remotely via the customer supplied equipment. Zero to full scale readings of the selected analyzer output range are available as isolated 4–20mA DC signals at the auxiliary panel.

The following is a brief description of the above mentioned equipment. Please note that detailed descriptions and operation instructions, for some components discussed, are contained in separate manuals included within this handbook.

(1) D–TP High Temperature Sample Probe and Heat Traced Umbilical.

One RA446 alloy D–TP Sample Probe is provided. A 2.5 inch NPT mounting hub, with locking screw, assures accurate and repeatable probe installation. A ⅜" diameter heat traced, single line umbilical connects the probe outlet to sample conditioner inlet. This prevents condensation of the sample gas flow prior to conditioning.

(2) SC–10D Sample Conditioner.

Sample gas extraction is achieved by a vacuum created in the SC–10D Sample Conditioner. Air flows through a venturi air eductor creating sufficient vacuum (approximately 15in Hg) to allow sample gas flow into the heated conditioner enclosure. Temperature within this enclosure is maintained between 185 and 215°F. This assures no condensation prior to drying. The sample to be analyzed is drawn through a 0.5 micron bypass filter, while unused sample is blended with the eductor air and exhausted from the enclosure. A pump, located in the CM10–1D Sample Control Module, draws the sample to be analyzed through the filter, into a permeation dryer for conditioning prior to transport. In the permeation dryer, clean, dry air counter–flows over the outside of hygroscopic ion exchange membranes. Water vapor is removed from the sample gas flowing inside the membrane. Sample gas exiting the dryer is, therefore, conditioned and is suitable for transport to the instrument enclosure for analysis.

(3) Umbilical.

The umbilical provides a pneumatic interconnect between the sample conditioner and control module.

(4) Instrument Enclosure.

Contained in the Instrument Enclosure are the following major components. Where possible each unit is slide mounted allowing easy access for maintenance and trouble shooting.

(a) CM10-1D Control Module

The CM10-1D Control Module provides control necessary for remote operation of the SC-10D Sample Conditioner. This unit controls the sample pump and provides associated valving for sample gas distribution. An additional feature provides for zero air dilution of the sample gas. An air operated venturi pump draws sample gas through a 100 ml/min critical orifice. Zero air is also drawn into the mixing chamber at a controlled flow rate. The resultant mixture is diluted in a precise and stable fashion by approximately 50:1. Both diluted and undiluted sample outputs are available.

The CM10-1D also controls the introduction and distribution of calibration gases to the system, either directly to the analyzer (INSIDE) or through the umbilical and SC-10 per EPA guidelines (OUTSIDE). Operation of the control module may be accomplished using front panel selector switches. Alternatively, a remote control source may be employed for automatic operation. A further detailed description of operation and maintenance procedures is given in the unit manual appended.

(b) HD10-1 Clean Air Supply

Efficient and reliable system operation is dependent on the air supply quality. The HD10-1 Clean Air Supply provides clean, dry and contaminant free air for each system requirement. Supply air enters the system through a shut off valve and is regulated to approximately 60 psig at the auxiliary panel. This air then flows through a gas reactor that effectively converts any carbon monoxide (CO) to carbon dioxide (CO_2), which in turn is then removed by passing through alternating columns of the heatless dryer. Final drying in a silica gel filled canister, and filtration in an activated charcoal filled canister, provides air suitable for analyzer zero or span checks. A pressure regulator set to 40 psig and flow meter adjusted for approximately 20 liters per minute provide clean air for the eductor supply. Similarly, a regulator set to 40 psig and flow meter adjusted for 20 to 40 liters per minute (depending on site requirements) provides clean, dry air for permeation dryer purge.

(c) HC500-2D Total Hydrocarbon Analyzer

The CSI Model HC500-2D Total Hydrocarbon Analyzer performs continuous dry analysis for total hydrocarbon content in gas mixtures. FID, the well established technique of flame ionization, is used as the detection method. Hydrocarbons, contained in the sample gas, pass through a hydrogen rich flame and are converted to ions. An electrostatic field in the burner causes these ions to migrate and collect on an electrode. This results in an electric current which is proportional to the concentration of ions collected. An electrometer amplifier converts the current to voltage which is fed to the amplifier output jacks. Standard outputs are 0-100mV and 0-1V. A further detailed description of operation and maintenance procedures is given in the unit manual appended.

(d) Model 3300 CO_2 Analyzer

The Milton Roy (formerly ACS) Model 3300 Carbon Dioxide Analyzer performs specific, real time and continuous dry analysis for carbon dioxide in gas mixtures. The Model 3300 is a highly selective, nondispersive infrared (NDIR) gas analyzer. It utilizes a beam of infrared energy which passes first through a Sample Cell and then through both cells of a Dual Cell Detector system. The Detector cells are filled with pure carbon dioxide. An externally mounted vacuum pump is used to draw sample gas through the detection system.

Two output signals are available from the Model 3300. Output I is a standard 0-1V signal. Output II is internally selectable from 4-20mA (standard), 0-10mV, 0-100mV or 0-1V. A further detailed description of operation and maintenance procedures is given in the unit manual appended.

(e) Model 3300 CO Analyzer

The Milton Roy (formerly ACS) Model 3300 Carbon Monoxide Analyzer performs specific, real time and continuous dry analysis for carbon monoxide in gas mixtures. The Model 3300 is a highly selective, nondispersive infrared (NDIR) gas analyzer. It utilizes a beam of infrared energy which passes first through a Sample Cell and then through both cells of a Dual Cell Detector system. The Detector cells are filled with pure carbon monoxide. An externally mounted vacuum pump is used to draw sample gas through the detection system.

Two output signals are available from the Model 3300. Output I is a standard 0-1V signal. Output II is internally selectable from 4-20mA (standard), 0-10mV, 0-100mV or 0-1V. A further detailed description of operation and maintenance procedures is given in the unit manual appended.

(f) Model 1420B Oxygen Analyzer

To monitor the oxygen (O_2) content of the sample gas, CSI has selected a Servomex Model 1420B Oxygen analyzer. The model 1420B uses the paramagnetic response of oxygen for detection. A magnetodynamic sample cell measures the paramagnetic susceptibility of the sample gas. The oxygen concentration is detected by means of a "dumb-bell" mounted on a torque suspension in a strong, nonlinear magnetic field. The higher the concentration of oxygen, the greater the "dumb-bell" is deflected from its rest position. This deflection is monitored by an optical system connected to an amplifier circuit. A further detailed description of operation and maintenance procedures is given in the appended manual.

(g) Auxiliary Panel

The Auxiliary Panel is located in the back of the instrument enclosure and may be accessed through the rear door. As previously described the air supply control and regulator valves are located on this panel and are labelled for easy identification and operation.

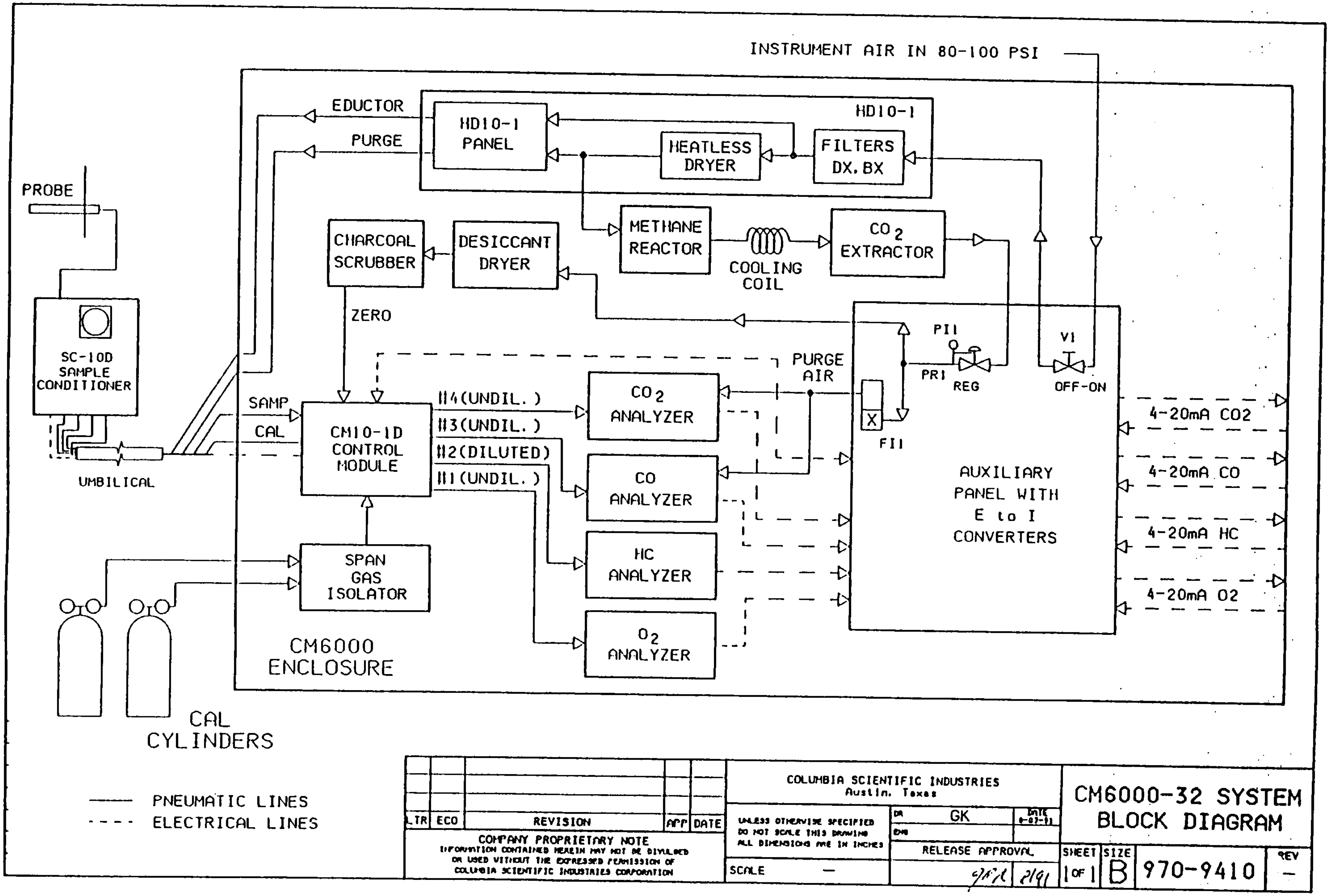
Signal distribution and output terminal strips are attached to the panel. TB1 furnishes connection points for the analyzer analog output signals. TB2 and TB3 provide connection points for the an external computer or data logger to CM10-1D interface. This provides easy access for electrical testing of the system control response.

(h) Span Source Isolator

Located between the calibration gas bottles and the sample controller (CM10-1D), the Span Source Isolator contains solenoid valves which are manually controlled by a toggle switch on the front panel.

This switching function allows the user to connect more than one calibration gas bottle to the sample controller.

3. FIGURES



INSTRUMENT AIR IN 80-100 PSI
EDUCTOR
PURGE
HD10-1 PANEL
HD10-1
HEATLESS DRYER
FILTERS DX, BX
PROBE
METHANE REACTOR
COOLING COIL
CO 2 EXTRACTOR
CHARCOAL SCRUBBER
DESICCANT DRYER
ZERO
SC-10D SAMPLE CONDITIONER
UMBILICAL
SAMP
CAL
CM10-1D CONTROL MODULE
#4(UNDIL.)
#3(UNDIL.)
#2(DILUTED)
#1(UNDIL.)
CO 2 ANALYZER
CO ANALYZER
HC ANALYZER
O 2 ANALYZER
PURGE AIR
PI1
PR1
REG
V1
OFF-ON
F11
AUXILIARY PANEL WITH E to I CONVERTERS
4-20mA CO2
4-20mA CO
4-20mA HC
4-20mA O2
SPAN GAS ISOLATOR
CM6000 ENCLOSURE
CAL CYLINDERS
PNEUMATIC LINES
ELECTRICAL LINES
LTR
ECO
REVISION
APP
DATE
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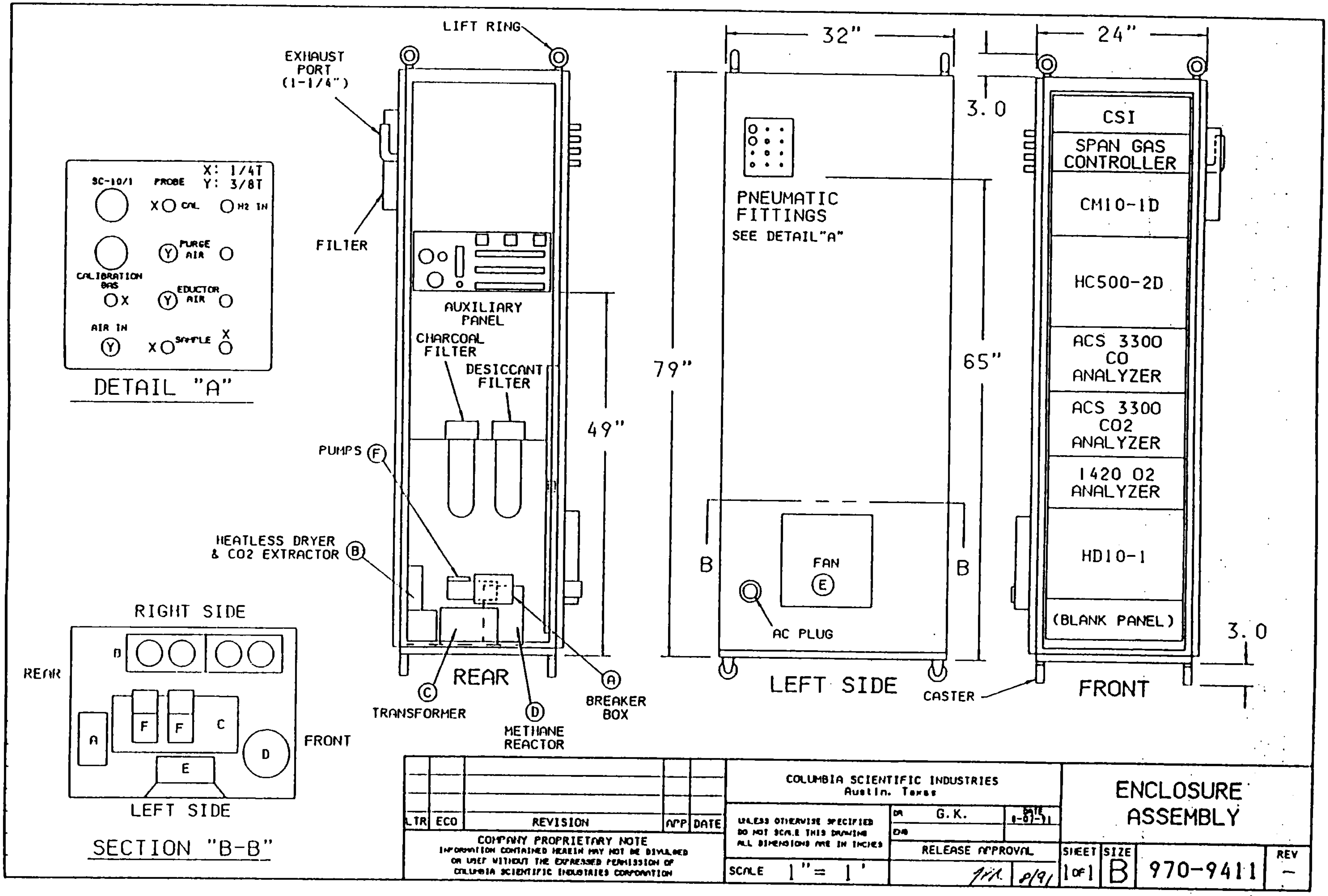
DR
GK
DATE
ENG
RELEASE APPROVAL
SCALE
CM6000-32 SYSTEM BLOCK DIAGRAM
SHEET 1 OF 1
SIZE B
970-9410
REV

FIGURE 3.1



LIFT RING
EXHAUST PORT (1-1/4")
FILTER
AUXILIARY PANEL
CHARCOAL FILTER
DESICCANT FILTER
PUMPS (F)
HEATLESS DRYER & CO2 EXTRACTOR (B)
(C) TRANSFORMER
REAR
(D) METHANE REACTOR
(A) BREAKER BOX
49"
32"
79"
65"
PNEUMATIC FITTINGS
SEE DETAIL "A"
FAN (E)
AC PLUG
B
B
LEFT SIDE
CASTER
24"
3.0
3.0
CSI
SPAN GAS CONTROLLER
CM10-1D
HC500-2D
ACS 3300 CO ANALYZER
ACS 3300 CO2 ANALYZER
1420 O2 ANALYZER
HD10-1
(BLANK PANEL)
FRONT
SC-10/1
PROBE
X: 1/4T
Y: 3/8T
CAL
H2 IN
PURGE AIR
CALIBRATION GAS
EDUCTOR AIR
AIR IN
SAMPLE
DETAIL "A"
RIGHT SIDE
REAR
FRONT
LEFT SIDE
SECTION "B-B"
LTR
ECO
REVISION
APP
DATE
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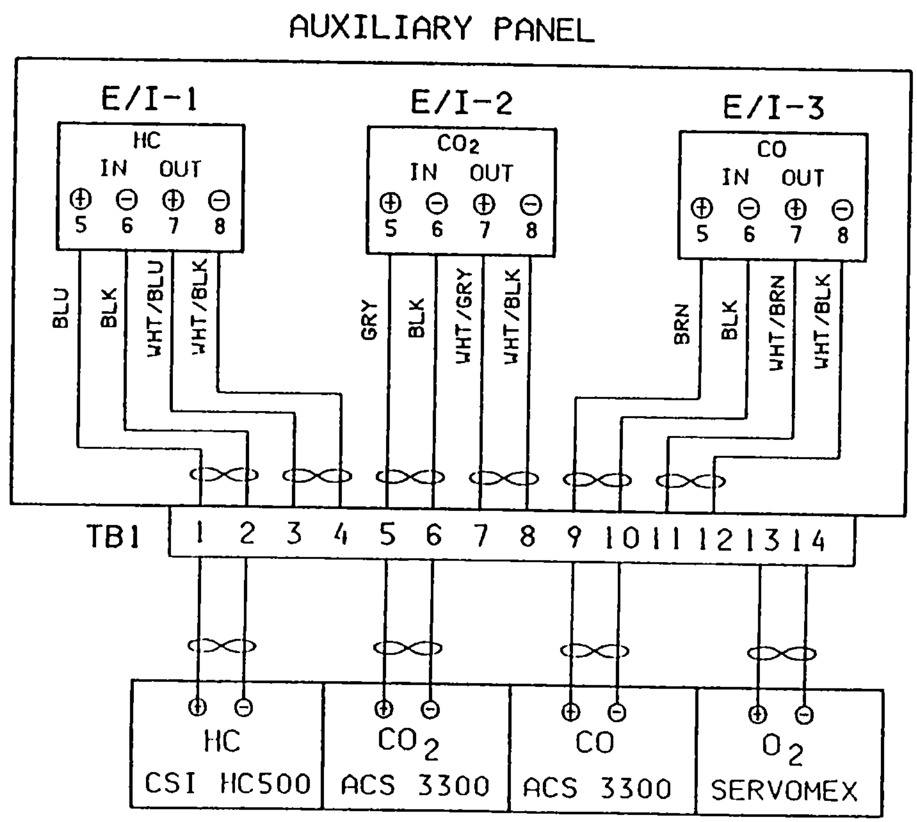
DR G.K.
CHK
RELEASE APPROVAL
SCALE 1" = 1'
ENCLOSURE ASSEMBLY
SHEET 1 OF 1
SIZE B
970-9411
REV -

FIGURE 3.2

3-3

FIGURE 3.3



LTR	ECO	REVISION	APP	DATE

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DR GK

ENG

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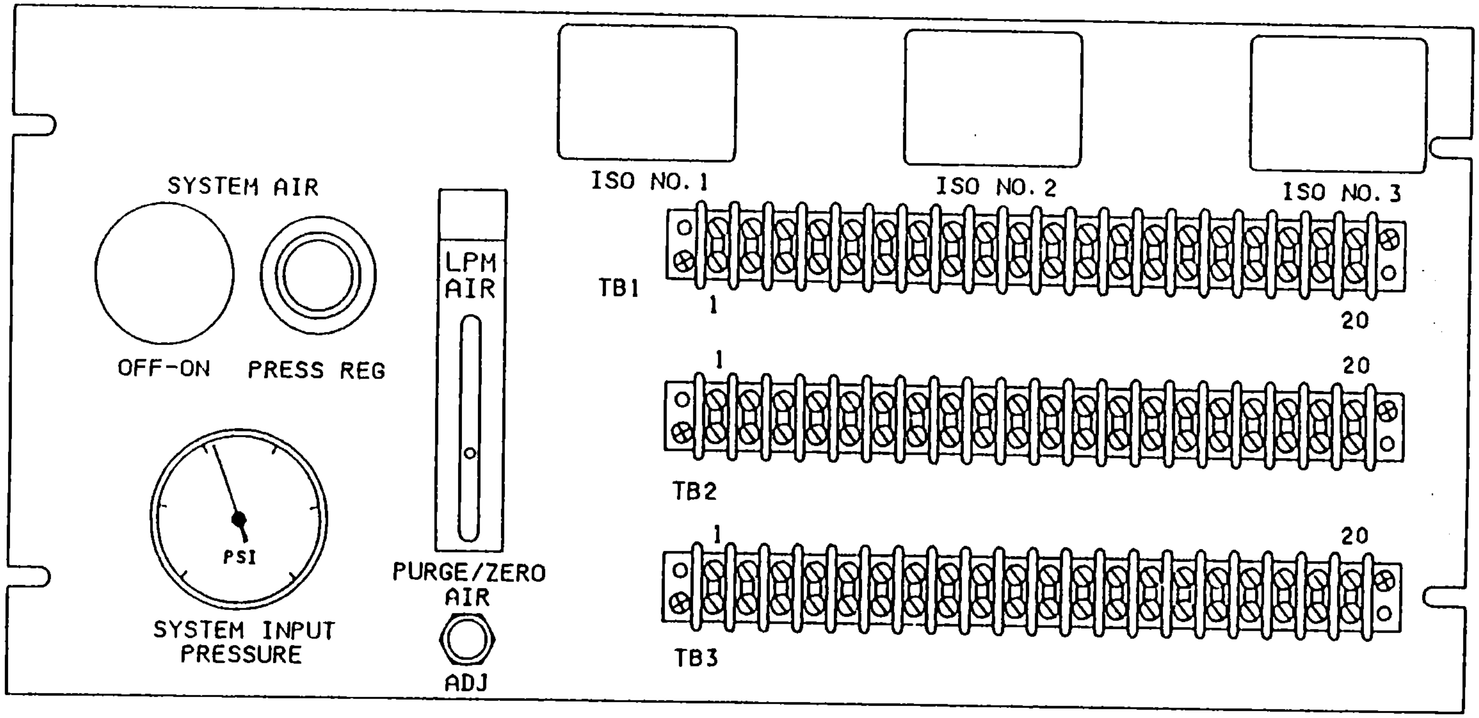
SCALE —

ANALOG WIRING
ANALYZERS TO
E/I CONVERTERS

SHEET	SIZE		REV
1 OF 1	B	970-9412	—

FIGURE 3.4



LTR	ECO	REVISION	APP	DATE

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SCALE 4/10

DR GK DATE 8-08-91
ENG

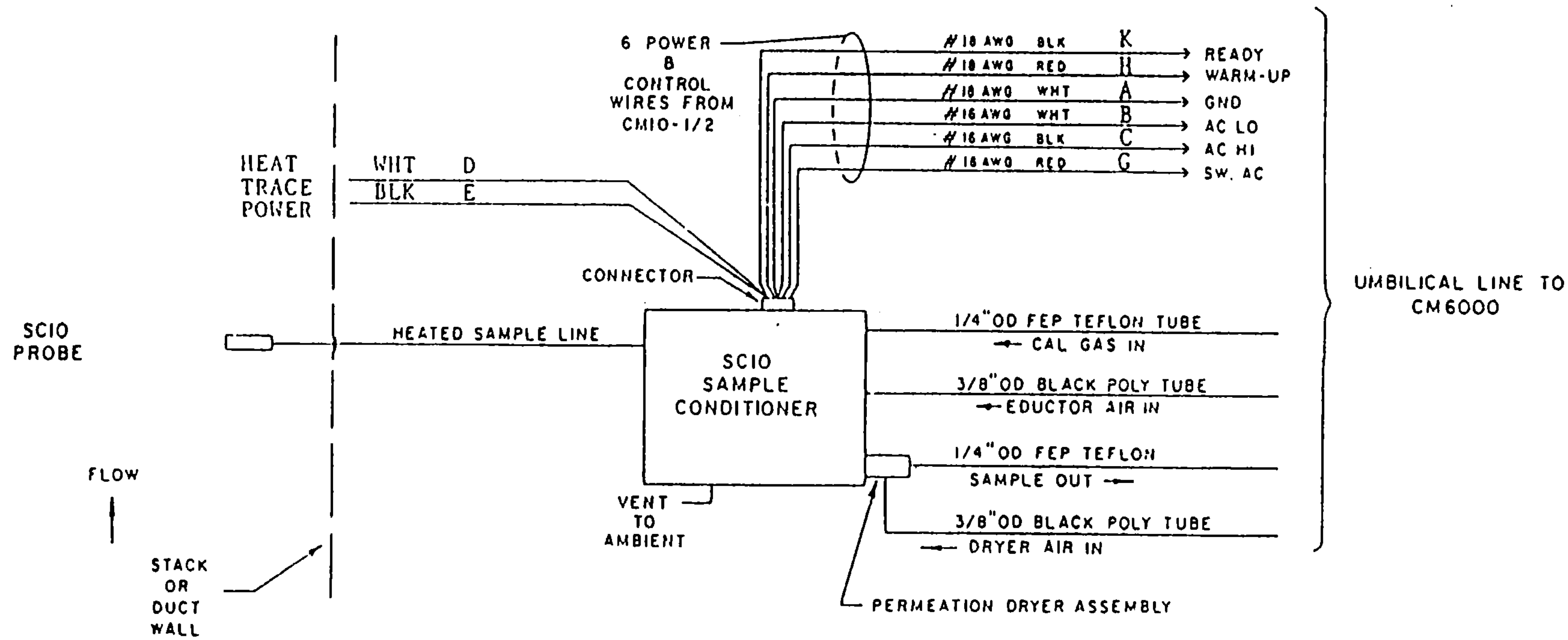
RELEASE APPROVAL 9K/R 8/91

AUXILIARY PANEL

SHEET 1 OF 1 | SIZE A | 970-9414 | REV –

FIGURE 3.5

3-6



CM6000 SAMPLE POINT INSTALLATION WITHOUT FILTER AND
AND FLYASH DIVERTER

LTR	ECO	REVISION	APP	DATE

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MATL —

FINISH —

SCALE —

UNLESS OTHERWISE SPECIFIED
DO NOT SCALE THIS DRAWING
ALL DIMENSIONS ARE IN INCHES
REMOVE ALL BURRS & SHARP EDGES
TOLERANCES: ANGLES ± 1°
3 PLACE DECIMALS ± .005
2 PLACE DECIMALS ± .015

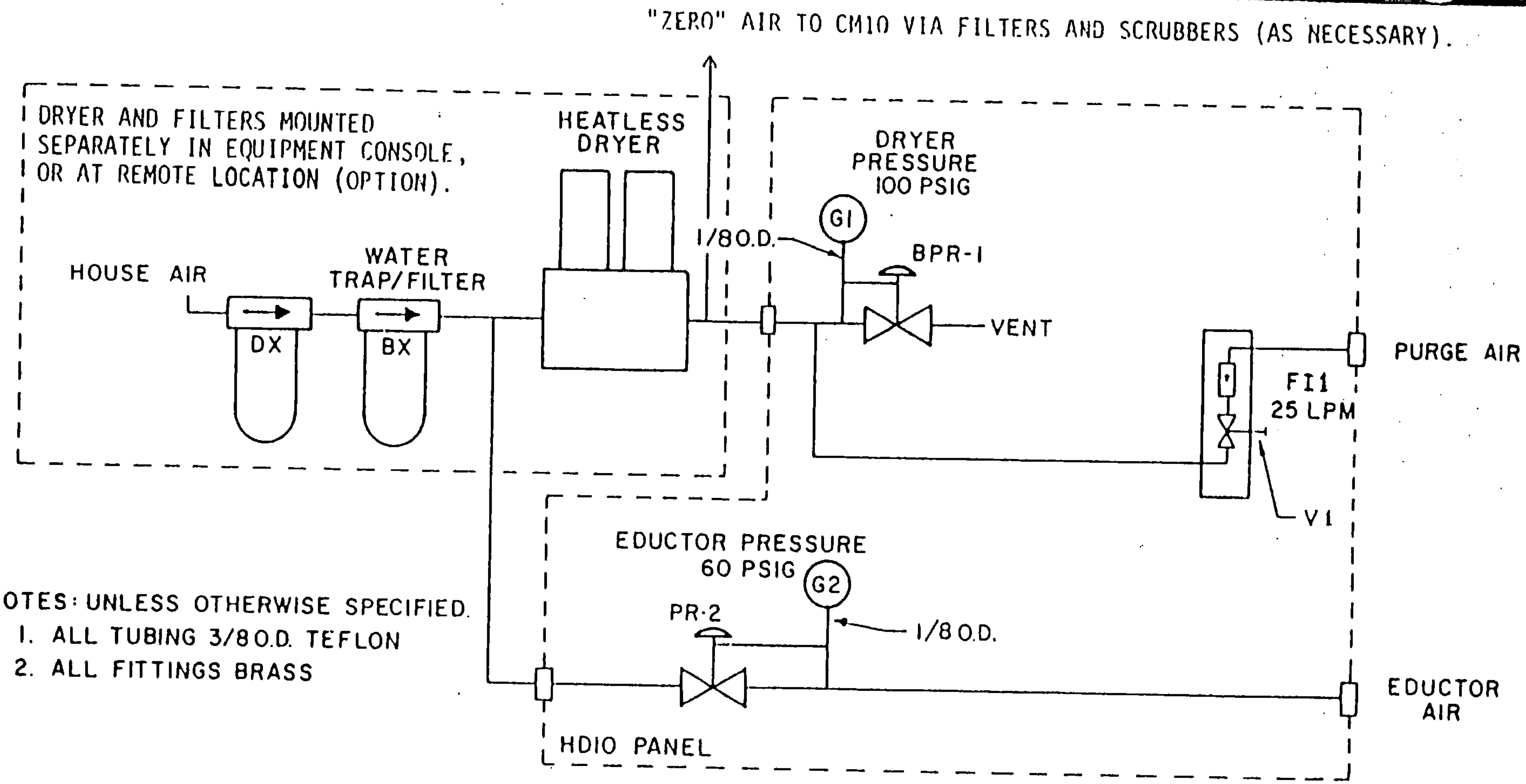
DR	G.KANIES	DATE 8-91
ENG		

RELEASE APPROVAL — 5/91

COLUMBIA SCIENTIFIC INDUSTRIES
Austin, Texas

SAMPLE POINT INSTALLATION
WITHOUT FILTER AND
FLYASH DIVERTER

SHEET	SIZE		REV
1OF 1	A	970-9415	—



NOTES: UNLESS OTHERWISE SPECIFIED.
1. ALL TUBING 3/8 O.D. TEFLON
2. ALL FITTINGS BRASS

LTR	ECO	REVISION	APP	DATE
A	4824	SEE ECO	[illegible]	7/90
—	4394	RELEASED	[illegible]	2/89

MATL ——
FINISH ——
SCALE ——

UNLESS OTHERWISE SPECIFIED
DO NOT SCALE THIS DWG
ALL DIMENSIONS ARE IN INCHES
REMOVE ALL BURRS & SHARP EDGES
TOLERANCES
3 PLACE DECIMALS ± .005
2 PLACE DECIMALS ± .015
ANGLES ± 1°

DR G.C.K. DATE 3-12-86
ENG
RELEASE APPROVAL [signature] 7/90

CSI COLUMBIA SCIENTIFIC INDUSTRIES AUSTIN, TEXAS

GAS FLOW DIAGRAM
HDIO-1, SINGLE PROBE

SHEET 1 OF 1 | SIZE A | 970-2051 | REV A

FIGURE 3.8

FIGURE 3.7

3-8

Title: Standard Tube Bundle, CM6000.

CSI Part Number: 970-3106

Mfr.: 00510 Eaton Control Systems
P.O. Box F, Aurora, OH 44202

or

Mfr.: 00521 Technical Heaters, Inc.
San Fernando, CA

Specification: Dekoron Type 1200 or equal.
OUTER JACKET PVC black (.062" wall) or polyurethane, black (0.055" avg. wall).
Nominal OD 1 1/8 inch.
INNER JACKET Mylar Sheath, clear, 3 mil. thick or Cotton Wrap.
Minimum Bending Radius 17.9 inches.
Maximum Pulling Tension : 140 lbs.

Contents: 2 each ¼" OD x .040" wall TFE or PFA tubes
2 each 3/8" OD x .062" wall PE, TFE, or PFA tubes
Each tube color-coded at each end.

3 each 18 AWG electrical conductors stranded, jacketted
3 each 16 AWG electrical conductors stranded, jacketted
Each electrical conductor to be color-coded.

LTR	ECO	REVISION	APP	DATE
B	4975	Chg Max Pull Tens.	[illegible]	1/90
A	4969	Del. "or less" (MBR)	[illegible]	8/90
---	4777		[illegible]	2/8[illegible]

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MATL

FINISH

SCALE

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DO NOT SCALE THIS DRAWING
ALL DIMENSIONS ARE IN INCHES
REMOVE ALL BURRS & SHARP EDGES
TOLERANCES: ANGLES ± 1°
3 PLACE DECIMALS ± .005
2 PLACE DECIMALS ± .015

	DATE
DR	
ENG	

RELEASE APPROVAL [illegible] 1/1/90

COLUMBIA SCIENTIFIC INDUSTRIES
Austin, Texas

STANDARD TUBE BUNDLE, CM6000

SHEET	SIZE		REV
1 OF 1	A	970-3106	B

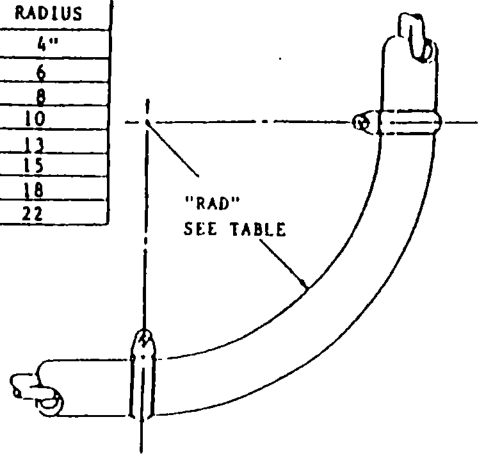
FIGURE 3.8
3- 9

CAUTION: THE BELOW SUGGESTIONS MUST BE FOLLOWED IN INSTALLING HIGH TEMP TUBE BUNDLE OR LINE FAILURE WILL RESULT.

LTR	DESCRIPTION	DATE	APPROVED

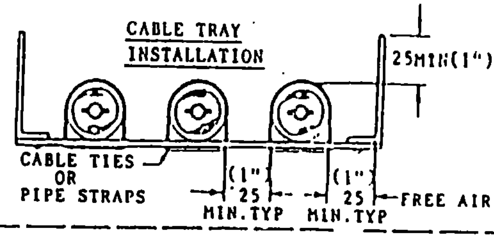
BEND RADIUS REFERENCE CHART

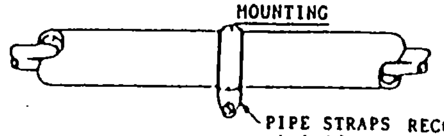
HOSE SIZE	RADIUS
4	4"
5	6
6	8
8	10
10	13
12	15
16	18
20	22

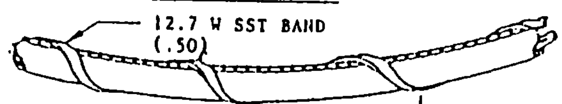


HORIZONTAL MOUNTING

DO NOT USE "U"BOLTS OR OTHER COMPRESSION TYPE CLAMPS.



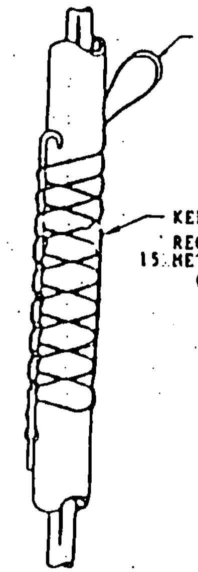




VERTICAL MOUNTING

SEE NOTE 2

KELLEM STANDARD SUPPORT GRIP MOUNTING (SPLIT W/ROD CLOSING & DOUBLE EYE)



INSTALLATION OF KELLEM GRIPS

WRAP KELLEM GRIP AROUND THE TUBE BUNDLE AND THREAD THE ROD THROUGH THE PREFORMED LOOPS WITH A CORKSCREW MOTION USING THE CURVED END OF THE ROD TO ENGAGE THE LOOPS. THE ACTION REQ'D IS A STEADY SIMULTANEOUS PUSH & TWIST MOTION. THE FINGERS OF THE LEFT HAND ARE USED TO BRING THE LOOPS TOGETHER JUST AHEAD OF THE HOOK ON THE OTHER END OF THE ROD.
TO REMOVE, SIMPLY PULL THE ROD OUT BY HOOKED END.

OVERALL HOSE O.D.	PIPE STRAP WITH BACK	KELLEM STANDARD SUPPORT GRIP
1-1¼ (25-32mm)	3/4"	022-03-041 $30
1¼-1½ (32-38mm)	1"	022-03-042 $32
1½-1¾ (38-45mm)	1¼"	022-03-043 $36
1¾-2" (45-51mm)	1½"	022-03-044 $48
2-2½" (51-64mm)	2"	022-03-045 $58
2½-3" (64-76mm)	2½"	022-03-046 $72

CAUTION THE ABOVE SUGGESTIONS MUST BE FOLLOWED INSTALLING HIGH TEMP TUBE BUNDLE OR LINE DAMAGE WILL RESULT.

3. SUGGESTED HARDWARE SUPPLIER: LOCAL ELECTRICAL SUPPLY HOUSE.

2. WHEN MOUNTING SAMPLE LINE INTO VERTICAL POSITION, MAINTAIN WEIGHT OF LINE ON SUSPENSION APPARATUS. LINE IS NOT DESIGNED TO SUPPORT ITS OWN WEIGHT, WHEN HOT, FOR MORE THAN 15 METERS (50') WHEN MTD VERTICALLY. DO NOT PULL OR STRETCH BUNDLE MORE THAN FREE HANGING WEIGHT OR KINK SAMPLE LINE DURING INSTALLATION.

1. DO NOT ENERGIZE SAMPLE LINE WHILE IN COIL.

NOTES:

QTY REQD	PART NO.	MATERIAL	NOMENCLATURE OR DESCRIPTION	ITEM NO.

LIST OF MATERIALS

DIMENSIONS ARE IN INCHES
TOLERANCES ON
.X ±
.XX ±
.XXX ±

DO NOT SCALE DRAWING

SIGNATURES		DATE
DR	D.D.	[illegible]
CHK		
ENGR	[illegible]	8-3-03
ENGR	[illegible]	[illegible]
MFG APPD	D.C.	[illegible]
CUST APPD		

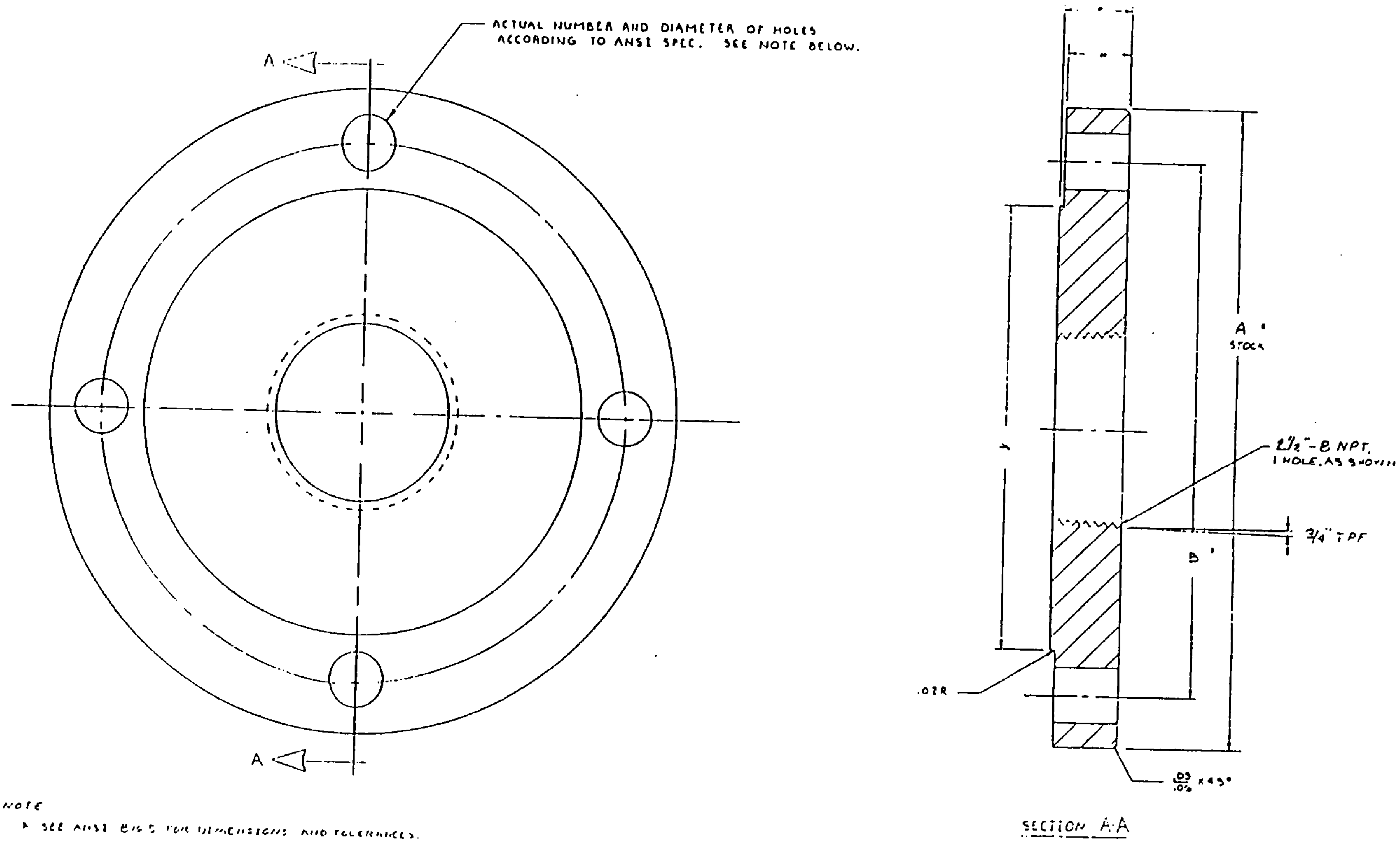
NEXT ASST | USED ON
APPLICATION

TECHNICAL HEATERS, INC.
SAN FERNANDO, CALIFORNIA

INSTALLATION RECOMMENDATION FOR HEAT LINE HOSES

SIZE	CODE IDENT NO	CSI DWG #	REV
C	32446	970-9248	1

SCALE | DWG NO. F-1002 | SHEET



NOTE

* SEE ANSI B16.5 FOR DIMENSIONS AND TOLERANCES.

PART DASH №	PIPE SIZE	DIM. "A" FLANGE O.D.	DIM. "B" DIA. BOLT CIRCLE
-1	4"	9.00	7.50
-2	3½"	8.50	7.00
-3	3"	7.50	6.00
-4	2½"	7.00	5.50
-5	8"	13.50	11.75
-6	6"	10.90	9.50

LTR	ECO	REVISION
C	5021	ADD TABLE, DELETE 1/4 NPT HOLES
B	4661	DEL 2.25 ø B.C. + 1.06 DIA.
A	4624	TAP 1/4-18 NPT FROM FAR SIDE

BLIND FLANGE 150 lb ANSI RAISED FACE 316 SS SEE TABLE

SCALE: NTS

CSI COLUMBIA SCIENTIFIC INDUSTRIES AUSTIN TEXAS

CM6000 PROBE FLANGE

SHEET 1 OF 1 | SIZE C | 970-3094 | REV C

FIGURE 3.9

4. OPERATION

4.1 Unpacking and Inspection

(1) Consult each appended manual for specific unpacking and inspection instructions.

(2) Remove all cushion type and bracing packing material and inspect for damage. All pneumatic tube openings are sealed with dust plugs, closed fittings or plastic bags taped in place.

DO NOT REMOVE THESE PLUGS OR PLASTIC BAGS
UNTIL THE INDIVIDUAL TUBES ARE READY FOR CONNECTION.

(3) Unpack all the boxes and inspect the external surfaces of all pieces and the internal components of the enclosure and instruments for physical damage. If any damage is found, notify both the carrier and CSI at once.

(4) Check the inside of the enclosure and instruments for loose pneumatic or electrical connections.

(5) Verify all options ordered have been supplied and all parts for system assembly are present.

4.2 Set-Up Procedure

CAUTION: THE ELECTRICAL POWER AND AIR SUPPLY TO THE SYSTEM MUST BE TURNED OFF TO AVOID INJURIES TO PERSONNEL OR DAMAGE TO THE SYSTEM. ALSO ALL WORK MUST BE PERFORMED BY QUALIFIED SERVICE PERSONNEL.

Generally, the system is supplied with rack mounted units. Before delivery, the entire system is fully assembled and tested at the factory. After completion of the tests, the instruments are removed from the racks leaving all interconnecting tubing attached to bulkhead fittings, where feasible, for easy re-assembly at the final location. Each tube when completely disconnected is labeled on both sides of the connector for convenient re-assembly in the field.

Some instruments and the control unit are supplied with slide mounts for easy access to the inside of the units. Such items as fans, blowers, vent lines, rack temperature control circuits, special transformer, the final dilution air drying system and pressure controller are left mounted and interconnected in the enclosure when possible.

(1) Enclosure Assembly

NOTE: THE EMPTY ENCLOSURE SHOULD BE PLACED AT ITS FINAL LOCATION AND ANY MODIFICATIONS MADE BEFORE FINAL ASSEMBLY OF THE SYSTEM.

Using the system drawing given in Section 3 of this manual, and any specific assembly instructions supplied with the system, install the major components and instruments in the enclosure.

WARNING: TAKE CARE THAT DURING THE INSTALLATION PROCEDURE NO DUST OR DEBRIS ENTERS THE LINES OF THE UMBILICAL. ANY MALFUNCTION OF THE PROBE OR OTHER PNEUMATIC DEVICE CAUSED BY PARTICULATE MATTER IS EXCLUDED FROM THE WARRANTY.

(2) Pneumatic Connections

Install pneumatic lines per the system pneumatic drawings shown in Section 3. It is preferred that all lines be made of a fluorocarbon plastic, either PFA or PTFE, unless otherwise specified on the drawing. Degreased, cleaned and passivated stainless steel may be used, if desired, for air supply and exhaust lines. However, use of stainless steel lines for span gas cylinders is not recommended but may be satisfactory in certain applications. All pneumatic connections should be made with instrument quality swage-type fittings. These fittings should preferably be made of stainless steel although brass can be used in the air supply lines. Plastic polyethylene can be used in the air supply and exhaust lines.

All lines and fittings supplied by customer should be precleaned in a high grade degreasing solvent. The solvent must be fresh or residues from the solvent could cause problems in the analysis.

NOTE: DO NOT TURN ON THE AIR OR CYLINDER GAS SOURCES AT THIS TIME.

The umbilical sheath is a thick, black polyurethane covering which is abrasion resistant. Installation in horizontal runs, trays or other types of continuous support is recommended. For vertical drops, braided support line hangers are recommended approximately every 50 feet with conduit clamps or electrical cable ties every few feet attached to a solid structure, such as conduit, to restrict movement by winds or vibration. The smallest running radius is 17.9 inches. Maximum pulling tension is 140 lbs.

When connecting the umbilical, all four tubes are color coded like the probe lines and system external pneumatic fittings to simplify assembly.

It is recommended that the customer connect a tube to the round system exhaust vent in order to exhaust all sample or calibration gas out of the working location and so prevent build-up of unwanted gases. (Note: A 1.25 in. diameter flexible tube, 24 ft. long, is provided).

(3) Electrical Connections

Using caution, connect all electrical lines per system electrical diagrams given in Section 3. All cable or wire supplied by the customer should be UL approved for the voltage and current requirements given.

4.3 Start-up Procedure

(1) Read start-up procedures in each of the instrument manuals and any special instructions provided with this system given in this section and Section 2. The customer needs to be familiar with each procedure to assure proper start-up and prevent damage to a unit.

(2) Ensure all power switches for the system and instruments are in the OFF position. Ensure also that all system air is turned off.

(3) Turn on the main power to the system and one by one turn on the power strips for each instrument. Check for any problems each time.

(4) Turn on the system air supply and slowly bring up the pressure. Inspect for any leaks. Turning off noisy equipment (e.g. pumps) may assist in detection of audible leaks.

(5) Follow the start-up and operating procedures for the probe Sample Conditioner, then each of the analyzers.

4.4 Operations Procedure

(1) Set the analyzers to the recommended ranges required for this installation.

(2) After all units have warmed up and stabilized, perform a zero then short span check of the analyzers using the calibration gases provided. If not already tested, the pneumatic system from the span cylinder(s) to the controller should be leak checked to prevent loss of toxic and expensive calibration gases.

(3) If system response time is slow, leave the system in span mode for several hours to condition the pneumatic circuit.

(4) After running overnight, the system can be initially calibrated. Set the analyzers to zero and span to obtain the exact analyzer output levels desired.

(5) Re-check the analyzer settings and adjust if necessary.

(6) After two days of stable operation, again check analyzer settings and adjust if necessary. The system can be recalibrated and the analyzers zero and span control settings recorded. Also, check and record eductor and purge flows and pressure setting.

(7) The system is now ready for operation. No adjustment to the controller or analyzers should be made unless the system is to be recalibrated.

5. MAINTENANCE

Consult the controller, conditioner and analyzer manuals for their specific maintenance requirements. This section will be directed to specific system related maintenance. Some general guidelines for other system components are also included to assist in providing the best maintenance for this system.

5.1 System Air Supply

System air is supplied by the customer and is further dried and purified by the Air Purifier and Heatless Dryer. A "Clean Air Package" inside the Instrument Enclosure ensures further protection in the form of an Indicating Silica Gel cannister and an Activated Charcoal cannister.

If the air to the system is kept clean, oil-free and dry, there is no scheduled maintenance of the air lines. However, periodically the lines should be checked for leaks, pressure line swelling, abrasion marks, kinking and loose connections. If a line needs replacing, prepare a new line using the same material for tubing and fittings. Cut the tubing to the length of the old tube. If abrasion is the problem, tie the line down or wrap with protective spiral material.

If water presence is noticed or evidence of the system getting wet, as indicated by the Silica Gel, determine the problem and repair immediately.

NOTE: SYSTEM PLUGGING DUE TO INADEQUATE AIR CLEANING, DRYING OR CAUSTIC CARRY-OVER IS NOT COVERED BY WARRANTY.

5.2 Enclosure Filters

The enclosure filters, both fan and outlet, should be cleaned periodically. It is recommended the filters be cleaned every six (6) months although the frequency is really site specific and should be determined by each customer.

To remove filters, simply pop out the snap-in filter grills and remove the filters. Clean the filters in detergent solution and air dry. Re-install filter and grille.

5.3 Flow Check

The system pressure and flows should be checked periodically. Generally, unless there is a system upset or flow problem, once every six (6) months is sufficient.

5.4 Probe Filter

The porous metal filter at the probe tip should be checked occasionally. For dirty, wet stacks this filter may require changing. The requirement is site-specific and must be determined at each location.

5.5 Umbilical

No scheduled maintenance is required on the umbilical cable. Prudence would suggest that the cable be examined from time to time to look for physical abrasion or for unusual or crimped positions which might tend to crease the cable. The heavy outer jacket tends to eliminate deterioration from normal atmospheric exposure. Feel along the length of the heat traced umbilical for uniform heat distribution.

5.6 Sample Conditioner

Cleaning or replacing of the tubing every 12 months is recommended. However, if the air supply and sample filters are maintained properly then these lines may never need cleaning. However, they should be checked periodically for damage (see discussion under system air supply). Sample switching solenoid valves should be replaced every 24 months.

5.7 Sample Control Module

Cleaning or replacing of sample and calibration tubing every 12 months is recommended. Periodic checks of the sample pump are recommended. Observe pump operation and verify that all connections remain leak tight. Sample and calibration gas switching solenoid valves should be replaced every 24 months. The fan filter should be cleaned or replaced periodically. It is recommended the filter be cleaned every six (6) months, although the frequency is really site specific and should be determined by system operators.

5.8 Analyzers

It is recommended to use the maintenance schedules given in each analyzer manual. However, if up time is critical, then each manual should be reviewed to determine items with high possibility of failure. Consult CSI for specific recommendations for each analyzer based on the desired up time.

5.9 Cabinet Fan and Exhaust Blower

Periodic lubrication of these components may be necessary. Refer to component manuals for specific lube schedules and lube points.

6. WARRANTY

1. Except as otherwise indicated, all instruments and stack systems manufactured and sold by Columbia Scientific Industries Corporation (CSI) are guaranteed for a period of one year from date of shipment from the factory against defects in materials and workmanship of those parts manufactured by CSI, and then, only when operated, serviced and maintained in accordance with the instruction manual. Those parts not manufactured by CSI are guaranteed only to the extent that they are covered by a warranty of original manufacturer. Permeation tubes are warranted for six (6) months. Spare parts and accessories, except expendables, are warranted for ninety (90) days. Expendables such as batteries, sample holders, fuses and indicating lamps are not covered by this warranty.

2. The warranty is voided by the following:

   a) Injection into CSI stack systems or CSI ambient air monitoring or calibrating equipment, of gas mixtures containing reactive suspended matter or molecules yielding and depositing liquids, tars, solids and other non-gaseous residues.

   b) Injection of caustic solutions into the hydrogen lines of CSI hydrocarbon monitors by a malfunctioning hydrogen generator.

   c) Damage to CSI Accelerating Rate Calorimeters or Quantitative Reaction Calorimeters caused by samples that detonate, deflagrate or otherwise escape the confines of the sample holder.

   d) Damage to stack sampling probes caused by severe corrosion.

   e) Damage caused by incorrect installation, by misuse, or by mishandling.

3. Warranty service requests must be received by CSI within the warranty period. Upon notification by the purchaser, CSI will correct defects coming within the scope of this warranty by repairing or replacing the defective unit either at the CSI factory or at the customer's site, at CSI's option. Return shipment of items to CSI must be authorized by a CSI representative and is at customer's expense.

4. Instruments and systems which have been repaired or replaced during their warranty period are themselves guaranteed for only the remaining unexpired portion of their original warranty period. Parts and accessories, including stack probes, umbilicals and permeation tubes, will receive their full warranty period from the date of replacement even if the instrument or system warranty period should expire.

5. Repairs, replacements, adjustments and service performed out-of-warranty shall be charged to the customer at the then current prices for parts, labor, transportation and subsistence.

6. This warranty attaches to the instrument itself and is not limited to the original purchaser.

7. In no event will CSI have any obligation or liability for damages, including but not limited to, consequential damage arising out of, or in connection with, the use or performance of equipment or accessories. No other warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose will apply to equipment or accessories.

8. This warranty constitutes the full understanding of the manufacturer and buyer, and no terms, conditions, understanding or agreement professing to modify or vary the terms hereof shall be binding unless hereafter made in writing and signed by an authorized official of CSI.

All price revisions and design modification privileges reserved.

7. RECOMMENDED SPARE PARTS

The user should remember that provisioning of spares for an instrument or system should depend on: (1) number of such components to be maintained, (2) proximity to available parts, (3) criticality of "down-time" and (4) operational conditions. (i.e. are conditions contributing to accelerated deterioration of parts, etc.).

Also a good routine maintenance schedule will allow a more predictive stocking of parts and should produce a good reserve for "emergency" repairs, if needed, on short notice. In this way, ordering and modes of delivery can be less expensive and more leisurely. (e.g. "fast" delivery by special handling for a single part is most expensive).

PART NUMBER	DESCRIPTION
	CM10-1D CONTROL MODULE
490-0338	Solenoid Valve, 2-way
490-0337	Solenoid Valve, 3-way
490-0339	Pressure Regulator 0-100 psig
585-0039	Sample Pump
514-0053	Fuse, 15A 250V
S901157	Relay, 2 PDT
C4053-1009	Needle Valve
490-0423	Solenoid Valve Repair Kit 3-way
490-0424	Solenoid Valve Repair Kit 2-way
491-2101	100 ml/min glass dilution orifice
	SC-10D SAMPLE CONDITIONER
240-0045	Lamp, Heater
970-8047	Dryer, Permeation, Painted
530-0030	Switch, Thermal
530-0031	Heater, Strip
490-0337	Solenoid Valve 3-way
490-0341	Bypass Filter
490-0340	Eductor
490-0338	Solenoid Valve 2-way
514-0053	Fuse, 15A, 250V
	D-TP PROBE
970-8026	10 ft. Heat Traced Line Assembly

PART NUMBER	DESCRIPTION
	EQUIPMENT ENCLOSURE
260-0022	Blower
514-0056	Breaker, 20 amp
260-0023	Fan Assembly, console
260-0024	Filter, Blower Exhaust
490-0369	"DX" Filter Element
S905022	"BX" Filter Element
M02133	Desiccant Filler 30 oz.
M02132	Charcoal Filler 24 oz.
514-0058	Breaker, 30 Amp
	AIR DRYER ASSEMBLY
490-0363	Air Dryer Assembly
160-0040	Desiccant Chamber (2)
250-0114	O-rings for Desiccant Chamber
450-0079	Solenoid Valve
350-0037	Timer Motor
490-0426	Orifice Set (2)
MODEL 3300	See appended manual. (Same manual as CO version).
MODEL 3300	See appended manual. (Same manual as CO_2 version).
MODEL 1400	See appended manual.
MODEL HC500-2D	See appended manual.

OPERATION AND MAINTENANCE MANUAL

CM10-1D

SAMPLE CONTROL MODULE

P/N 970-9279

COLUMBIA SCIENTIFIC INDUSTRIES CORPORATION
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Austin, TX 78720

Phone: (512) 258-5191
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August 1991
Rev --

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1. INTRODUCTION

Columbia Scientific Industries' CM10-1D Sample Control Module performs the control functions necessary for remote operation of one SC-10 Sample Conditioner and D-TP Sample Probe. Sample gas is extracted through the probe utilizing an air eductor within the SC-10 enclosure. A vacuum pump within the CM10-1D cabinet draws some of the extracted sample gas through a by-pass filter in the SC-10, into the permeation dryer and through the umbilical. The Control Module then distributes this sample gas to the analyzer(s) and exhausts all excess gas through a captured vent for safe release.

The CM10-1D also controls the introduction of calibration gases either directly to the analyzer(s) (Inside) or through the umbilical and SC-10 per EPA guidelines (Outside). Operation of the Control Module may be accomplished manually by actuating toggle switches on the front panel. Remote operation can be achieved by contact closures from a remote control source.

An additional feature of the CM10-1D is a dilution pump/orifice assembly. This allows dilution of the sample or calibration gas with clean, dry zero grade air, which means that two different concentrations of sample gas may be analyzed simultaneously.

This manual provides information necessary for the successful operation and maintenance of the CM10-1D Sample Control Module.

2. PRINCIPLE OF OPERATION

2.1 Manual

In the Manual mode of operation, all CM10-1D control functions may be activated by toggle switches located on the front panel. Indicator lamps, also located on the front panel, display the selected operating status. Leak Test and controlled dilution features are available which can be selected manually.

The two primary modes of operation for the CM10-1D control module are RUN and CALIBRATION. In the RUN mode, sample gas extracted from a process stream is drawn through the umbilical by the sample pump. The pump discharges this sample gas to a manifold (MANIFOLD 1, see Figure 8.1) for distribution to the analyzer(s). Excess sample is captured for venting to a safe area.

In the Calibration mode, either ZERO grade air or SPAN gas is supplied to the analyzer(s). A separate switch is provided to select either Zero or Span. An additional switch is provided to select either the Inside or Outside calibration gas route. With the switch in the INSIDE position, calibration gas is supplied directly to the sample pump for analyzer distribution. With the switch in the OUTSIDE position, calibration gas is first directed through the SC-10, the point of sample gas extraction, then to the sample pump per EPA established guidelines.

The CM10-1D also provides a diluted sample. Extracted sample or calibration gas from MANIFOLD 1 passes through a critical orifice which allows a specified volume to continuously flow into the mixing chamber. Inside the chamber a controlled volume of zero grade air is thoroughly blended with the sample or calibration gas. This diluted gas is then distributed to the analyzer(s) via MANIFOLD 2 (Figure 8.1).

When the Leak Test diagnostic mode is selected, internal plumbing and components may be evacuated and checked for leaks.

2.2 Automatic

In the Automatic mode of operation RUN, CALIBRATION and DILUTION functions are selected by contact closures controlled from a remote source. This remote interface allows preprogrammed introduction of calibration gases and subsequent return to the RUN mode. When the CM10-1D front panel toggle switches are placed in the "Auto" position AC power is directed to the remote controller. Appropriate contact closures select the Run, Calibration Zero, Calibration Span and Dilution functions of the CM10-1D. Status indications for "Stack Ready", "Run" and "Cal" are available for remote identification of the current operating mode. Rear panel terminal strips are provided for connection of these control and status signals. (See Figure 8.2).

3. SPECIFICATIONS

3.1 Site Requirements

Electrical Power:	120 Vac, 10 Amp, 60 Hz, Single Phase.
Zero Air Supply:	100 psig Maximum; 60 psig Nominal.

NOTE: If air supply contains any of the gases for analysis, consult factory.

Span Gas Regulated Supply:	30 psig Maximum; 20 psig psi Nominal.

3.2 Control Module Specifications

Size:	Length - ~19 3/4 inches Width - ~19 inches Height - ~ 8 7/8 inches
Weight:	28 pounds
Regulated Zero Air Supply:	20 psig Maximum
Pneumatic Connections:	1/4" Swagelok compression type tubing connections.

3.3 Dilution Ratios

Dilution ratios of 12 to 350 are available depending on the choice of orifice (see Section 9.2) and dilution air flow rate. Generally speaking the dilution air flow rate is variable between 4000 and 6000 ml/min.

Example: If we use the 50 ml/min orifice and use 5000 ml/min dilution air, the dilution ratio for the sample would be 100:1.

4. DESCRIPTION

The CM10–1D is a self contained control module approximately 19 3/4" x 19" x 8 7/8" outside dimensions and weighing 30 pounds (see Figure 8.3 and Section 3). The unit comes complete for installation in a 19" electronic rack enclosure, or can be configured for bench top use. Figure 8.1 shows the pneumatic flow diagram, Figure 8.2 shows the electrical connections and Figure 8.3 shows the actual component layout. The CM10–1D control module includes the following components:

ITEM	LEGEND	FUNCTION
SV1	Zero	Introduces zero air to the calibration manifold. An electrically actuated 2–way solenoid valve.
SV2	Cal	Introduces calibration gas to the calibration manifold while blocking the zero air supply. An electrically actuated 3–way solenoid valve.
G1	Compound Gauge	Pressure/vacuum gauge that shows vacuum held on system during leak test function and pressure on system during pressurization of system to find a leak or adjust regulator set point.
V1	Calibration By–pass Flow	Needle valve controls amount of ZERO or CAL gas being delivered to the calibration circuit.
FI1	CAL BYPASS	Rotameter to indicate that flowmeter excess CAL or ZERO air is provided to the calibration vent so that system is not starved or over pressurized.
SV3	Leak Test	2–way solenoid valve which closes the calibration source from the vent line in order to allow a vacuum to be drawn on the system for leak testing.

ITEM	LEGEND	FUNCTION
PR1	Zero Air Pressure Regulator	Adjustable pressure regulator used to set the zero air supply pressure to the system.
SV4	Inside/Outside	3-way solenoid valve that directs SPAN/ZERO gas to the sample conditioners for complete system calibration or to the analyzer(s) for instrument calibration only.
SV5	Sample/Calibrate	3-way solenoid valve that directs either sample or calibration gas to the analyzer(s).
SV6	Leak Trap	3-way solenoid valve that traps the vacuum on the CAL and sample lines during leak test while providing ambient air to the analyzer(s).
V2	On Line Sample Flow Adjust	Needle valve that adjusts the amount of sample/calibration gas that is delivered to the analyzer(s).
P1	Sample Pump	Pump that provides sample/calibration gas to the analyzer(s); all materials are Teflon or stainless steel.
FI-2		Rotameter with needle valve to indicate flow rate of sample 1.
FI-3		Rotameter with needle valve to indicate flow rate of sample 2.
FI-4		Rotameter with needle valve to indicate undiluted sample vent flow rate.
SV7	Pressure/Vacuum Gauge Selection	3-way solenoid valve that controls diluted or undiluted sample or calibration gas to the analyzer distribution manifold.

ITEM	LEGEND	FUNCTION
PR2	Dilution Air Pressure Regulator	Adjustable pressure regulator used to set the dilution air supply pressure for critical vacuum eduction and gas dilution.
DP-1	Dilution Pump	Air operated venturi/orifice assembly for critical vacuum eduction and mixing chamber for sample or calibration gas dilution.
GO-1	Glass Critical Orifice	Sealed quartz orifice used to meter a precise amount of sample or calibration gas into the dilution pump mixing chamber.

5. OPERATION

5.1 Initial Inspection and Installation

Upon receipt of a CM10-1D Control Module, the carton should be inspected for damage and carefully unpackaged. Any damage from shipment or handling should be reported immediately.

NOTE: Retain the original shipping carton until the unit is fully accepted.

The unit comes assembled with slide mounts for attachment to a 19" electronic rack. Remove the outer slides and attach to the rack frame at the desired height, one on each side. Slide the inner slides and control module into the outer slides until the latches engage. If desired, both slide assemblies can be removed from the CM10-1D chassis and the unit may be operated on any suitable bench top.

5.2 Electrical and Pneumatic Connections

A 10 pin MS type connector is provided to connect the SC-10 sample conditioner to the CM10-1D Control Module. These connections must be made according to Figure 8.2 of this manual, and the SC-10 manual. This allows for remote SC-10 operation via the CM10-1D.

All pneumatic connections are made at back panel bulkhead fittings. These fittings provide for connection of 1/4" O.D. tubing using Swagelok compressions seals. Each inlet or outlet is clearly marked and should be connected per Figure 8.1 of this manual, and the SC-10 manual.

Finally, the CM10-1D must be connected to a 110 Vac supply. A grounded supply cord is provided and should be connected to a similarly grounded AC supply of at least 10 Amps.

5.3 Manual Operation

With all connections completed per Section 5.2, the Control Module is ready for operation. As previously mentioned, in the manual mode all functions are controlled by front panel toggle switches. Ensure that all front panel toggle switches are in OFF or MANUAL position. Place the SPAN/ZERO switch (S6) in the AUTO position.

Switch the main power on by moving switch S-1 to the ON position, note the switch light should illuminate. This action supplies AC power to the SC-10 heaters. Also, the CM10 fan should be running and the WARM UP status light (L3) should be illuminated.

Once the SC–10 reaches its operating temperature (185–220°F), the WARM UP status light (L3) will extinguish and the READY light (L2) will illuminate. Relay (K1) is energized and switched AC power is now supplied to the SC–10. At any time, during normal operation, when the SC–10 internal temperature drops below its established range, relay (K1) is de–energized, the "READY" light (L2) will extinguish and the WARM UP (L3) light will illuminate. At this time the SC–10 is in blowback mode and no control is available through the CM10–1D.

To place the CM10–1D into the RUN mode, ensure the Manual/Auto selector switch (S3A and 3B) is in the "MANUAL" position. Place the RUN/CAL selector switch (S4) in the RUN position. Check that the RUN indicator light (L9) is illuminated. Switch the sample pump (P1) on by moving selector switch (S2) to the ON position. Ensure that the PUMP light (L1) is illuminated and that the sample pump is running. In this mode of operation, sample gas from the SC–10 is drawn through the pump and discharged to manifold 1. Excess sample gas is exhausted to a safe area through the vent outlet also on the rear panel. Sample gas flow rate through the pump (P1), may be adjusted using the ON LINE SAMPLE valve (V2) located on the front panel. Sample gas flow rate to analyzer 1 may be set using FI–2 and to analyzer 2 using FI–3. Both FI–2 and 3 are adjustable for 0 to 1 liter/min flow.

Before selecting the CALIBRATION mode it is important to ensure that the selector switches (S6) and (S9) are set properly.

Calibration gas may be supplied to the analyzer(s) either directly from the CM10–1D (Inside) or via the umbilical and SC–10 (Outside). When selector switch (S9) is set to INSIDE, solenoid valve (SV4) is not energized and solenoid valve (S5) is energized. Calibration gas flows directly through the pump to the analyzer(s). Also, the INSIDE lamp (L10) is illuminated. When selector switch (S9) is set to OUTSIDE, solenoid valve (S4) is energized and solenoid valve (S5) is not. Now calibration gas is directed up the calibration tube in the umbilical, through the SC–10 and back through the sample pump. Also the OUTSIDE lamp (L14) is illuminated.

Two calibration gases may be supplied to the analyzer(s). ZERO gas provides for an output level of zero for the analyzer(s) attached. SPAN gas provides for an output level of approximately 80% of full scale for the range selected on the analyzer(s). When selector switch (S6) is set to the ZERO position, solenoid valve (SV1) is energized. This allows externally supplied "zero" grade air, regulated by (PR1) to 20 psig non–flowing pressure as indicated on gauge (G1), to be supplied to the sample pump. Also, the ZERO lamp (L12) is illuminated. At this time, the calibration gas flow valve (V1) should be opened only enough to provide an adequate flow rate for the length of calibration circuit. (Observe the Cal Bypass flowmeter F1). When selector switch (S6) is set to the SPAN position, solenoid valve SV2 is energized (SV1 is then de-energized). This allows regulated span gas or Certified Reference Material (CRM) to be supplied to the sample pump, while blocking the zero air supply. Also, the SPAN light (L13) is illuminated. Before proceeding ensure switches (S6) and (S9) are set as required.

To place the CM10-1D into the CALIBRATION mode, ensure the Manual/Auto selector switch (S3A and 3B) is in the MANUAL position. Move selector switch (S4) to the CALIBRATION position. Check that the CALIBRATION light (L8) is illuminated. In this mode of operation calibration gas is supplied to the sample pump via the route selected by switch (S9). By moving the selector switch (S4) back to the RUN position, calibration mode is exited and sample gas is again supplied to the analyzer(s).

To manually control the dilution of sample or span gas, set the vacuum/pressure switch (S5) so that the gauge, G2, reads vacuum and adjust PR2 (Dilution Air Adjust) until the vacuum reading is greater than 15"Hg. Then switch S5 so that the gauge reads pressure and check that the dilution air pressure is less than 40 psig. The dilution ratio for a given critical orifice can be varied by changing the dilution air pressure.

5.4 Auto Operation

In the Automatic mode of operation, RUN and CALIBRATION functions are selected by remote contact closures rather than manual operation of the front panel selector switches. When the MANUAL/AUTO selector switch (S3A and 3B) is set to the AUTO position, AC power is removed from control switches (S4, S6 and S7). At this time, operation of these control switches performs no activity within the CM10-1D. AC power required to operate the CM10-1D valves and relays must be delivered through contacts of the remote control device (see Figure 8.2). However, to assure proper operation, all front panel switches should be placed in the AUTO position before proceeding.

Place the MANUAL/AUTO selector switch (S3A and 3B) into the AUTO position. Check that the AUTO light (L11) is illuminated. Relays (K6 and K7) should not be energized, allowing control signal access from the remote contacts. AC power should be available at the back panel terminal strip TB4-1. With no remote contact closure, the CM10-1D is in the CALIBRATION mode which provides probe "Blowback" through the SC-10. Check that the CALIBRATION light (L8) is illuminated.

To continue through the calibration functions a contact closure is necessary between TB4-1 and TB4-4. This closure selects the calibration ZERO sequence. Check that the ZERO light (L12) is illuminated. Solenoid valve SV-1 should be energized which supplies "zero" grade air to the system. It is necessary to manually select the calibration gas route to be supplied. Selector switch (S9) must be set for Inside or Outside operation (see Section 5.3). To exit the ZERO mode, open the remote contact closure. The ZERO light (L12) should extinguish.

To operate the SPAN function, a contact closure between TB4-1 and TB4-5 is necessary. (Note: Ensure the zero function is not selected). Check that the SPAN light (L13) is illuminated. The Span solenoid valve (SV2) should be energized allowing span gas to flow to the system. To exit the SPAN mode, open the remote closure. The SPAN light (L13) should extinguish.

Operation in the RUN mode requires a contact closure between TB4-1 and TB4-2. The CALIBRATION light (L8) should extinguish and RUN light (L9) should illuminate. Sample gas extracted through the SC-10 is now supplied to the system.

System status is available for transmission to the remote control device or any data acquisition system. An isolated contact closure is provided for each status signal. The following table describes the available status outputs and their rear panel terminal locations.

STATUS	TERMINAL
CAL/RUN	TB5-1
COMMON	TB5-5
STACK READY	TB5-3
COMMON	TB5-6

The RUN mode is indicated when TB5-1 to TB5-5 is closed. CALIBRATION mode is indicated when these terminals are open. Similarly, a closure between TB5-3 and TB5-6 indicates STACK READY, open suggests either WARM UP or system failure.

6. MAINTENANCE

When properly installed and operated, the CM10-1D Control Module requires little maintenance. However, the control module should be included in regularly scheduled maintenance/inspection routines. In applications where the process stream has high levels of particulates or water vapor, daily inspections of the sampling system should become standard practice.

1. Observe the control module and verify that it is operating properly. Check that the proper indicator lights are illuminated for the mode of operation selected.

2. Listen to determine if all solenoid coils are fully engaged and their valves are properly seated. Ensure that the sample pump is operating and no signs of wear or damage exist.

3. Check for any sign of leaks or wear to pneumatic tubing.

4. Check that all electrical connections are properly made.

5. Check that the cooling fan filter is clean and free of obstructions. Use compressed air to remove foreign material and dust.

7. TROUBLE SHOOTING

7.1 Control Module Electrically Non-Operative

a. Unit not turned on.

Check that the main power switch (S1) is ON and indicator light is illuminated.

b. Blown Fuse (F1).

Ensure that the main power switch (S1) is OFF. Remove fuse (f1) and check for continuity, replace as needed.

c. Main power supply is broken.

Check supply voltage to control module, check breakers on main power supply.

7.2 No Sample Gas Flow

a. Sample pump (P1) not operating.

Check supply voltage to the pump (P1), if voltage is present, repair or replace pump. Ensure that pump is not pressure locked by venting both fittings and retighten.

b. Trap solenoid valve (SV6) energized.

Check supply voltage to trap solenoid valve (SV6), the valve should not be energized except during Leak Test. Check for gas exhaust through muffler.

c. Run/Cal solenoid valve (SV5) energized.

Check supply voltage to Run/Cal solenoid valve (SV5), the valve should not energized except during calibration mode.

d. Flowmeter (FI2 or FI3) plugged.

Check for free flow through the flowmeter(s). Ensure that the adjustment valve functions properly and flow can be set at desired.

7.3 No Calibration Gas Flow

a. Span gas bottle shut off or empty.

Check that the supply regulator gauge indicates ample bottle pressure, the outlet gauge is set at approximately 20 psi and the shut off valve is open. Check that the supply line is not damaged or plugged.

b. Sample pump (P1) not operating.

Check supply voltage to the pump (P1), if voltage is present, repair or replace pump.

c. Zero solenoid valve (SV1) not operating.

When solenoid valve (SV1) is energized ZERO grade air is supplied to the pump. Check that the main air supply valve to the control module is open and the supply line is not damaged or plugged. Check supply voltage to (SV1), if present and ZERO air does not flow, repair or replace as needed.

d. Zero air pressure regulator (PR1) not operating.

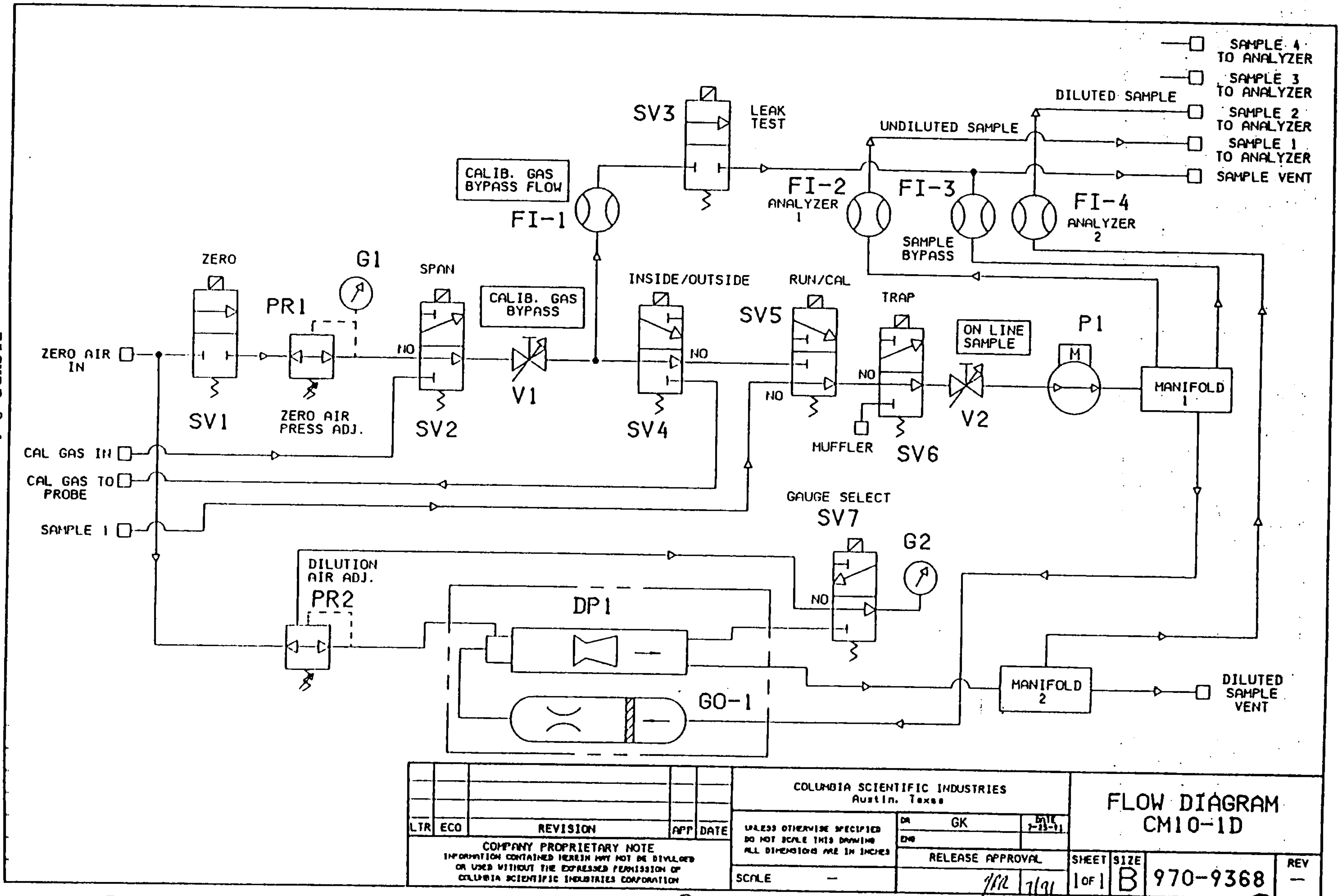
Check pressure regulator PR1 for outlet flow. If no flow is present, repair or replace regulator as needed. Ensure that the pressure regulator is operating properly and verify that the outlet pressure is 20 psi.

e. Span solenoid valve (SV2) not operating.

When solenoid valve (SV2) is energized, span gas should be supplied. When SV2 is de-energized, zero air should be supplied. Check supply voltage to SV2, if present and span gas does not flow, repair or replace as needed.

8. ILLUSTRATIONS

FIGURE 8.1



SAMPLE 4 TO ANALYZER
SAMPLE 3 TO ANALYZER
SAMPLE 2 TO ANALYZER
SAMPLE 1 TO ANALYZER
SAMPLE VENT
DILUTED SAMPLE
UNDILUTED SAMPLE
SV3
LEAK TEST
CALIB. GAS BYPASS FLOW
FI-1
FI-2
ANALYZER 1
FI-3
SAMPLE BYPASS
FI-4
ANALYZER 2
ZERO
G1
PR1
SPAN
CALIB. GAS BYPASS
INSIDE/OUTSIDE
RUN/CAL
TRAP
ON LINE SAMPLE
P1
M
SV5
ZERO AIR IN
NO
SV1
ZERO AIR PRESS ADJ.
SV2
V1
SV4
MUFFLER
SV6
V2
MANIFOLD 1
CAL GAS IN
CAL GAS TO PROBE
SAMPLE 1
GAUGE SELECT
SV7
G2
DILUTION AIR ADJ.
PR2
DP1
GO-1
MANIFOLD 2
DILUTED SAMPLE VENT
LTR
ECO
REVISION
APP
DATE
COMPANY PROPRIETARY NOTE
COLUMBIA SCIENTIFIC INDUSTRIES
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UNLESS OTHERWISE SPECIFIED DO NOT SCALE THIS DRAWING ALL DIMENSIONS ARE IN INCHES
DR
GK
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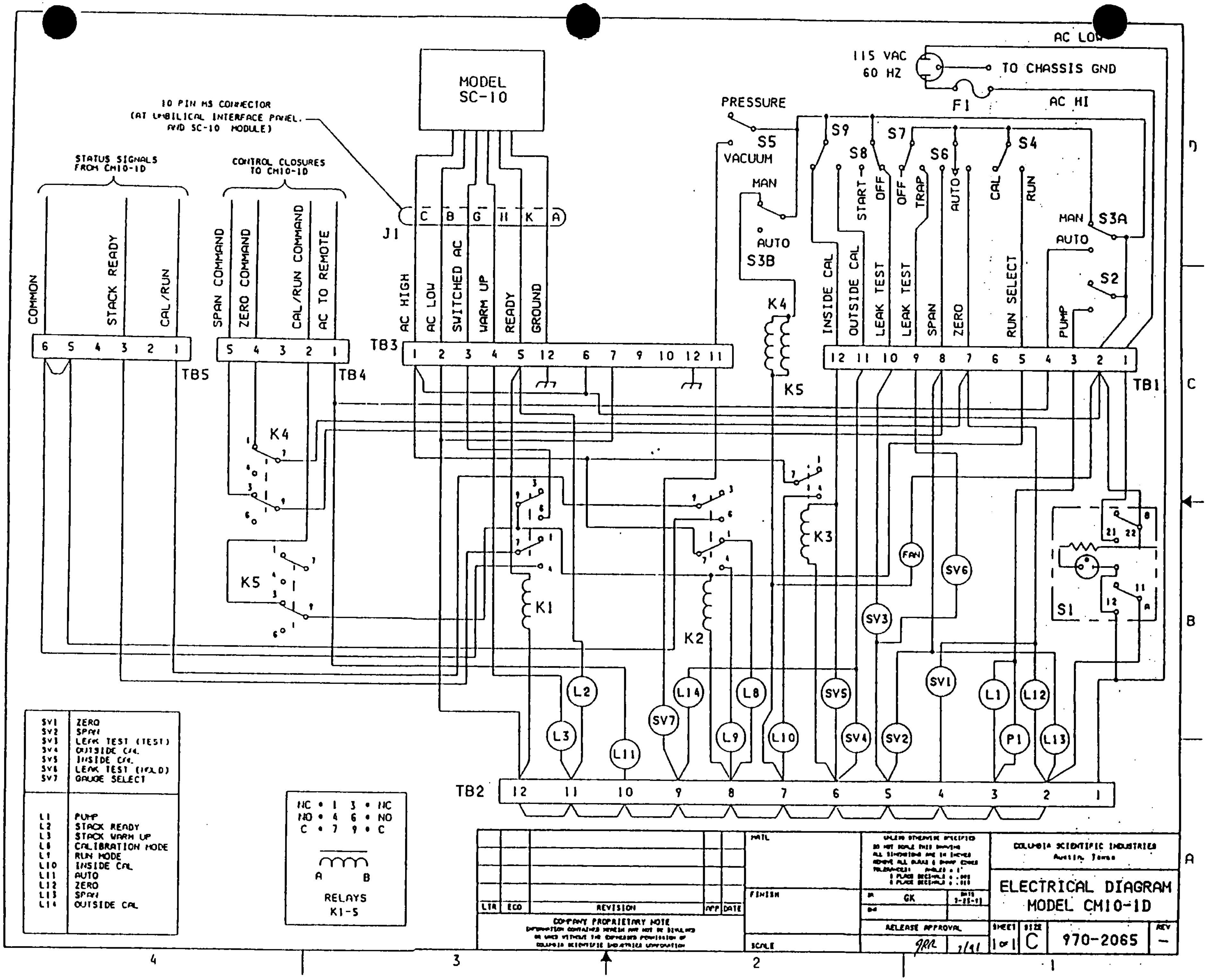
RELEASE APPROVAL
SCALE
—
FLOW DIAGRAM
CM10-1D
SHEET 1 OF 1
SIZE B
970-9368
REV —



MODEL SC-10
10 PIN MS CONNECTOR (AT UMBILICAL INTERFACE PANEL AND SC-10 MODULE)
STATUS SIGNALS FROM CM10-1D
CONTROL CLOSURES TO CM10-1D
COMMON
STACK READY
CAL/RUN
SPAN COMMAND
ZERO COMMAND
CAL/RUN COMMAND
AC TO REMOTE
J1
AC HIGH
AC LOW
SWITCHED AC
WARM UP
READY
GROUND
TB5
TB4
TB3
TB1
TB2
115 VAC 60 HZ
TO CHASSIS GND
AC LOW
AC HI
F1
PRESSURE
VACUUM
S5
S9
S8
S7
S6
S4
S3A
S3B
S2
S1
MAN
AUTO
START
OFF
TRAP
CAL
RUN
INSIDE CAL
OUTSIDE CAL
LEAK TEST
SPAN
ZERO
RUN SELECT
PUMP
K1
K2
K3
K4
K5
FAN
SV1
SV2
SV3
SV4
SV5
SV6
SV7
L1
L2
L3
L8
L9
L10
L11
L12
L13
L14
P1
SV1 ZERO
SV2 SPAN
SV3 LEAK TEST (TEST)
SV4 OUTSIDE CAL
SV5 INSIDE CAL
SV6 LEAK TEST (HOLD)
SV7 GAUGE SELECT
L1 PUMP
L2 STACK READY
L3 STACK WARM UP
L8 CALIBRATION MODE
L9 RUN MODE
L10 INSIDE CAL
L11 AUTO
L12 ZERO
L13 SPAN
L14 OUTSIDE CAL
NC • 1 3 • NC
NO • 4 6 • NO
C • 7 9 • C
A B
RELAYS K1-5
LTR ECO REVISION APP DATE
COMPANY PROPRIETARY NOTE
MATL
FINISH
SCALE
UNLESS OTHERWISE SPECIFIED
DR GK
RELEASE APPROVAL
COLUMBIA SCIENTIFIC INDUSTRIES
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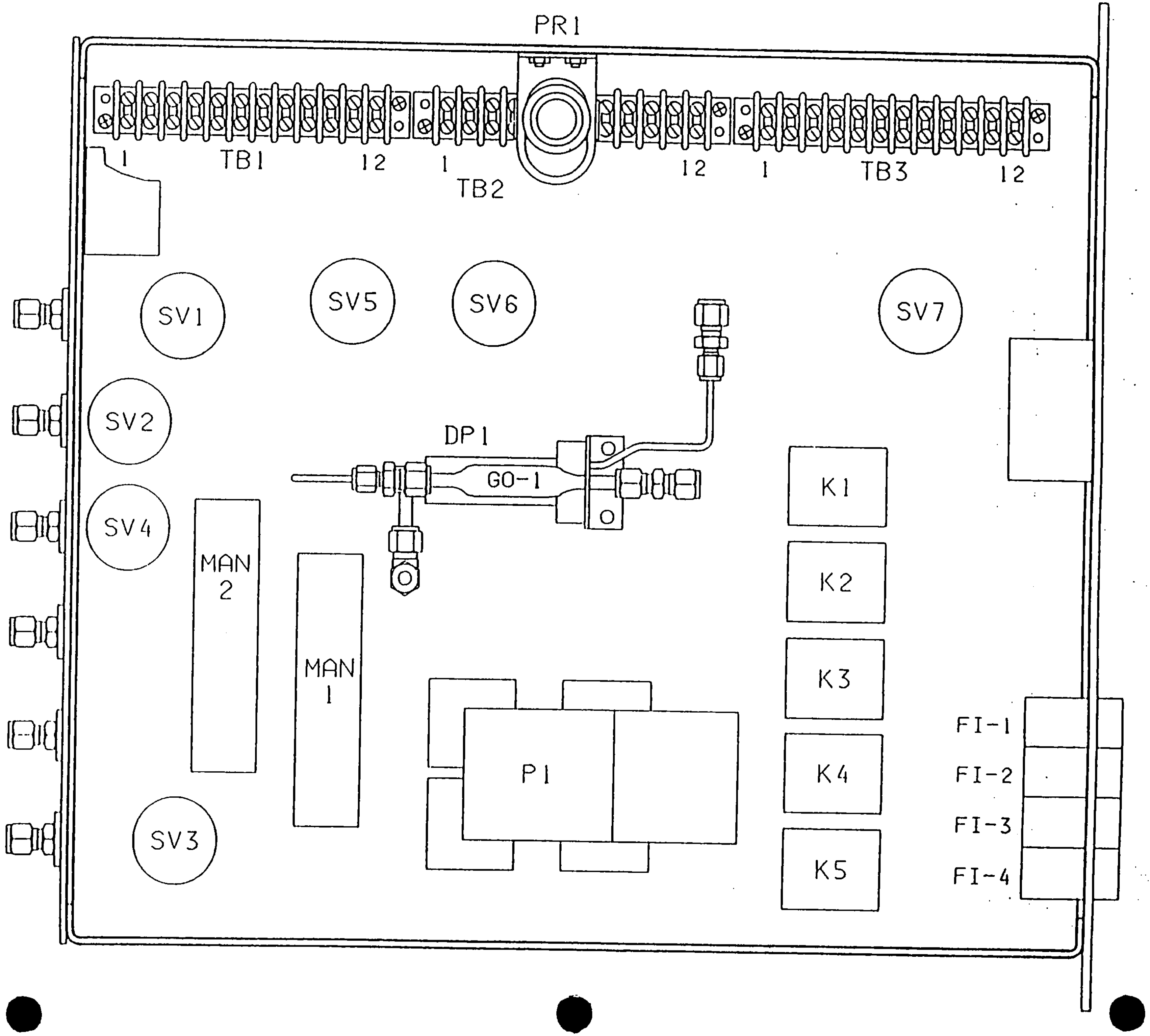
ELECTRICAL DIAGRAM
MODEL CM10-1D
SHEET 1 of 1
SIZE C
970-2065
REV –

FIGURE 8.2



PR1
TB1
1
12
TB2
1
12
TB3
1
12
SV1
SV5
SV6
SV7
SV2
SV4
SV3
DP1
GO-1
MAN 2
MAN 1
P1
K1
K2
K3
K4
K5
FI-1
FI-2
FI-3
FI-4

FIGURE 8.3

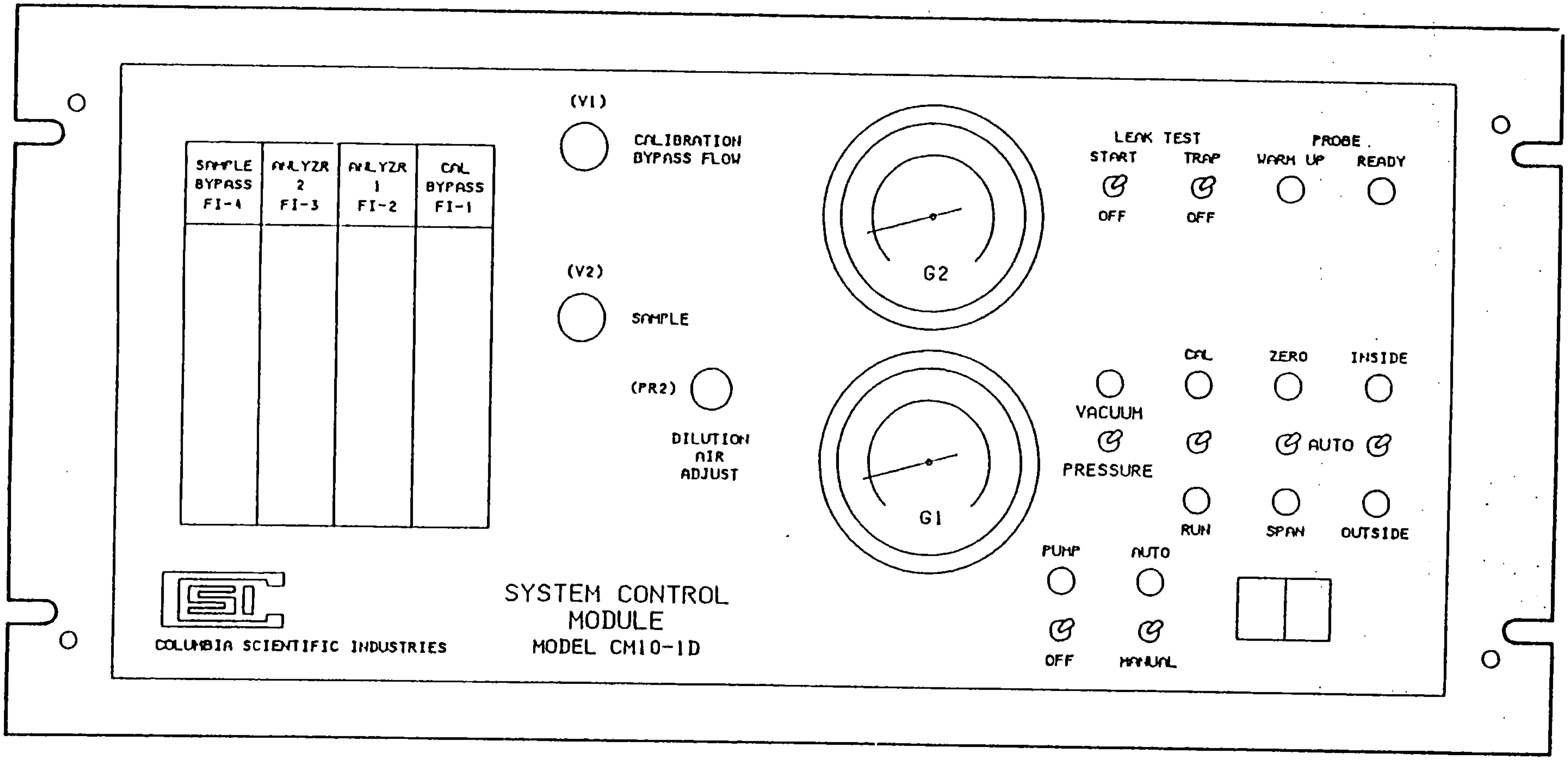

(V1)
CALIBRATION BYPASS FLOW
(V2)
SAMPLE
(PR2)
DILUTION AIR ADJUST
SAMPLE BYPASS FI-4
ANLYZR 2 FI-3
ANLYZR 1 FI-2
CAL BYPASS FI-1
G2
G1
LEAK TEST
START
OFF
TRAP
OFF
PROBE
WARM UP
READY
CAL
ZERO
INSIDE
VACUUM
PRESSURE
AUTO
RUN
SPAN
OUTSIDE
PUMP
OFF
AUTO
MANUAL
COLUMBIA SCIENTIFIC INDUSTRIES
SYSTEM CONTROL
MODULE
MODEL CM10-1D

FIGURE 8.4

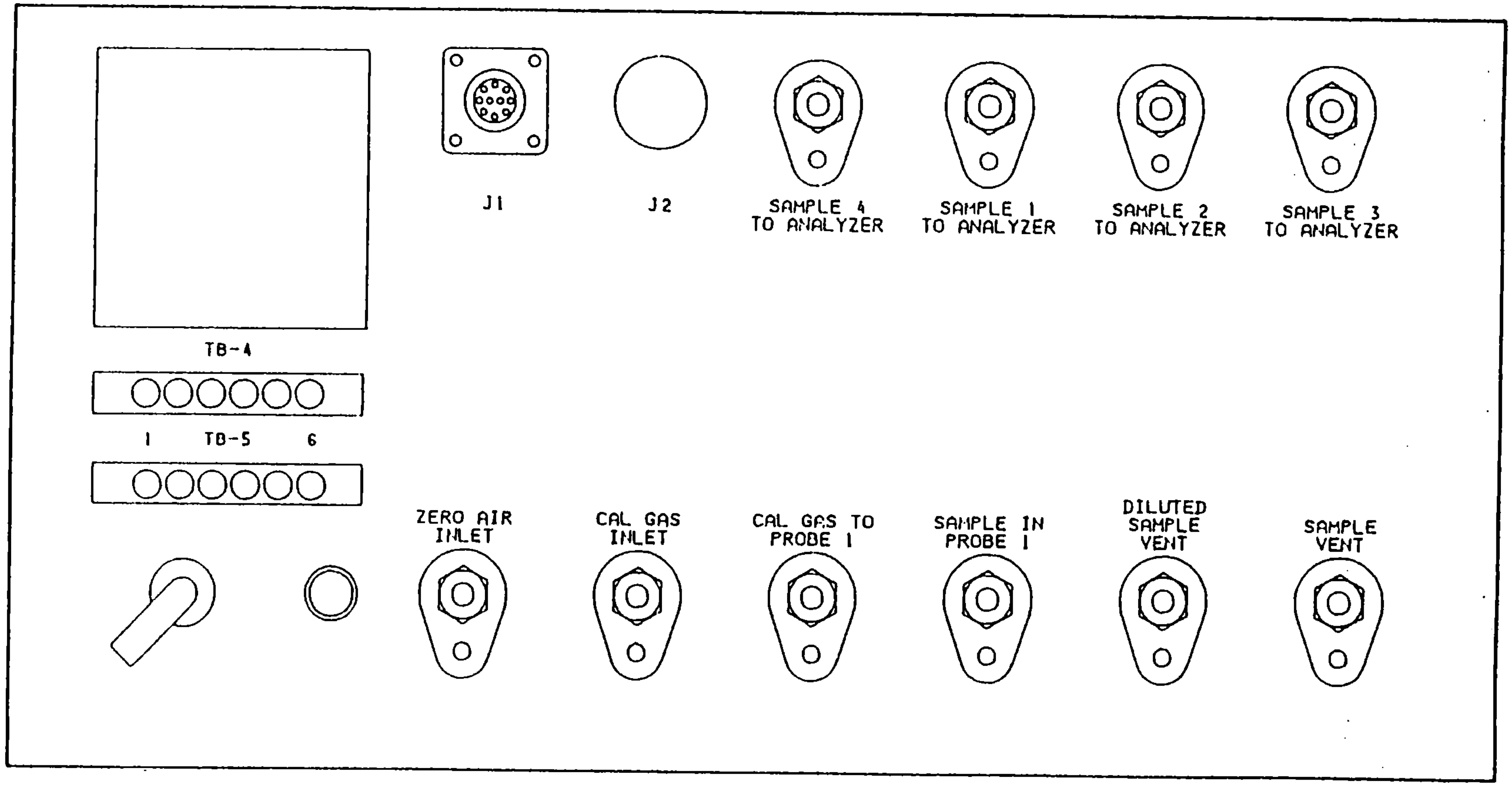

J1
J2
SAMPLE 4
TO ANALYZER
SAMPLE 1
TO ANALYZER
SAMPLE 2
TO ANALYZER
SAMPLE 3
TO ANALYZER
TB-4
1
TB-5
6
ZERO AIR
INLET
CAL GAS
INLET
CAL GAS TO
PROBE 1
SAMPLE IN
PROBE 1
DILUTED
SAMPLE
VENT
SAMPLE
VENT

FIGURE 8.5

9. PARTS LIST

9.1 Recommended Spare Parts for 1 Year

PART NUMBER	DESCRIPTION	QUANTITY
514-0054	Fuse, 10A	1
S900137	Light, Yellow	2
S900243	Light, Red	1
S904979	Muffler	1

9.2 Other Essential Components

PART NUMBER	DESCRIPTION	QUANTITY
260-0013	Fan	1
490-0337	Solenoid Valve, 3-way	1
490-0338	Solenoid Valve, 2-way	1
490-0339	Pressure Regulator	1
490-0428	Gauge	1
511-0012	Toggle Switch	1
585-0039	Pump	1
585-0045	Pump Repair Kit	1
C4053-1009	Metering Valve	1
490-0292	Dilution Pump	1
491-2021	Glass Orifice, dilution pump 20 ml/min	1a)
491-2051	Glass Orifice, dilution pump 50 ml/min	1a)
491-2101	Glass Orifice, dilution pump 100 ml/min	1a)
491-2151	Glass Orifice, dilution pump 150 ml/min	1a)
491-2201	Glass Orifice, dilution pump 200 ml/min	1a)
491-2251	Glass Orifice, dilution pump 250 ml/min	1a)
491-2501	Glass Orifice, dilution pump 500 ml/min	1a)
490-0271	Graphite Ferrule	2
320-0093	Wool Quartz	1

NOTE a): Select required flow rate.

10. WARRANTY

1. Except as otherwise indicated, all instruments and stack systems manufactured and sold by Columbia Scientific Industries Corporation (CSI) are guaranteed for a period of one year from date of shipment from the factory against defects in materials and workmanship of those parts manufactured by CSI, and then, only when operated, serviced and maintained in accordance with the instruction manual. Those parts not manufactured by CSI are guaranteed only to the extent that they are covered by a warranty of original manufacturer. Permeation tubes are warranted for six (6) months. Spare parts and accessories, except expendables, are warranted for ninety (90) days. Expendables such as batteries, sample holders, fuses and indicating lamps are not covered by this warranty.

2. The warranty is voided by the following:

   a) Injection into CSI stack systems or CSI ambient air monitoring or calibrating equipment, of gas mixtures containing reactive suspended matter or molecules yielding and depositing liquids, tars, solids and other non-gaseous residues.

   b) Injection of caustic solutions into the hydrogen lines of CSI hydrocarbon monitors by a malfunctioning hydrogen generator.

   c) Damage to CSI Accelerating Rate Calorimeters or Quantitative Reaction Calorimeters caused by samples that detonate, deflagrate or otherwise escape the confines of the sample holder.

   d) Damage to stack sampling probes caused by severe corrosion.

   e) Damage caused by incorrect installation, by misuse, or by mishandling.

3. Warranty service requests must be received by CSI within the warranty period. Upon notification by the purchaser, CSI will correct defects coming within the scope of this warranty by repairing or replacing the defective unit either at the CSI factory or at the customer's site, at CSI's option. Return shipment of items to CSI must be authorized by a CSI representative and is at customer's expense.

4. Instruments and systems which have been repaired or replaced during their warranty period are themselves guaranteed for only the remaining unexpired portion of their original warranty period. Parts and accessories, including stack probes, umbilicals and permeation tubes, will receive their full warranty period from the date of replacement even if the instrument or system warranty period should expire.

5. Repairs, replacements, adjustments and service performed out-of-warranty shall be charged to the customer at the then current prices for parts, labor, transportation and subsistence.

6. This warranty attaches to the instrument itself and is not limited to the original purchaser.

7. In no event will CSI have any obligation or liability for damages, including but not limited to, consequential damage arising out of, or in connection with, the use or performance of equipment or accessories. No other warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose will apply to equipment or accessories.

8. This warranty constitutes the full understanding of the manufacturer and buyer, and no terms, conditions, understanding or agreement professing to modify or vary the terms hereof shall be binding unless hereafter made in writing and signed by an authorized official of CSI.

All price revisions and design modification privileges reserved.

MODEL SC-10D DRYSTAK

SAMPLE CONDITIONING MODULE

OPERATION AND MAINTENANCE MANUAL

P/N 970-9218

Columbia Scientific Industries Corp.
11950 Jollyville Road
P.O. Box 203190
Austin, Texas 78720

Phone: 512-258-5191

January 1991
Rev -

TABLE OF CONTENTS

ILLUSTRATIONS

1. INTRODUCTION

Columbia Scientific Industries Corporation manufactures the DRYSTAK*line of stack sampling probes and conditioners. This manual describes the operation, installation and maintenance of the DRYSTAK Model SC-10D Sample Conditioner.

The Model SC-10D is an important component of the CSI CM6000 stack sampling system. It is designed to extract a continuous sample from a process stream which, in most cases, is an extremely harsh environment. The SC-10D utilizes a unique, dual bypass filtering arrangement which reliably removes particulates greater than 0.5 microns in diameter. All surfaces that come in contact with the sample are made of 316 stainless steel or Teflon,** and are heated above the sample dewpoint, eliminating possible corrosion of the SC-10D by condensed gases.

After filtration, the sample gas passes through a Permeation Dryer where water is removed, without condensation, to yield a dewpoint of -30 deg C or less. The SC-10D is normally operated by a CM10 Control Module (see Manuals 970-9130, 1, 2).

1.1 Specifications

Sample Inlet Temperature: Up to 300 deg C (572 deg F) standard. High temperature probes to 1300 deg C (2372 deg F) available. Corrosion resistant probes made from hastelloy-C also available.

Sample Inlet Dewpoint: Up to 80 deg C (176 deg F).

Conditioned Sample Flow: Up to 5 lpm (10 CFH).

Instrument Air Requirement: Purge air; 10-40 lpm with a dewpoint of -40 deg C (-40 deg F) or lower and pressure, 25 -40 psig. Eductor air, 30 lpm at 40 psig.

Filters: 316 sintered stainless steel; probe filter 100 microns, bypass filter 5 microns, effective porosity 0.5 microns.

Probe length: 3 feet standard. Other lengths available.

Blowback: Local and remote blowback of probe is standard.

Calibration: Local and remote calibration is standard.

Housing Temperature: 82 to 93 deg C (180 to 200 deg F).

Weight: 10 Kg (22 lbs) without probe and mounting hardware.

*CSI Registered Trademark **Dupont Registered Trademark

Power: 115 VAC, 60 Hz, 1000 Watts.

Dewpoint of conditioned sample: varies with ambient temperature, sample flow rate and inlet sample water vapor content, but is always below the ambient temperature for sample water vapor contents and flow rates less than the limiting ones.

Limiting conditions: Inlet sample water vapor content 50% by volume (80 deg C - 176 deg F - dewpoint); Sample flow rate 5 lpm; dewpoint of conditioned sample less than -30 deg C (-22 deg F).

2. PRINCIPLE OF OPERATION

2.1 Filters

The first stage filter is made of sintered 316 stainless steel and has effective filtering down to 100 microns. As shown in Figure 2.1 (Flow Diagram), this filter is provided with a flyash diverter to protect the sintered element from direct impaction of flyash. A manual blowback solenoid is provided to allow for periodic cleaning of the first filter.

The second stage bypass filter is also made of sintered 316 stainless steel. This element has a pore size of 5 microns. The main flow of extracted sample passes through the inside of the second filter's element, through the eductor and blow-back valve and out the vent. The stack sample, used for measurements, is drawn off the main flow at a 90 degree angle through the sintered element. Due to the high velocity of the sample gas, particulates have difficulty making the 90 degree angle. Thus, the effective filtering of the bypass filter is better than the 5 micron pore size and has typically been shown to be ten times finer (0.5 micron) than the actual pore size. The bypass filter is also "self cleaning", since particulates do not impact the filter element and are carried to the vent by the high velocity flow.

Both filters can be supplied in hastelloy-C for extra corrosion resistance.

2.2 Air Eductor

Sample is drawn from the stack by an air operated eductor. The eductor works on the venturi principle and allows for high sample flowrates without the use of a pump. Clean, oil-free air should be used to operate the eductor. Typically, 30 lpm at 40 psig of instrument air is sufficient. Lower pressure or flow will decrease the amount of extracted sample. The main portion of the extracted sample joins the eductor air and is vented to the outside of the SC-10D via the 3/8" stainless steel tube fitting. (Optional through-probe return is available).

The eductor can be supplied in nickel-200 for extra corrosion resistance.

2.3 Permeation Dryer

The DRYSTAK Model SC-10D employs a permeation drying technique for removal of water vapor without condensation. The Dryer is fabricated as a tube bundle in a "heat exchanger" config-uration with sample gas passing through special tubing where it is dried before introduction to the analyzer. The outside of the tube bundle is continuously purged with dry air (low dewpoint). Water vapor from the sample selectively passes through the tubing from the sample side to the purge air side of the membrane. The dewpoint of the sample gas leaving the DRYSTAK SC-10D is a function of the number of tubes in the bundle, length of the bundle, the sample flow rate, temperature of Dryer, and the flow rate and dewpoint of the purge air. The SC-10D employs a 200 -tube bundle, 24 inches long, for superior drying capacity.

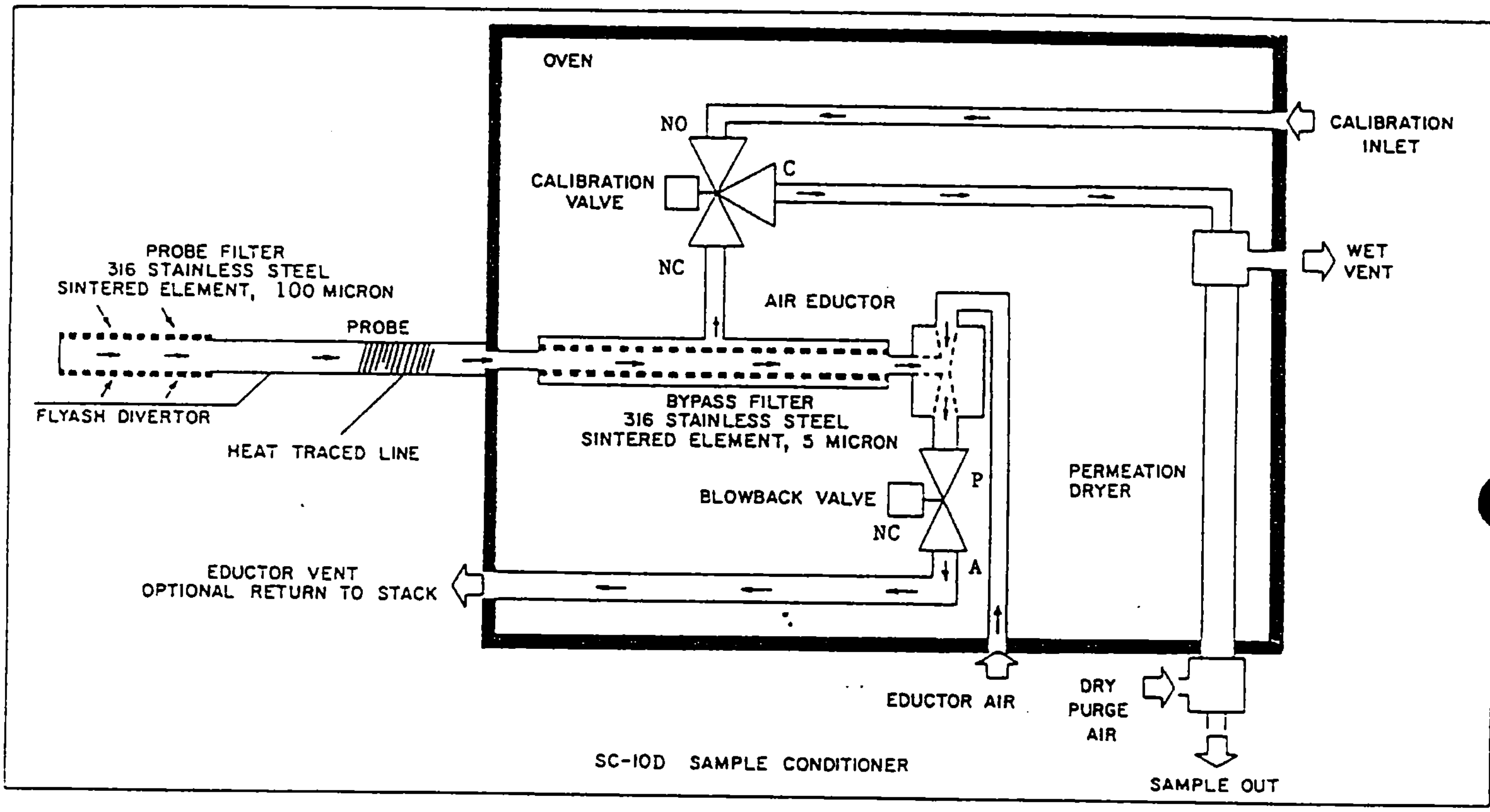

OVEN
NO
CALIBRATION INLET
CALIBRATION VALVE
C
WET VENT
NC
PROBE FILTER
316 STAINLESS STEEL
SINTERED ELEMENT, 100 MICRON
AIR EDUCTOR
PROBE
FLYASH DIVERTOR
HEAT TRACED LINE
BYPASS FILTER
316 STAINLESS STEEL
SINTERED ELEMENT, 5 MICRON
PERMEATION DRYER
P
BLOWBACK VALVE
NC
A
EDUCTOR VENT
OPTIONAL RETURN TO STACK
EDUCTOR AIR
DRY PURGE AIR
SC-10D SAMPLE CONDITIONER
SAMPLE OUT

FIGURE 2.1

3. INSTALLATION

3.1 Mounting

The Model SC-10D is housed in a rain-tight, fiberglass case and can easily handle a harsh outside environment. When selecting a sampling site, attention should be paid to the nearest instrument air supply and accessibility by the operator. The only assembly required before mounting is to connect the sample probe and heat traced line.

If necessary, the hinged cover can be detached from the box by spreading each wire hinge loop. (The wire hinge loop is open at the end attached to the cover clip).

3.2 Pneumatic Connections

3.2.1 Eductor Air

A supply of clean instrument or service air must be brought to the SC-10D for operation of the air eductor. Figure 3.1 shows the recommended hardware used for delivery of the eductor air. Use of the shutoff valve, oil/water coalescing filter, and pressure regulator provides protection from water or oil saturation and allows for easy maintenance of the system.

3.2.2 Sample

Sample enters the SC-10D through the probe and heat-traced line. The end of the line with the amphenol connector connects to the 3/8" stainless steel SAMPLE IN fitting on the SC-10D. The probe connects to the other end of the heat-traced line.

3.2.3 Purge Air

Purge gas enters the Permeation Dryer via its lower fitting (Figure 3.2). A supply of clean, dry, oiless instrument air is essential for the operation of the SC-10D. The sample dewpoint is a function of purge air dryness; the drier the purge gas, the drier the sample will be. It is recommended that a purge gas dewpoint of no higher than -40 deg C (-40 deg F) be used. It is advised that the purge gas dewpoint at the installation site be tested to assure the dryness of the purge air. If plant instrument air does not meet requirements, Columbia Scientific Industries can provide a service air dryer or pump module.

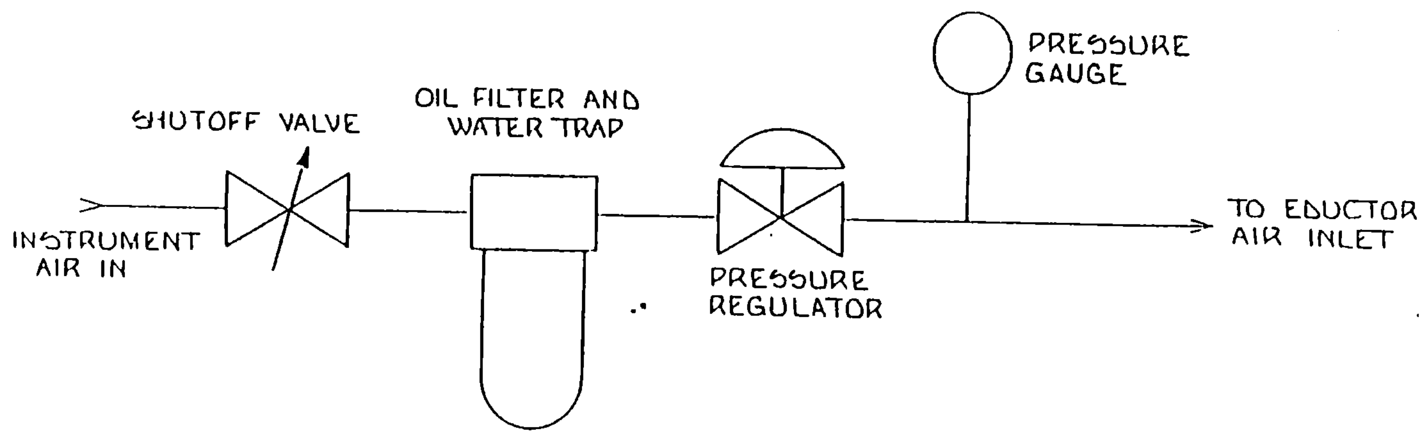
3.2.4 Calibration Gas

A calibration gas port is provided on the SC-10D which allows calibration gas to pass through the Permeation Dryer to the analyzer(s). This is to assure the absence of sample degradation in the Permeation Dryer and sample

DWG. NO. 970-2042 SH 1 REV.

REVISIONS

REV	DESCRIPTION	DATE	APPROVED



PARTS LIST

COLUMBIA SCIENTIFIC INDUSTRIES
Austin, Texas

EDUCTOR AIR
DELIVERY SYSTEM

DRAWN J.E.M 5-82

SIZE B DWG. NO. 970-2042 REV –

SCALE – SHEET 1 OF 1

APPLICATION

DO NOT SCALE DRAWING

Figure 3.1

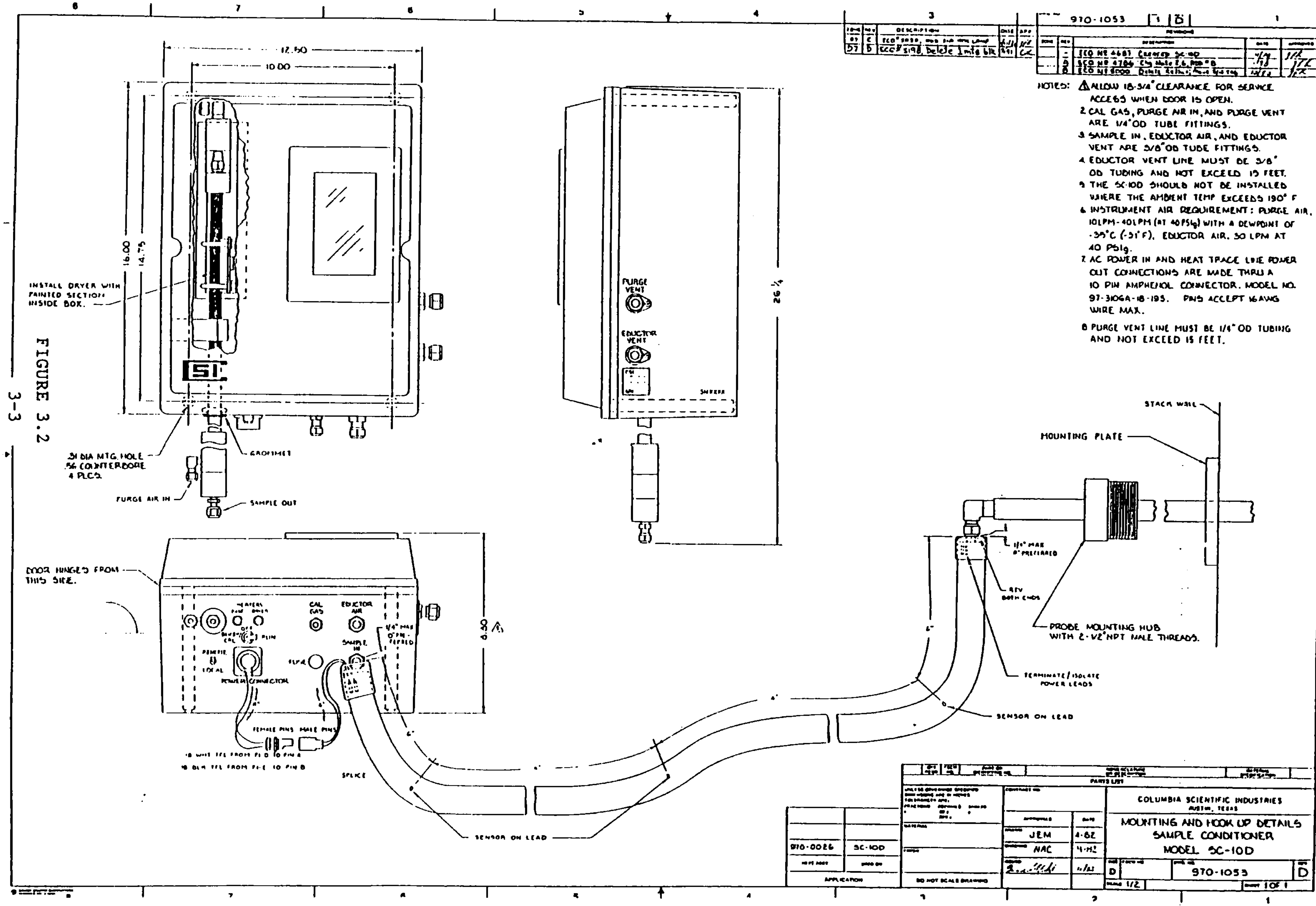

970-1053 D
NOTES: 1. ALLOW 18-3/4" CLEARANCE FOR SERVICE ACCESS WHEN DOOR IS OPEN.
2. CAL GAS, PURGE AIR IN, AND PURGE VENT ARE 1/4" OD TUBE FITTINGS.
3. SAMPLE IN, EDUCTOR AIR, AND EDUCTOR VENT ARE 3/8" OD TUBE FITTINGS.
4. EDUCTOR VENT LINE MUST BE 3/8" OD TUBING AND NOT EXCEED 15 FEET.
5. THE SC-10D SHOULD NOT BE INSTALLED WHERE THE AMBIENT TEMP EXCEEDS 130° F
6. INSTRUMENT AIR REQUIREMENT: PURGE AIR, 10LPM-40LPM (AT 40PSIG) WITH A DEWPOINT OF -35°C (-31°F). EDUCTOR AIR, 30 LPM AT 40 PSIG.
7. AC POWER IN AND HEAT TRACE LINE POWER OUT CONNECTIONS ARE MADE THRU A 10 PIN AMPHENOL CONNECTOR. MODEL NO. 97-3106A-18-19S. PINS ACCEPT 16AWG WIRE MAX.
8. PURGE VENT LINE MUST BE 1/4" OD TUBING AND NOT EXCEED 15 FEET.
12.50
10.00
16.00
14.75
INSTALL DRYER WITH PAINTED SECTION INSIDE BOX.
.31 DIA MTG. HOLE .56 COUNTERBORE 4 PLCS.
GROMMET
PURGE AIR IN
SAMPLE OUT
PURGE VENT
EDUCTOR VENT
26 1/4
DOOR HINGES FROM THIS SIDE.
HEATERS
CAL GAS
EDUCTOR AIR
SAMPLE IN
REMOTE
LOCAL
POWER CONNECTOR
FUSE
1/4" MAX 0" PREFERRED
8.00
FEMALE PINS
MALE PINS
SPLICE
SENSOR ON LEAD
STACK WALL
MOUNTING PLATE
PROBE MOUNTING HUB WITH 2-1/2" NPT MALE THREADS.
TERMINATE/ISOLATE POWER LEADS
SENSOR ON LEAD
COLUMBIA SCIENTIFIC INDUSTRIES
AUSTIN, TEXAS
MOUNTING AND HOOK UP DETAILS
SAMPLE CONDITIONER
MODEL SC-10D
JEM 4-82
NAC 4-82
970-0026 SC-10D
APPLICATION
DO NOT SCALE DRAWING
D 970-1053 D
SCALE 1/2
SHEET 1 OF 1

FIGURE 3.2

lines. The calibration gas is sent to the analyzer by switching the bottom panel switch to the BLOWBACK position.

3.2.5 Vent

Diluted stack gas is vented from the SC-10D through the 3/8" stainless steel fitting on the left side. Excessive vent line length (greater than 15 feet) will cause reduced efficiency of the air eductor.

3.3 Electrical

Power is provided to the SC-10D and the heat-traced line via the amphenol connector. The pin assignment is:

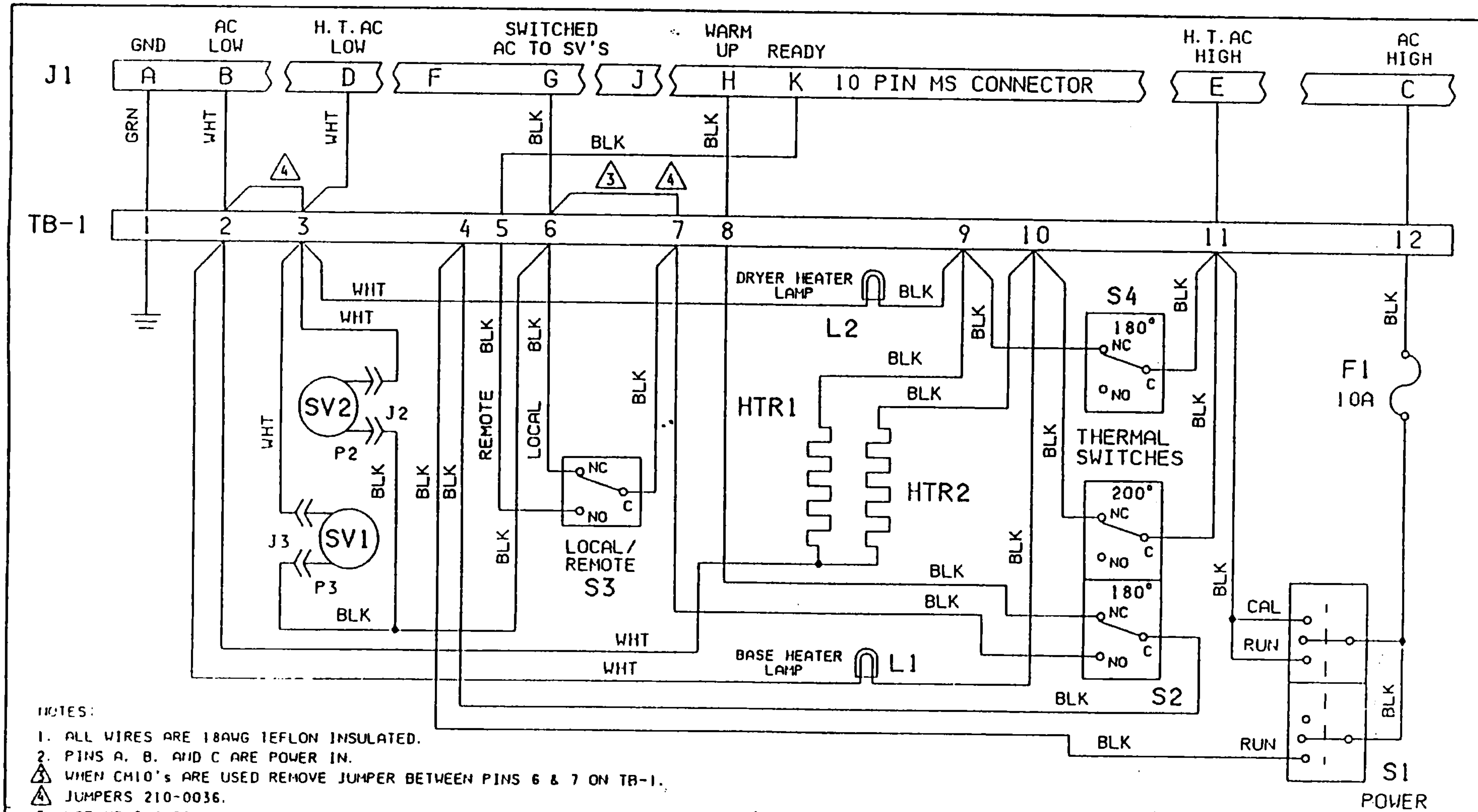
A	Ground In
B	AC Low In
C	AC High In
D	AC Low Out (Heat-Traced Line)
E	AC High Out (Heat-Traced Line)
F	(not used)
G	Remote Power In (Option)
H	Warm Up Status (Option)
J	(not used)
K	Ready Status (Option)

regulation is required.

Figure 3.3 shows the electrical diagram for the SC-10D.

Figure 3.4 shows the internal layout.

FIGURE 3.3
3-5



NOTES:

1. ALL WIRES ARE 18AWG TEFLON INSULATED.
2. PINS A, B, AND C ARE POWER IN.
3. WHEN CH10's ARE USED REMOVE JUMPER BETWEEN PINS 6 & 7 ON TB-1.
4. JUMPERS 210-0036.
5. USE HEAT SHRINK TUBING ON ALL EXPOSED PINS.

LTR	ECO	REVISION	APP	DATE
A	5176	CHG S2 TEMPS.		
–	5030	FROM 970-2027; ADD S4,L2		12-90

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COLUMBIA SCIENTIFIC INDUSTRIES
Austin, Texas

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DR GK
ENG
RELEASE APPROVAL
SCALE —

ELECTRICAL DIAGRAM
SC-10D

SHEET 1 OF 1 | SIZE B | 970-2062 | REV A

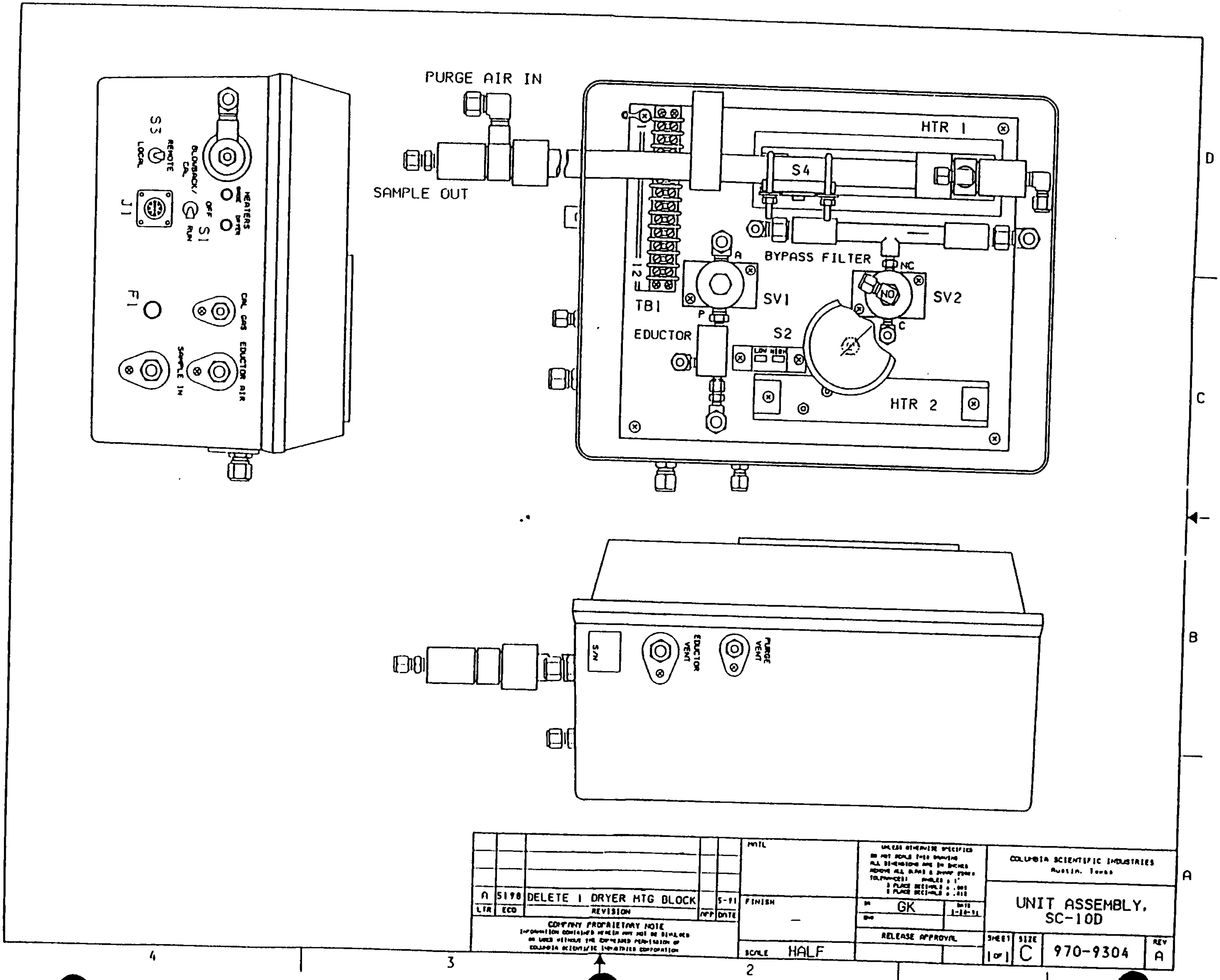

PURGE AIR IN
SAMPLE OUT
HTR 1
S4
BYPASS FILTER
TB1
SV1
SV2
NC
NO
C
A
P
EDUCTOR
S2
LOW HIGH
HTR 2
S3
REMOTE
LOCAL
BLOWBACK/ CAL
HEATERS
OFF
RUN
S1
J1
F1
CAL GAS
EDUCTOR AIR
SAMPLE IN
S/N
EDUCTOR VENT
PURGE VENT
A 5198 DELETE 1 DRYER MTG BLOCK 5-91
LTR ECO REVISION APP DATE
COMPANY PROPRIETARY NOTE
MATL
FINISH
—
SCALE HALF
GK
RELEASE APPROVAL
COLUMBIA SCIENTIFIC INDUSTRIES
Austin, Texas
UNIT ASSEMBLY,
SC-10D
SHEET 1 OF 1
SIZE C
970-9304
REV A

FIGURE 3.4

3-6

4. OPERATION

4.1 Initial Start Up

Before sample can be extracted or the eductor air system turned on, the box and heat-traced line must be warmed up to operating temperature and the purge air should be flowing. To accomplish this connect the heat-traced line, turn the power switch to BLOWBACK/CAL and connect the purge gas. Adjust purge gas flow to at least 4 times the sample flow.

The SC-10D contains a thermal safety switch which allows power to the blowback and calibration valves only if the SC-10D temperature is at approximately 85 deg C (185 deg F) or greater. Since both the calibration and blowback valves are normally closed, the SC-10D remains in the BLOWBACK/CAL mode until operating temperature is reached. This prevents hot stack gas from entering a cold SC-10D due to lack of warm-up time or due to a power failure. Once the SC-10D is turned on, the eductor air and cal gas line can be connected. Once the SC-10D reaches operating temperature, 82 to 93 deg C (180 to 200 deg F), the SC-10D may be placed in the RUN mode and the sample line can be connected so that the bypass sample can be drawn to the analyzer modules for measurement. When starting up the SC-10D after it has been off for a long period of time, it is advisable to allow at least one hour for the dry purge gas to condition the Permeation Dryer.

4.2 Blowback

Periodic blowback of the first stage filter will be required during normal operation. The frequency of blowback will be a function of the amount of flyash and particulates impacting on the first stage filter. It is recommended that a one to two minute blowback be initiated every 24 hours. Blowback is activated by switching the bottom panel switch to the BLOWBACK position.

4.3 Purge Rate Adjustments

Purge gas enters the Permeation Dryer via its lower fitting (Figures 3.2). The actual flow rate of purge gas is not critical, provided that the flow rate is high enough to remove the moisture permeating through the membrane. As a general rule, the flow rate of purge air should be about 4 times the desired sample flow rate. Thus, if a sample flow of 2 liters/minute is to be drawn to the analyzer, a purge flow of about 10 liters/minute should be used. A purge flowmeter can be installed, if desired, on the PURGE VENT fitting (see Figures 3.2). Higher inlet sample moisture contents may require higher purge flow rates.

5. MAINTENANCE

5.1 Filter Maintenance

The SC-10D, when properly installed and operated, requires little or no maintenance. In applications where the process stream has a high level of flyash or particulates, periodic maintenance of the first stage filter may be required. It is recommended that when the entire stack is down for maintenance, the SC-10D should be removed and visually inspected for excessive build up of particulates and flyash on the first stage filter. If the filter is heavily impacted with flyash, it is recommended that the entire probe and flyash diverter be soaked in a suitable solvent that will allow for loosening of the impacted particulates. After the filter element has soaked for approximately one half hour, place the SC-10D in the blowback mode so that the impacted particulates will break away from the filter element. On extremely dirty filters, use of an ultrasonic cleaner is recommended to break away the impacted particulates.

The second stage bypass filter is "self-cleaning" by design and requires no maintenance. However, should excessive sample flowrates be drawn from the bypass filter, it is possible that some build up of particulates may take place. To clean the bypass filter, remove it from the baseplate. Remove the two end cap pieces that hold the sintered element in place. The sintered element will slide out of the stainless steel housing by applying force to one end of the sintered element, lightly tapping the top to break the sintered element from the internal Teflon seals. Visually inspect the bypass filter for build up on the internal walls. To clean this filter, follow the procedure used for the first stage stack filter.

5.2 Permeation Dryer

5.2.1 Water Contamination

Liquid water should not be allowed to enter the Permeation Dryer. If this does occur accidentally, the water should be blown out using dry air. The membrane will become saturated with moisture under these conditions. This does not harm the Dryer but it will require a period of time to drive the water from the membrane. After removing any liquid water, simply operate the Dryer under normal conditions for several hours to recondition the membrane. If desired, the dewpoint of the product sample gas can be observed by means of a dewpoint hygrometer or relative humidity meter.

5.2.2 Oil Contamination

If any oil is allowed to accidentally enter the Permeation Dryer, it can reduce the drying efficiency by coating the permeable membrane. In this case it will be necessary to remove the Dryer from the module and clean the membrane. See Figure 5.1 for disassembly instructions. 1.1.1 Trichlorethane is recommended to clean coated oil from the inside of the membrane. This should be followed by purging with dry air. After cleaning, the Dryer should be operated under normal conditions for a period of time to assure proper conditioning. Again, the performance of the Dryer can be checked by means of a dewpoint hygrometer or relative humidity meter.

5.3 Eductor Assembly

Periodic examination of the removable eductor nozzle should be performed, as well as inspection of the rest of the eductor assembly.

Corrosion or abrading of the nozzle or clogging of the eductor body will reduce the efficiency of sample extraction, as well as the effectiveness of the inertial by-pass filter.

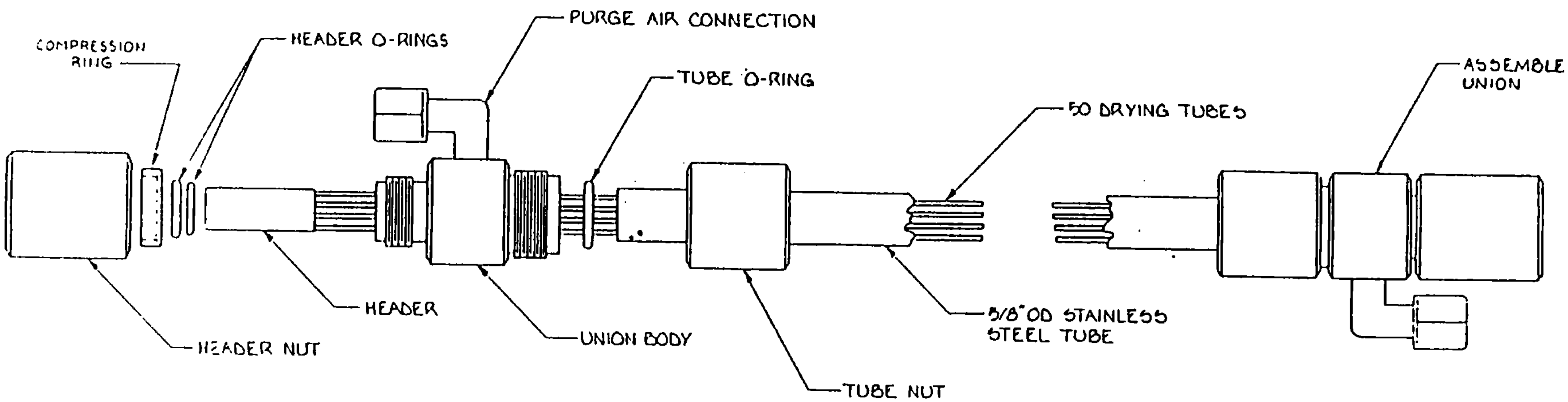
Depending on the specific stack conditions (particulates, corrosive vapors, etc.) the eductor may require periodic replacement.

ZONE	REV	DESCRIPTION	DATE	APPROVED
C3,4	A	ECO #4687, ADD 2ND O-RING		
B,C-4	B	ECO# 5148, ADD COMP RING		

TO DISASSEMBLE PERMEATION DRYER –

1. REMOVE HEADER NUTS BY ROTATING THEM COUNTERCLOCKWISE. (DO NOT ALLOW THE UNION BODY TO ROTATE.)
2. SLIDE HEADER O-RINGS OFF OF BOTH HEADERS.
3. ROTATE TUBE NUTS COUNTERCLOCKWISE AND SLIDE NUTS BACK ON STAINLESS STEEL TUBE. (DO NOT ALLOW THE UNION BODY TO ROTATE.)
4. GENTLY SLIDE THE UNION BODIES OVER THE HEADERS.
5. GENTLY SLIDE THE HEADER THROUGH THE STAINLESS STEEL TUBE.

ASSEMBLE IN REVERSE ORDER.



NOTE: IT CAN CAUSE STRESS ON THE MEMBRANE TUBE BUNDLE IF THE DRYER IS ASSEMBLED IN A "WET" CONDITION AND THEN EXPOSED TO DRY PURGE AIR. THIS CAN BE COMPENSATED FOR BY RUNNING PURGE AIR THRU THE DRYER WITH ONE HEADER NUT LOOSE TO SHRINK THE TUBE BUNDLE BEFORE COMPLETING ASSEMBLY.

COLUMBIA SCIENTIFIC INDUSTRIES
AUSTIN, TEXAS

PERMEATION DRYER DISASSEMBLY INSTRUCTIONS

DRAWN: JEM 6-2-82
SIZE: C | DWG. NO. 970-1044 | REV: B
SCALE: FULL | 403-1000001 | SHEET 1 OF 1

APPLICATION — DO NOT SCALE DRAWING

FIGURE 5.1m
5-3

6. TROUBLESHOOTING GUIDE

6.1 Box Will Not Heat

A. No power to heaters:

a. Unit not turned on. Place switch in RUN or BLOWBACK/CAL position.

b. Blown fuse. Check fuse for continuity.

c. Loose wire. Check for wire pulled from terminal.

d. Wiring error. Check placement of AC power coming into SC-10D.

e. Defective temperature controller. Check for continuity between terminals.

B. Power to heaters:

a. Defective heaters. Replace.

6.2 Cannot Get Sample - Box is Above 180 deg F

A. Box in RUN Mode and valves are energized:

a. Eductor not working properly. Assure 40 psig air supply. Disconnect line between bypass filter and eductor. Test for vacuum. If no vacuum, remove eductor and clean.

b. Probe filter plugged. Blowback for ten minutes. If eductor pressure builds up, remove probe and clean.

c. Vent line blocked. Check for positive pressure at SAMPLE OUT port at end of Dryer.

d. Sample pump not working or not pulling enough vacuum to overcome eductor vacuum.

e. Bypass filter plugged. Remove and clean.

B. Box not in RUN mode or valves not energized:

a. Place in RUN mode.

b. Power going to solenoid valves but are not energized. Defective coil. Replace.

c. No power to solenoid valves. Check thermal safety switch. Replace if defective.

6.3 Water In Sample Line. SC-10D is at Operating Temperature:

A. Sample rate too high.

Should be 5 lpm or lower for standard SC-10D.

B. Purge air too low.

Should be at least 4 times the sample flow rate.

C. Purge air not dry.

Check dewpoint. Should be -40 deg C (-40 deg F) or lower. If not, consult factory.

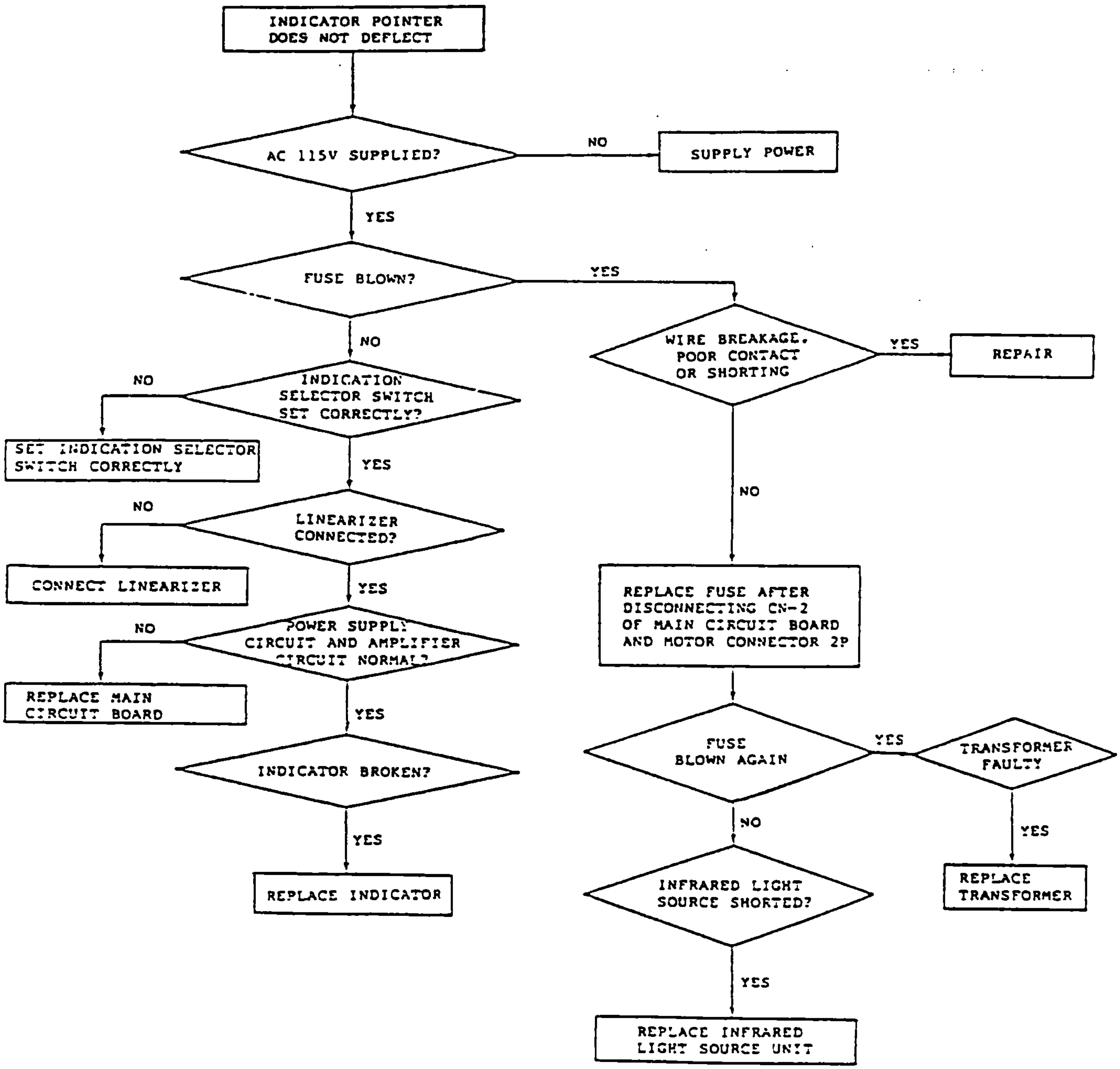
D. Permeation Dryer contaminated.

See Maintenance section. Call factory for assistance.

TROUBLESHOOTING GUIDE (Continued)

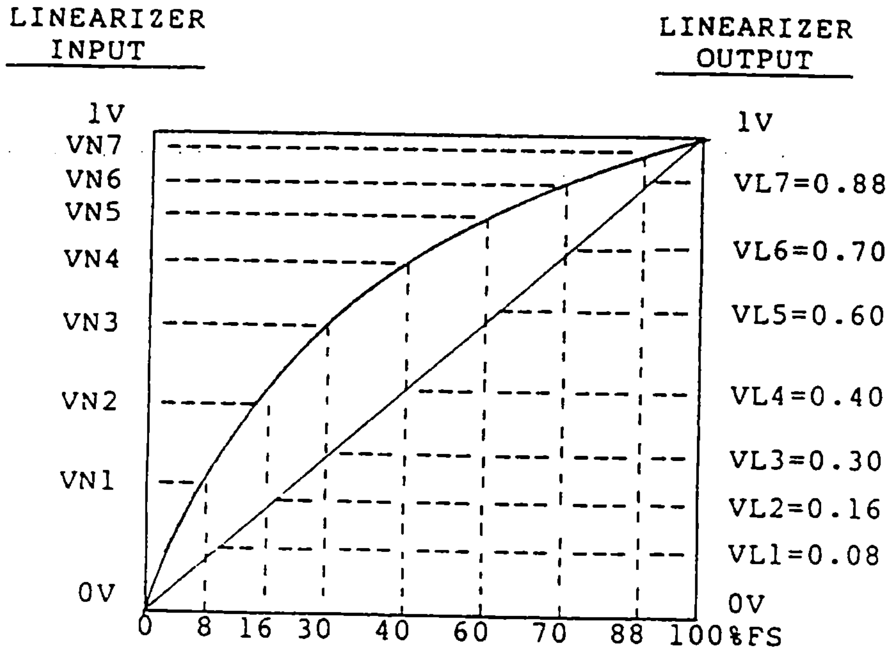
TROUBLESHOOTING CHARTS

Chart 1: No Deflection of Indicator



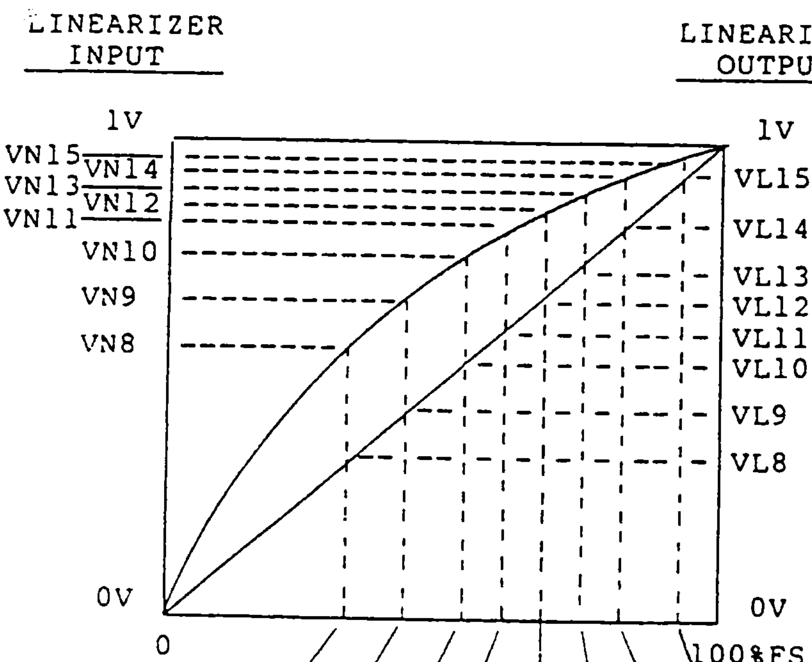
TROUBLESHOOTING GUIDE (Continued)

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)



INPUT	OUTPUT
0V	0V
VN1=	VL1=0.08
VN2=	VL2=0.16
VN3=	VL3=0.30
VN4=	VL4=0.40
VN5=	VL5=0.60
VN6=	VL6=0.70
VN7=	VL7=0.88
1	1

Figure 16: Calibration Curve for Low Range on 3300 Models, or first and second component gases on 3400 Models.



RANGE RATIO	1:2	1:4	1:5	2:5
INPUT	OUTPUT			
VN8=	VL8=0.50V	0.25V	0.20V	0.40V
VN9=	VL9=0.56V	0.31V	0.27V	0.47V
VN10=	VL10=0.62	0.37V	0.34V	0.54V
VN11=	VL11=0.69	0.46V	0.41V	0.62V
VN12=	VL12=0.75	0.55V	0.49V	0.70V
VN13=	VL13=0.80	0.65V	0.60V	0.76V
VN14=	VL14=0.85	0.74V	0.73V	0.82V
VN15=	VL15=0.92	0.85V	0.85V	0.88V
1	1	1	1	1

LOW RANGE								
50	56	62	69	75	80	85	92	(Range Ratio 1:2)
25	31	37	46	55	65	74	85	(Range Ratio 1:4)
20	27	34	41	49	60	73	85	(Range Ratio 1:5)
40	47	54	62	70	76	82	88	(Range Ratio 2:5)

Figure 17: Calibration Curve for High Range, 3300 Models Only

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)

g. Adjust VR12 until the voltage across A6 and M equals the negative equivalent (-VHF) of the noted voltage in the previous step (f).

h. Make input change until the voltage across A2 and M equals VN10. At the same time adjust VR5 to make the voltage across A8 and M equals VL10.

i. Make input change until the voltage across A2 and M equals VN12. At the same time adjust VR6 to make the voltage across A8 and M equal VL14.

j. Make input change until the voltage across A2 and M equals VN14. At the same time adjust VR7 to make the voltage A8 and M equal VL14.

k. Make input change until the voltage across A2 and M equals 1.000V. At the same time adjust VR8 to make the voltage across A8 and M equal 1.000V.

l. Then apply input so as to obtain an intermediate point voltage for each segment, VN9, VN11, VN13, and VN15 across A2 and making sure that output corresponding to each input stays within the range of VL9, VL11, VL13, and VL15 +/- 2%.

In case that the outputs do not fall into the range of the specified values +/- 2%, repeat the procedures of paragraph "h" through "k" until outputs VL10, VL12, VL14, and 1V to repeat with intermediate point outputs VL9, VL11, VL13, and VL15 in the range of the specified values +/- 2%.

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)

i. Then apply input so as to obtain an intermediate point voltage for each segment; VN1, VN3, VN5, and VN7 across A1 and M; making sure that output corresponding to each input stays within the range of VL1, VL3, VL5 or VL7 +/- 2%

In case that the outputs do not fall into the range of the specified values +/- 2% repeat the procedures of paragraphs "e" through "h" until outputs VL2, VL4, VL6, and 1V together with intermediate point outputs VL1, VL3, VL5, and VL7 come in the range of the specified values +/- 2%.

D. Adjustment of High Range; for 3300 Models Only

a. Make adjustments in the high range after adjustments in the low range are made.

b. Adjust VR14, when the voltage across A7 and M is set to 1V, until the voltage across A8 and M corresponds to the range ratio.

For example, when the range ratio is 1 : 2, adjust the voltage across A8 and M to be 1 X 1/2 = 0.5 V with the voltage across A7 and M being 1V.

c. Read VN8 value corresponding to the low range FS from the high range calibration curve.

d. Apply 1.000V input across A1 and M adjust with VR9 until the voltage across A2 and M equals VN8.

e. Adjust with VR11 so that the voltage across A5 and M will be the value shown in the table below.

Range Ratio	Across A5 & M
1 : 2	-2.10 V
1 : 4	-2.20 V
1 : 5	-2.20 V
2 : 5	-2.15 V

D. Adjustment of High Range; for 3300 Models Only (Continued)

f. Then increase the input until the voltage across A2 and M equals 1.000V. Read and note the voltage (VHF) across A3 and M.

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)

c. Connect a standard voltage generator between check terminals Fa and M2. The positive side of the voltage generator should be connected to M1 and the negative side to FA.

C. Adjustments for: Low Range on 3300 Models; first and second gas components on 3400 Models.

a. Turn controls VR1 through VR8, VR11 and VR12 fully counterclockwise on the linearizer circuit board.

b. After turning OFF the main switch on the infrared gas analyzer, connect the linearizer to connector CN4 on the main circuit board. Turn ON the main switch.

c. Adjust VR10 to obtain a voltage of -2.000 V across check terminals A4 and M.

d. Apply a voltage of 0 V from the standard voltage generator. Perform fine adjustment until a voltage of 0 +/- 0.005 V is obtained across check terminals A1 and M on the linearizer. At this stage, adjust VR13 so as to obtain a Voltage of 0 +/- 0.005 V across check terminals A7 and M on the linearizer.

e. Then apply voltage VN2 from the standard voltage generator. Make sure that voltage VN2 is applied across check terminals A1 and M on the linearizer. Adjust VR1 until voltage VL2 is applied across check terminals A7 and M on the linearizer.

f. While applying voltage VN4, make sure that voltage VN4 is applied across A1 and M. Adjust VR2 so as to obtain voltage VL4 across A7 and M.

g. While applying voltage VN6, adjust VR3 so as to obtain VL6 across A7 and M.

h. While applying a voltage of 1 V, adjust VR4 until 1 V is applied across A7 and M.

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)

D. For Model 3400 the Indicator may be switched to read the output from either gas. Be sure that the switch is correctly positioned for the channel being calibrated. After completing settings on one channel, follow the same steps for the second channel.

7. **Adjusting the Span Check Value**

A. Check that the Zero and Span levels have been correctly set.

B. Flow Zero Gas through the Instruments. Depress the Span Check Switch on the Front Panel. Adjust VR2 until the voltage across E4 on connector CN6, and M1, reads about 0.9 V. (For Dual Range instruments, this adjustment should be done in Range "L").

C. For Model 3400 the Indicator may be switched to read the output from either gas. Be sure that the switch is correctly positioned for the channel being calibrated. After completing settings on one channel, follow the same steps for the second channel.

8. **Adjustment of Linearizer**

A. Determination of adjusting voltages

Output voltages VL corresponding to inputs VN are listed in Figures 16 and 17.

Input voltages VN can be determined by corresponding the calibration curve illustrated in the test report (or by developing a gas curve using a high accuracy calibration - gas and a gas divider) to Figures 16 and 17.

B. Preparations for adjustment

a. Adjust the zero control on the front panel so as to obtain a voltage of 0 V across check terminals A4 and M1 on the main circuit board.

b. Connect Fa to F1 and Fb to F4 of connector CN5 on the main circuit board.

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)

D. If a Standard Voltage Source is not available, set a voltage of 1 V +0.001 V across E4 of connector CN6, to M1, by adjusting VR1. In this case, the Linearizer should be left plugged in. After the Indicator span has been correctly adjusted, readjust VR1 to reset the Zero Level of the Indicator output.

E. For Model 3400 the Indicator may be switched to read the output from either gas. Be sure that the switch is correctly positioned for the channel being calibrated. After completing settings on one channel, follow the same steps for the second channel.

5. **Adjusting Coarse Zero**

A. Set the Zero Control on the Front Panel to the middle of its range.

B. Flow Zero gas through the instrument. Adjust VR1 until 0 V is read between E4 of connector CN6, and M1. Fine adjustments may be made using the Front Panel Zero Control.

C. For Model 3400 the Indicator may be switched to read the output from either gas. Be sure that the switch is correctly positioned for the channel being calibrated. After completing settings on one channel, follow the same steps for the second channel.

6. **Adjusting Coarse Span**

A. Adjust the Zero with Zero gas flowing through the Instrument.

B. Set the Span Control on the Front Panel to the middle of its range.

C. Flow Span Gas through the instrument. Adjust VR10 until the voltage between E4 on connector CN6, and M1, corresponds nearly to the concentration of the Span Gas. Fine adjustments may be made using the Front Panel Span Control.

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)

3. **Adjustment of Detector Voltage**

The Detector Voltage will vary depending upon the particular Detector and gas specified for that instrument.

A. The voltage supplied to the Detector can be checked using Test Point A8. Adjust VR9 to set the Voltage between A8 and M1 to match the specifications of the installed Detector (correct voltage marked on Detector).

NOTE

When adjusting VR9 for setting the Detector voltage, always turn the potentiometer to its lowest voltage position (fully counterclockwise) and then gradually rotate clockwise to bring up the reading to the specified voltage. Exceeding the specified voltage can burn out the Detector.

B. For Model 3400, repeat procedure "A" for the second gas system.

4. **Adjustment of the Indicator Span**

This control must be reset if the indicator or main circuit boards are replaced.

A. Turn OFF the Power Switch. Check that the Indicator Pointer reads ZERO. Adjust if necessary using the Mechanical Zero Set Control.

B. Disconnect the Linearizer Circuit Board. Connect a Standard Voltage Source between J16 on the Main Circuit Board (or pin B7 of Connector CN3) and Test Point M1.

NOTE

Take care not to accidentally connect to the wrong pin or to short across two pins since this may damage the circuits.

C. Turn ON the Instrument and the Standard Voltage Source. Adjust the Standard Voltage Source until the voltage between E4 of connector CN6, and M1, reads 1 V +0.001 V. Adjust VR3 to deflect the indicator Pointer to FULL SCALE. Reconnect the Linearizer.

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)

TABLE 1: Amplifier Gain Settings 3400 (Continued)

Standard Gas	Measuring Range	Amplifier Gain Code
CO_2 & CO	0 to 1 % CO_2 & 0 to 3 % CO	G1 (CO_2) & G5 (CO)
CO_2 & CO	0 to 1 % CO_2 & 0 to 6 % CO	G1 (CO_2) & G5 (CO)
CO_2 & CO	0 to 20% CO_2 & 0 to 0.05% CO	G3 (CO_2) & G5 (CO)
CO_2 & CO	0 to 20% CO_2 & 0 to 0.1 % CO	G3 (CO_2) & G5 (CO)

TABLE 2: Amplifier Gain Setting Jumper Connection
(J numbers refer to markings on circuit board)

Gain Code	Connection	AC Amplifier Gain
G1	J1 to J2 J4 to J5 J7 to J8	41x to 475x
G2	J1 to J3 J4 to J6 J7 to J8	146x to 2160x
G3	J1 to J2 J4 to J5 J7 to J9	400x to 4750x
G4	J1 to J3 J4 to J6 J7 to J9	1860x to 2160x
G5	J1 to J3 J4 to J6 J7 to J10	5000x to 58000x

2. **Voltage Adjustment of Power Supply Circuits**

The voltage of the positive line of the power supply output may be measured at Test Point A6. Test Points M1 and M2 are 0 V.

Adjust VR8 so A6 to M1 (or M2) reads +14 V +0.01 V. Check Test Point A7 to M1 (or M2) for a reading of about -15V. The second gas Circuit Board in Model 3400 does not require adjustment since it receives drive voltages from the Main Circuit Board. Test Points A6 and A7 on the extra board should read the same as for Channel 1.

ELECTRONIC CIRCUIT ADJUSTMENTS (Continued)

TABLE 1: Amplifier Gain Settings for CO, CO_2, and CH_4 (3300)

Standard Gas	Measuring Range	Amplifier Gain Code
CO	0 to 500 & 0 to 1000 ppm	G5
	0 to 0.1 & 0 to 0.2 %	G5
	0 to 0.2 & 0 to 0.5 %	G5
	0 to 0.5 & 0 to 1.0 %	G5
	0 to 1 & 0 to 2 %	G5
	0 to 2 & 0 to 5 %	G5
	0 to 5 & 0 to 10 %	G5
	0 to 10 & 0 to 20 %	G3
CO_2	0 to 500 & 0 to 1000 ppm	G3
	0 to 0.1 & 0 to 0.2 %	G3
	0 to 0.2 & 0 to 0.5 %	G3
	0 to 0.5 & 0 to 1.0 %	G3
	0 to 1 & 0 to 2 %	G3
	0 to 2 & 0 to 5 %	G3
	0 to 5 & 0 to 10 %	G1
	0 to 10 & 0 to 20 %	G1
CH_4	0 to 0.1 & 0 to 0.2 %	G5
	0 to 0.2 & 0 to 0.5 %	G3
	0 to 0.5 & 0 to 1.0 %	G3
	0 to 1 & 0 to 2 %	G3
	0 to 2 & 0 to 5 %	G3
	0 to 5 & 0 to 10 %	G3
	0 to 10 & 0 to 20 %	G3

ELECTRONIC CIRCUIT ADJUSTMENTS

The Main Circuit Board (and for the Model 3400, the second gas Circuit Board) will require adjustment if either changes or replacements are made to the circuit board or to the optical bench components.

1. **Selection of Amplifier Gain**

   Detector signal output varies depending upon the type of Standard Gas and the desired measuring range. It is necessary to adjust correspondingly, the amplifier gain. To make the circuit board universal for a wide range of applications, the amplifier gain is changed by a set of circuit board jumpers.

   Table 1 provides a listing of amplifier gain settings required for various measuring ranges of CO and CO_2. The Linearizer Codes called out in the Table will be referred to later. Table 2 provides the jumper positions for various amplifier gain settings.

   NOTE

   For gases and ranges not listed in Table 1, please Contact our Applications Engineering Department.

ELECTRONIC CIRCUITS (Continued)

The output of the DC amplifier, Q4, is then passed through a linearizing circuit (see detailed schematic Figure 25) on a separate plug in board attached to the Main Circuit Board. This output is directly proportional to the gas concentration. The linearized output is then fed into a dual buffer amplifier, Q5. One buffer provides an output with a fixed range of 0 to 1 VDC. The other drives the Front Panel Meter, and also provides a selection of three output voltage ranges. A current amplifier Q6, connected to the output of this second buffer, provides the optional current output. Potentiometers are provided for adjusting the Indicator Span (VR3), the ranges of the optical voltage outputs (VR4 and VR5) and the zero and range (VR6 and VR7) of the optional current output.

Power supplies are also on the Main Circuit Board to power the circuits just described (and similar circuits for the second gas Circuit Board used in the dual gas Model 3400). Voltage regulators, Q7, Q8, and Q9 control the circuits that provide power for the Infrared Light Source and for the detector. Potentiometers VR8 and VR9 are set to provide the correct voltages for the Infrared Source and the installed Detector.

Model 3400 has an additional second gas Circuit Board with similar signal processing circuits for the output for the second gas Detector system (for the circuit board layout, see Figure 22, and for the detailed circuit schematic, see Figure 24). This board also provides the drive voltage for the second Detector Assembly.

The chassis wiring is detailed in Figure 26 for Model 3300 and Figure 27 for Model 3400. The Model 3400 has a Front Panel Indicator Selection Switch to allow the Front Panel Meter to be manually switched to display the output from either signal processing system.

ELECTRONIC TEST EQUIPMENT

The procedures for calibration and field service of the Model 3300 or 3400 Gas Analyzer require the following electronic test equipment:

Oscilloscope

Precision Calibration Standard Voltage Source -
0 to 1 VDC

Digital Voltmeter - AC and DC ranges

ELECTRONIC CIRCUITS (Continued)

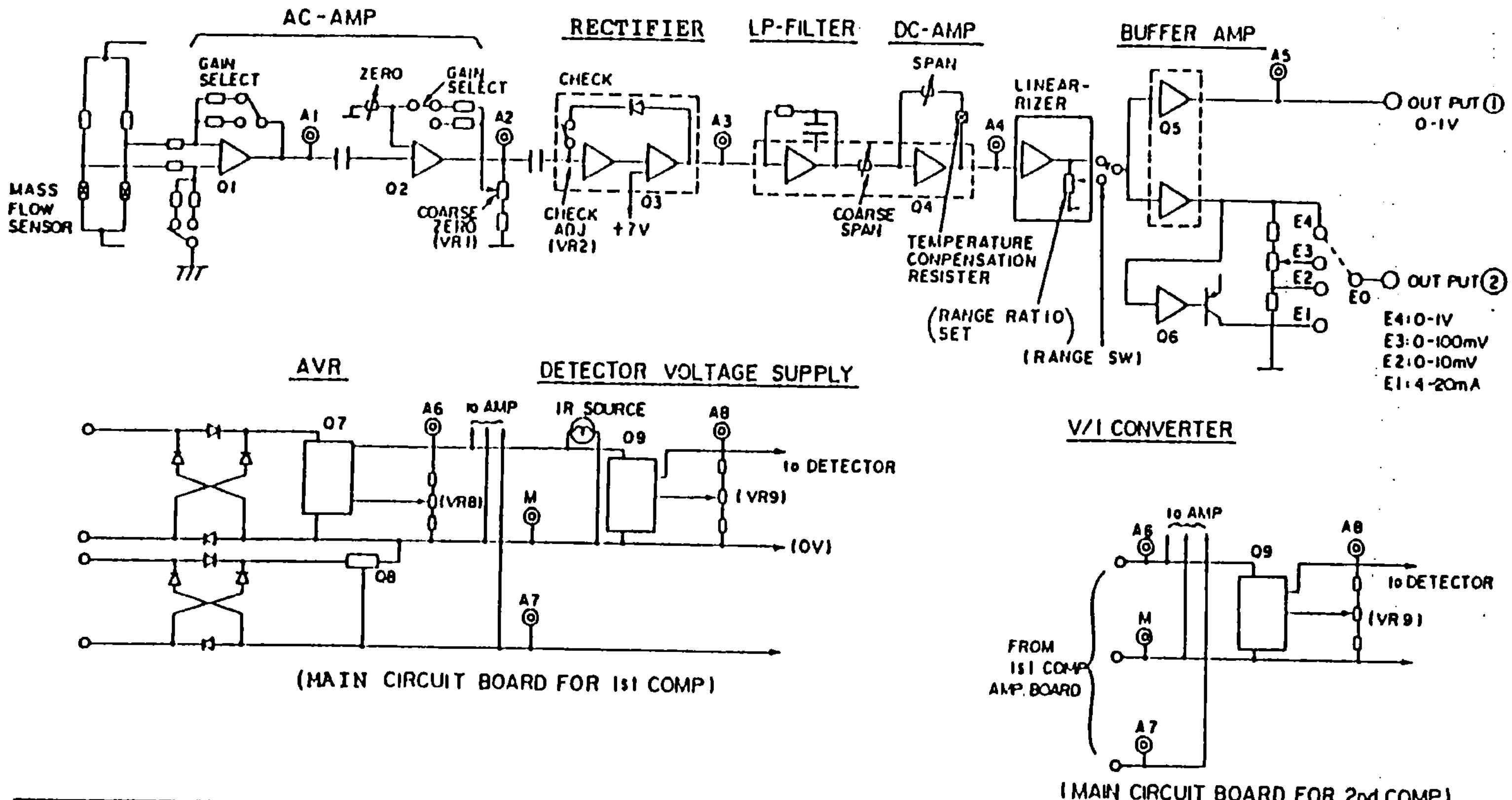
The measured concentration of the gas of interest is converted into AC electrical signal at the output of the mass-flow sensor, part of the Dual-Detector System. The frequency is proportional to the rate of the rotation of the beam Chopper blade. The amplitude is related to the gas concentrations in the Sample Cell. The signal is amplified by the AC amplifier, Q1, on the Main Circuit Board (see Figures 15, 21, and circuit schematic Figure 23). The amplifier output appears at Test Point A1 Typical oscilloscope waveforms and test voltages are shown in Figure 15.

The output from Q1 is further amplified by a second AC amplifier, Q2. The amplitude of the output of Q2 may be measured by observing the signal at Test Point A2. The Course Zero Adjustment potentiometer, VR1, Controls the feedback across Q2 and is set with Zero Gas flowing through the Sample cell. VR1 is adjusted until a reading of approximately 6 volts peak to peak is observed at Test Point A2. The Analyzer should provide a Zero reading in this state.

The gain of the AC amplifier (Q1 & Q2) is selected at the factory by setting jumpers J1, J2, J3, J4, J5, J6, J7, J8, J9, and J10. These jumper settings are provided to allow a wide range of applications with the same circuit board, and are determined by the expected range of Detector output, depending upon the gas being measured.

The output from Q2 is demodulated by Q3. A constant DC bias offset voltage is added to the signal. The output from Q3 appears at Test Point A3. The Front Panel Span Check Switch is connected to the circuits of Q3. With Zero Gas flowing, upon depressing the Check Switch, the signal level observed at A3 drops to about 50 to 60% of the earlier reading. The Front Panel Indicator should read about 90%. This reading is adjustable by the Check Adjust potentiometer VR2.

The demodulated output from Q3 is smoothed to remove AC ripple by a low band-pass filter. The filtered output is then further amplified by the DC amplifier, Q4. The output of this amplifier appears at Test Point A4. This voltage varies according to the concentration of the measured gas flowing through the Sample Cell. A temperature-compensating resistor forms part of the feedback circuit of Q4. This, together with the Front Panel Span Set Control, compensates for variations in the Span signal caused by variations in the ambient temperature.

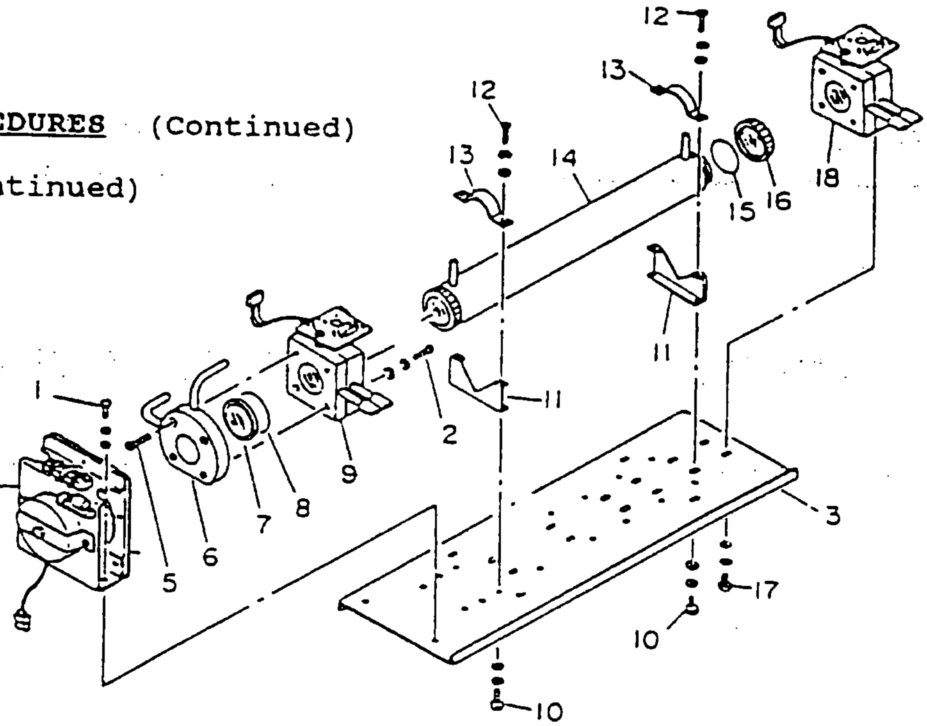


Checkpoint	A1	A2	A3	A4	A5	A6	A7	A8
Output at checkpoint	Depend on detector & range mVp-p	Ca. 6V p-p (ZERO GAS)	Ca. 6V (ZERO GAS)	DC 0-1 VFS (L-RANGE) DC 0-1.2 to 2.6 VFS * (H-RANGE) *DEPEND ON CAL. CURVE	DC 0 - 1VFS	DC +14.00V ±0.05V	DC -15V±1V	DC DETECTOR VOLTAGE ±0.05V
Waveform at checkpoint	10Hz at 60Hz 8 1/3 Hz at 50Hz	ZERO	ZERO 0V CHECK	SPAN 0 ZERO	SPAN 0 ZERO			

Figure 15: Schematic Block Circuit Diagram

DISASSEMBLY PROCEDURES (Continued)

SAMPLE CELL (Continued)



1, 2	SCREW	11	CELL BRACKET
3	BASE	12	SCREW
4	INFRARED SOURCE UNIT	13	CELL BRACKET
5	SCREW	14	SAMPLE CELL
6	BLOCK SAMPLE CELL	15	O-RING
7	WINDOW	16	WINDOW
8	O-RING	17	SCREW
9	DETECTOR	18	DETECTOR
10	SCREW		

Figure 14: Model 3400
Optical Bench with both Pipe and Block Type Sample Cells.

OPTICAL BENCH

1. **Optical Bench Removal**

   A. Follow steps "A" through "D" as described in "Removal of Pipe Type Sample Cell" above. For Model 3400, also disconnect the tubing to the second Sample Cell.

   B. Uncouple the cable connecting the Detector system(s) to the Main Circuit Board(s).

   C. Disconnect the wires from the 2-pin terminal block of the Infrared Light Source Assembly. Also unplug the 2-pin connector (Item 8 of Figure 12) from the Chopper Motor.

   D. Remove the four retaining screws (Item 3, Figure 12), and lift out the bench.

DISASSEMBLY PROCEDURES (Continued)

SAMPLE CELL (Continued)

5. **Disassembly of Pipe and Block Type Cells only on some 3400 Instruments.** (Refer to Figure 14).

   A. Follow steps "A" through "C" as described in "Removal of Pipe Type Sample Cell" (Page 29).

   B. Disconnect the tubing connected to the Sample Cells.

   C. Loosen the Infrared Light Source retaining screws (Item 1 in Figure 14). Slide the Light Source towards the Front Panel to form a gap with the Pipe Type Sample Cell.

   D. Loosen and remove the four Sample Cell retaining screws and two brackets (Item 12 & 3). Lift out the Sample Cell.

   E. Disconnect the cable connecting the Dual-Detector Assembly from the Main Circuit Board.

   F. Loosen and remove the two retaining screws (Item 2) which hold the Sample Cell and Detector Assembly to the Infrared Light Source Assembly. Both the Sample Cell and Detector are now removable from the Optical Bench as a single assembly.

NOTE

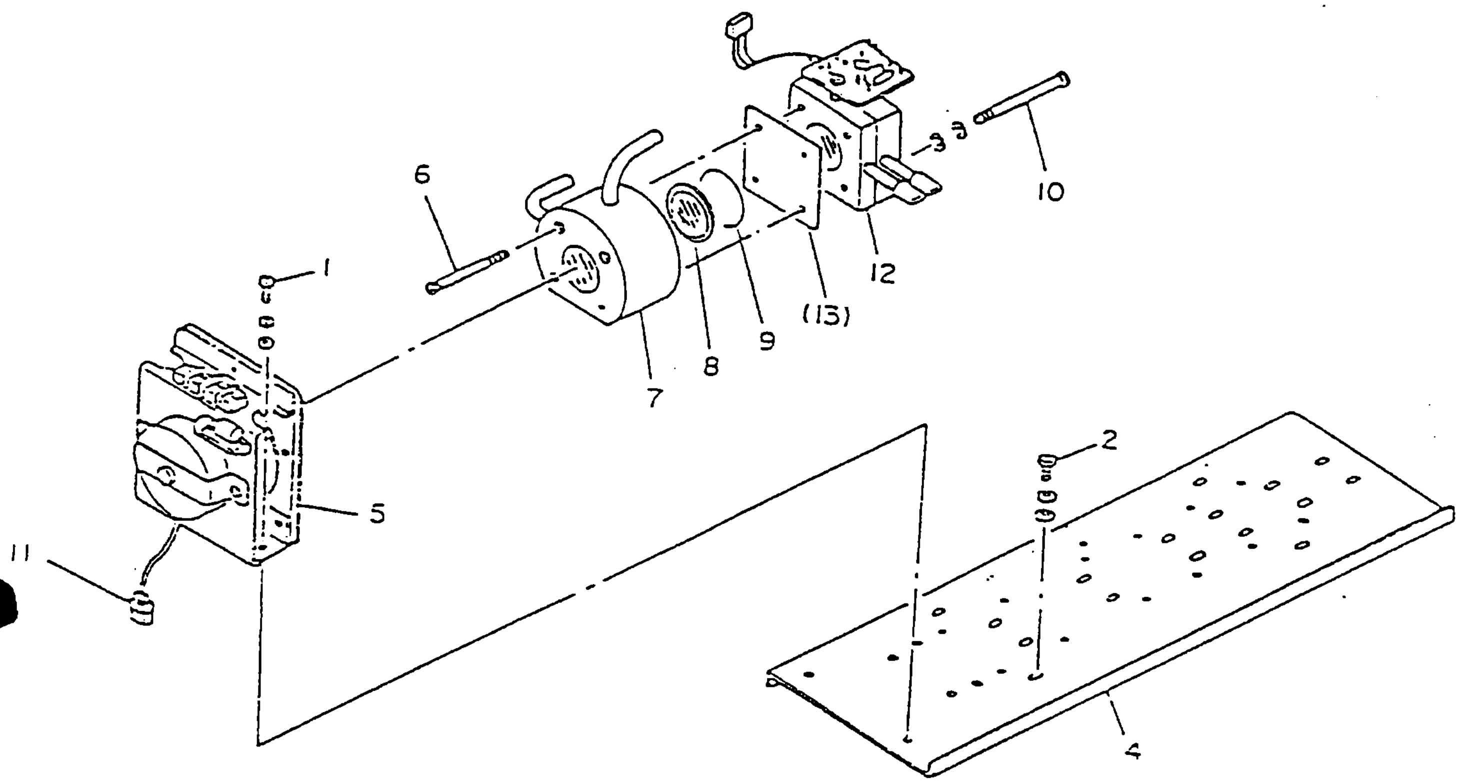
The Sample Cell Window between the Sample Cell and Detector is loose and only retained by the clamping action between the two units. Take care not to drop the Window.

   G. Carefully holding the Detector/Sample Cell Assembly with the Detector upwards, loosen and remove downwards the two remaining screws (Item 5) which clamp the Sample Cell to the Detector. Lower the Sample Cell slowly taking care not to drop the loose Window and O-Ring.

6. **Reassembly of the Pipe and Block Type Cells**

   A. Follow the above instructions in reverse order.

SAMPLE CELL (Continued)



1, 2	SCREW	8	WINDOW
4	BASE	9	O-RING
5	INFRARED SOURCE UNIT	10	SCREW
6	SCREW	11	CONNECTOR
7	BLOCK SAMPLE CELL	12	DETECTOR
		13	FILTER (if necessary)

Figure 13: Model 3300
Optical Bench with Block Type Sample Cell

SAMPLE CELL

H. Clean the window and cell walls with acetone or isopropyl alcohol and lens tissue as required.

2. **Reassembly of Pipe Type Sample Cell**

Follow above instructions in reverse. Be sure to leave approximately 0.02 inch (0.5 mm) gaps at both ends of the pipe type Sample Cell.

3. **Disassembly of Block Type Cell** (Refer to Figure 13)

A. Follow steps "A" through "D" in the above procedure for "Removal of Pipe Type Sample Cell".

B. Disconnect the cable connecting the Dual-Detector Assembly from the Main Circuit Board.

C. Loosen and remove the two retaining screws (Item 10) which hold the Sample Cell and detector Assembly to the Infrared Light Source Assembly. Both the Sample Cell and Detector are now removable from the Optical Bench as a single assembly.

NOTE

The Sample Cell Window between the Sample Cell and Detector is loose and only retained by the clamping action between the two units. Take care not to drop the Window.

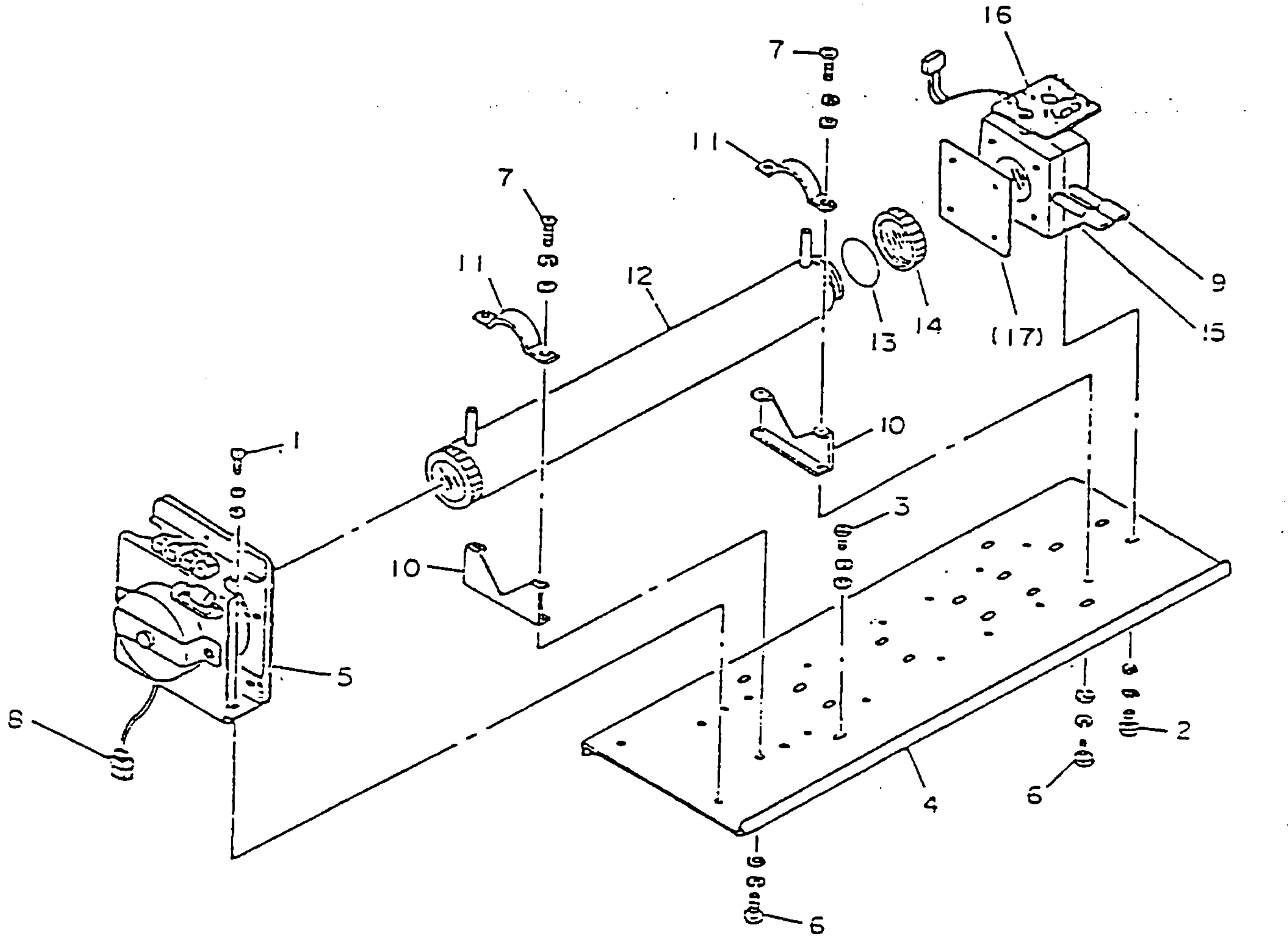
D. Carefully holding the Detector/Sample Cell assembly with the Detector upwards, loosen and remove downwards the two remaining screws (Item 6) which clamp the Sample Cell to the Detector. Lower the Sample Cell slowly, taking care not to drop the loose Window and O-Ring.

E. Clean the window and cell walls with acetone or isopropyl alcohol and lens tissue as required.

4. **Reassembly of Block Type Sample Cell**

Follow the above instructions in reverse. Set the O-Ring between the window holder and the detector.

SAMPLE CELL (Continued)



1 to 3	SCREW	11	CLAMP
4	BASE	12	PIPE SAMPLE CELL
5	INFRARED SOURCE UNIT	13	O-RING
6, 7	SCREW	14	WINDOW
8	CONNECTOR	15	DETECTOR
9	SEALED TUBES	16	BRIDGE CIRCUIT BOARD
10	SUPPORT	17	OPTICAL FILTER (if installed)

Figure 12: Model 3300
Optical Bench with Pipe Type Sample Cell

SECTION VI

DISASSEMBLY PROCEDURES

SAMPLE CELL

The Model 3300 Gas Analyzer may use either "Pipe" or "Block" type Sample Cells. Block type cells come in lengths of 0.16, 0.31, 0.63, and 1.26 inches (4, 8, 16, and 32 mm). Pipe cells come in lengths of 2.52, 4.92, and 9.84 inches (64, 125, and 250 mm).

Model 3400 may use both types of cells in the same instrument. When disassembling, always remove the Pipe type Sample cell first.

NOTE

In disassembling and reassembling the Sample Cell take care to avoid stress on the sealed tubes projecting from the Detector Assembly and the Infrared Light Source. Stressing or bending these tubes may cause gas leaks which can cause the instrument to malfunction.

1. **Removal of Pipe Type Sample Cell** (Refer to Figure 12).

   A. Shut off the Sample Gas flow. If the gas is toxic, purge the Sample Cell with Zero Gas.

   B. Remove power from the Instrument.

   C. Loosen the Front Panel retaining screws (Item 8 in Figures 3 and 4). Pull out the internal chassis from the case until the stop is reached. To completely remove the chassis, lift the front panel up while withdrawing the chassis.

   D. Disconnect the tubing connected to the Sample Cell.

   E. Loosen the Infrared Light Source retaining screws (Item 1 in Figure 12). Slide the Light Source towards the Front Panel to form a gap with the Sample Cell.

   F. Loosen and remove the four Sample Cell retaining screws and two brackets (Item 7 and 11 in Figure 12). Lift out the Sample Cell.

   G. Unscrew and remove the Window Assemblies (right-hand threads, Item 14). The CaF_2 plate is permanently bonded to the Window Assembly.

FUNCTIONAL DESCRIPTION (Continued)

ELECTRONICS (Continued)

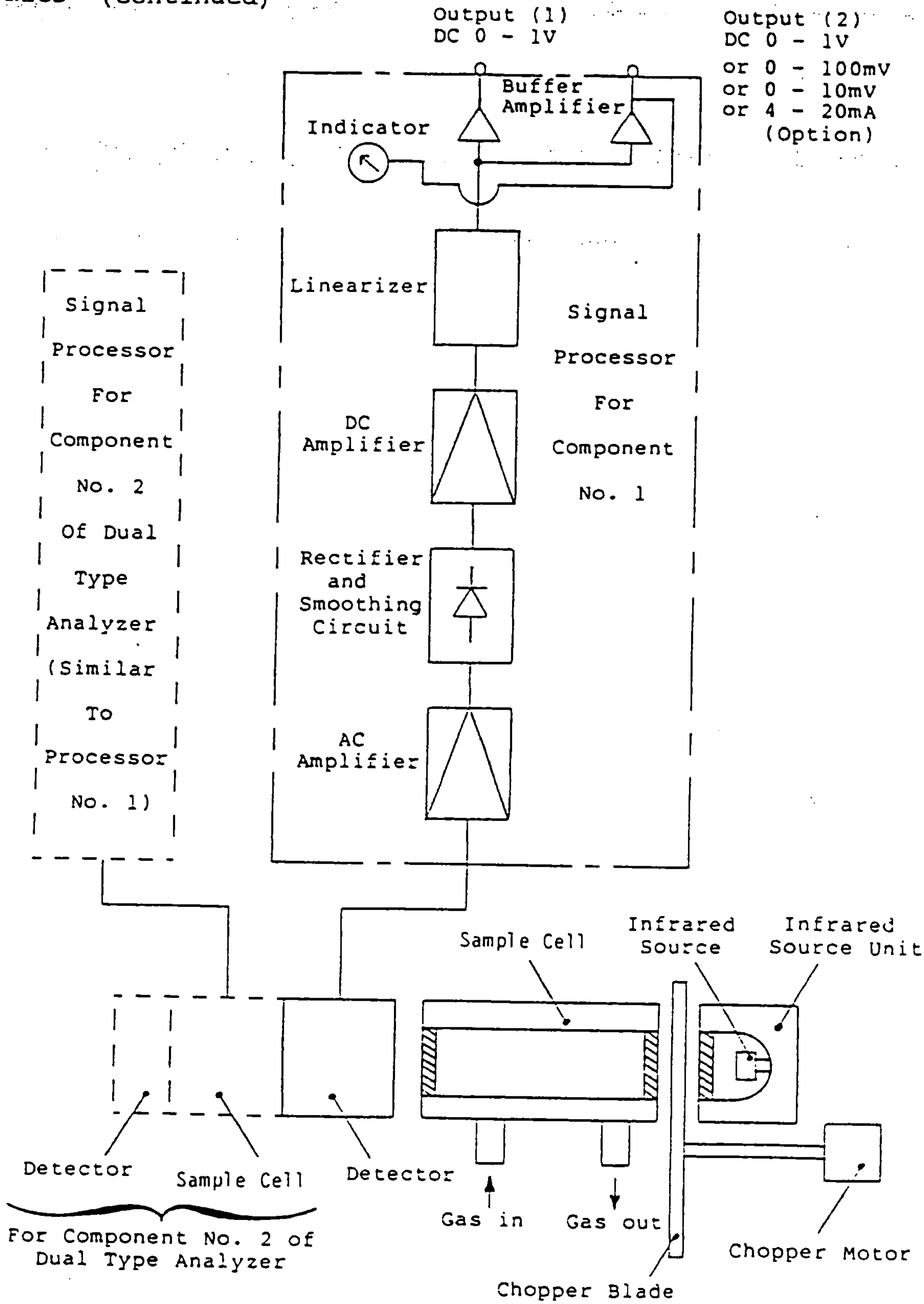


Figure 11: Schematic Block Diagram

FUNCTIONAL DESCRIPTION (Continued)

OPTICAL BENCH (Continued)

The Model 3400 Dual Gas Instrument utilizes a second Sample Cell and Dual-Cell Detector, using the residual beam energy emitted from the first system, just described (see Figure 11). The infrared beam continues on through the first Dual-Cell Detector into the second Sample Cell, and on into the second Dual-Cell Detector. The dual cells of the second Detector are filled with the second gas, and the second system operates in the same way as the first. Gas flow rates between the cells of the second Detector are separately electronically processed to develop the readings of the second gas concentration.

ELECTRONICS

The pulsing output from the Detector's mass-flow sensor appear at the sensor output as an AC electrical signal. The signal frequency is related to the rate of the beam-interrupting chopper blade. The signal amplitude is related to the measured gas concentrations in the Sample Cell.

This AC signal is amplified by the AC amplifier (see Figure 11), and then demodulated and filtered. The resulting DC signal is further amplified, linearized, and fed into two buffer amplifiers. One buffer provides a 0 to 1 VDC output. The other drives the Front Panel Indicator Meter, and provides a selection of three voltage range outputs. A current amplifier, connected to the second buffer, provides the optional current output.

Model 3400 has a second set of similar circuits for processing the signal from the second gas Detector. The Front Panel Indicator Meter may be manually switched to display the output from either gas.

OPTICAL BENCH (Continued)

Front Panel control allows this Electrical Span Check to beundertaken at any time. Since no mechanical moving parts are involved, the stability and repeatability of this check are excellent.

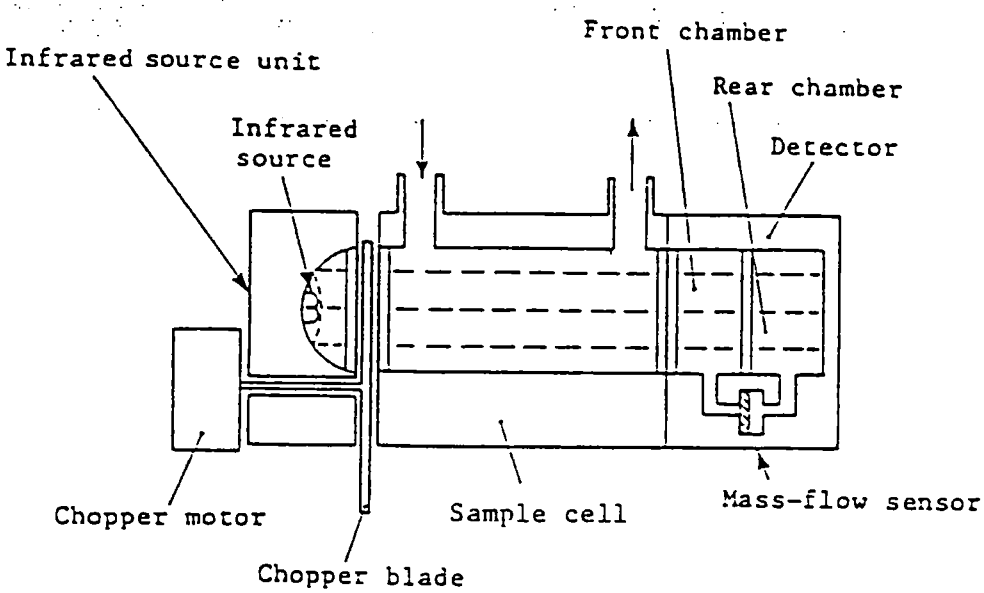
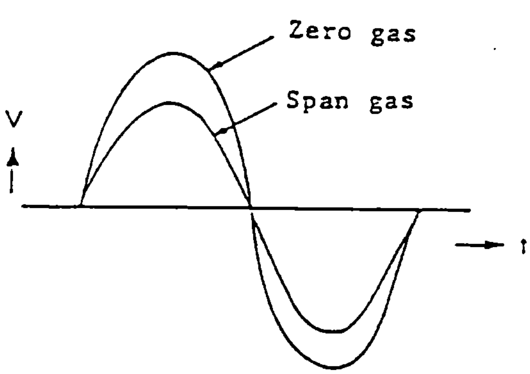


Figure 8: Single Beam NDIR Analyzer



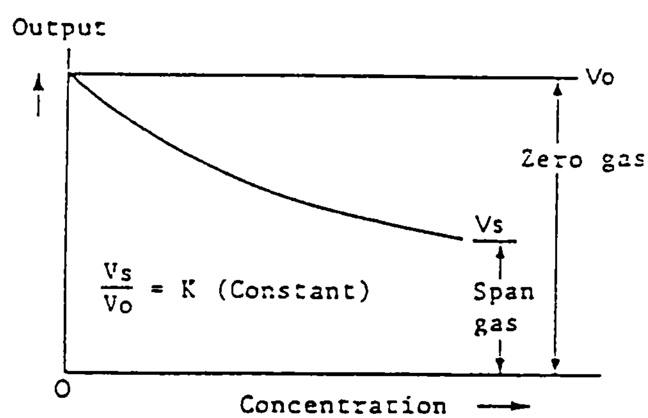


Figure 9: Output Signal of the Detector

Figure 10: Absorption Characteristic of the Detector

SECTION V

FUNCTIONAL DESCRIPTION (Refer to Figure 11, page 28)

OPTICAL BENCH

The Analyzer utilizes a beam of infrared energy which passes first through a Sample Cell, and then through both cells of a Dual-Cell Detector system (see Figure 8). The Detector cells are filled with pure gas of the type to be measured. The infrared beam is selectively attenuated in the Sample Cell by spectral absorption lines from the unknown concentrations of gas. The remaining unabsorbed energy passes on into the front and rear cells of the Detector, where further selective spectral absorption takes place in the gas contained within the cells. Absorption in the Detector cells causes slight heating and expansion of the gas in the two cells. Since the amount of energy reaching the rear cell is less that that reaching the front cell, the expansion is unequal and a measured small gas flow takes place between the two cells (see Figure 10).

Presence of the measured gas in the Sample Cell results in some absorption of the beam energy prior to entering the Detector cells. With this lower level of energy in the spectral range of the gas, less gas expansion occurs in the dual cells, with a resulting smaller gas flow. A rotating chopper blade interrupts the infrared beam. The measured gas flow rate pulses in step with the blade rotations, and is electronically processed to develop the gas concentration reading.

A chopper blade rotates between the infrared source and the Sample Cell. This interrupts the infrared beam at regular intervals. As a result, the beam falling upon the detector cells is pulsed. The pressure within, and the slight flow between the dual cells, also rises and falls regularly in synchronism with the rotations of the chopper. This slight rhythmic flow is detected and converted into an AC electrical signal by a mass-flow sensor in the connecting channel between the cells. This AC signal is amplified and demodulated into a DC voltage supplied to a Front Panel Indicator and to output terminals for driving external controllers and/or recorders.

Figure 9 shows a typical output signal from the Detector. The signal is largest when Zero Gas is flowing through the Sample Cell, and reduces as the concentration of the measured gas increases. The single-beam optical system design significantly reduces span drift due to ambient temperature changes. The span of the instrument can be calibrated by first adjusting the Zero Level while flowing Zero Gas. The condition of the instrument can then be checked by applying to the front end of the amplifier chain, an electrical signal equivalent to the Span Gas Level. A

START-UP AND ROUTINE MAINTENANCE

1. **Sampling System:** Prepare and check the Sampling System. Adjust the flow of Sample Gas to about 2 scfh (1 liter/min. The instrument should show a Meter indication. The Models 3300 and 3400 Gas Analyzers are designed for extended operation and may be left switched ON continuously.

2. **Zero and Span Calibration:** Zero Level, and Span Adjustment, using the Span Check Control should be checked daily.

   A. Check the Zero Level while flowing Zero Gas, and readjust if necessary, using the Front Panel Zero Control.

   B. Depress the Span Check switch while the Zero Gas is still flowing. After the Indicator has stabilized, compare the reading with the earlier recorded value. If the output drift exceeds the allowable range, readjust the Span Control to obtain the prerecorded reading.

   Zero and Span should be checked, using Zero and certified Span Gas, (see page 15) at least once a month.

3. **Sample Cell:** Dust, water droplets, or mist entering the sample cell may cause drift due to contamination. If the Front Panel Zero Level Control(s) fails to bring the Pointer to the Zero mark, check the Sample Cell for contamination. (For cleaning of the Sample Cell, see page 31 and/or 33). Also check the sampling system and sampling filters.

OPERATION

1. **Power On:** Turn ON the Power Switch on the Front Panel. The Power Indicator Lamp should illuminate. The Indicator Meter Pointer should flicker in both directions, stabilizing at the Zero position. Allow the instrument to warm up for approximately two hours. It is preferable, but not essential, that Zero Gas flow through the instrument during warm up.

2. **Zero Adjustment:** After the two-hour warm up period, and after the Indicator Pointer Stabilizes, flow Zero Gas through the instrument Sample Cell at a rate of about 2 scfh (1 liter/min). Adjust the zero Control on the Front Panel until the Indicator Pointer (or Recorder reading, if an external Recorder is attached) is exactly on the Zero mark. For the Model 3400 repeat this procedure for the second gas.

NOTE

For the Model 3400, the Front Panel Indicator Meter only displays readings for one gas at a time. The Indicator Gas Selection switch must be correctly positioned during the adjustment and set-up procedures.

3. **Span Adjustment:** Flow Span Gas through the instrument at about 2 scfh (1 liter/min). After the Indicator Pointer stabilizes, adjust the Span Control on the Front Panel until the Indicator Pointer, or Recorder, reading is at the value specified for the Span Gas concentration.

   For Model 3400, repeat the procedure for the second Channel Span Gas. It is not important which gas is set up first.

4. **Span Check:** Flow Zero Gas through the instrument. when the Span Gas has been completely purged from the sample cell, depress the span Check switch. After the Indicator Pointer stabilizes, record the Indicator Pointer reading (and also the Recorder reading, if connected).

NOTE

This value will be required for later reference (see below).

For the Model 3400, repeat this procedure for the second gas.

PREPARATION FOR OPERATION

1. Check that the external plumbing and wiring have been connected correctly, as described in Section III of this manual.

2. **Response Time:** Electrical system response time for 90% indication is selectable (for Model 3400 independently for each gas) at 2, 3, or 5 seconds. The instrument is set to 2 seconds when delivered. The response time may be changed by modifying the wiring to connector CN5 (see Figure 21, page 61) on the Main circuit Board (and CN5 see Figure 22, page 62, on the second gas board for Model 3400).

Response Time (seconds)	Circuit Board Connection
2	Fa to F1, & Fb to F4
3	Fa to F2, & Fb to F5
5	Fa to F3, & Fb to F6

3. **Output Range Selection:** The instrument may be adjusted to provide at one pair of its output terminals (or one pair of terminals for each gas in the Model 3400), one of four type of output signals. The selection is made by modifying the wiring to connector CN6 (see Figure 21, page 61) on the Main Circuit Board (and CN5, see Figure 22, page 62 on the second gas board for Model 3400).

Selected Output	Circuit Board Connection
0 to 1 V	E0 to E4
0 to 100 mV	E0 to E3
0 to 10 mV	E0 to E2
4 to 20 mA	E0 to E1

4. **Fuse:** Check that the fuse holder contains a 1 A fuse.

5. **Purging:** When the instrument is installed at sites where corrosive or combustible gases, or high concentrations of CO_2 are present, the instrument must be purged. Purging takes approximately one hour. The procedure is described in Section III (see page 16).

6. **Zeroing the Front Panel Indicator:** With the Power OFF, check that the Front Panel Indicator Meter is reading Zero. If the Pointer is off the Zero mark, use a small flat-bladed screw driver to adjust the Mechanical Adjustment Screw. (Item 2 in Figures 3 and 4, page 18).

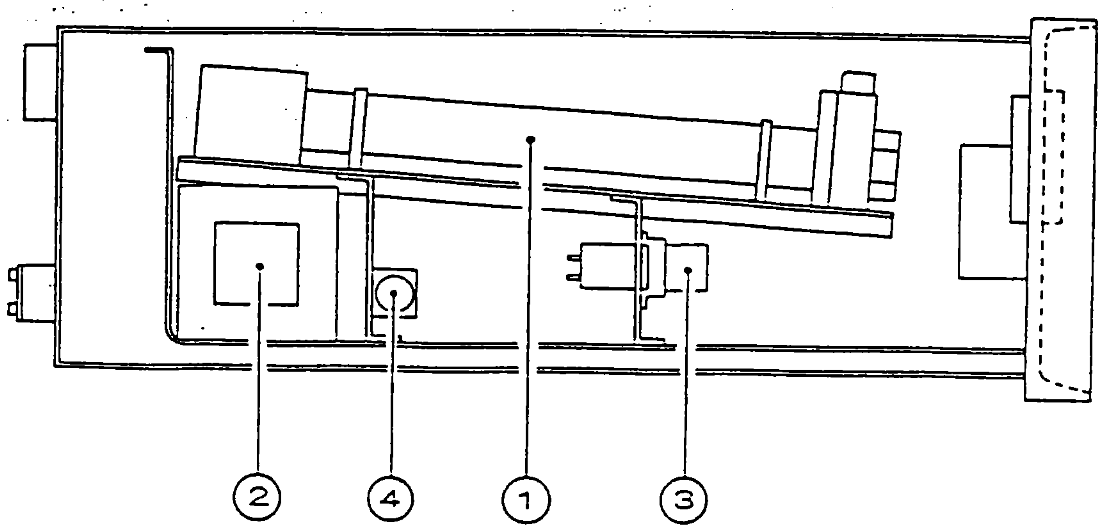


Figure 7: Major Internal Components - Optical Bench Side. (Shown with cover removed).

Major Internal Components - Optical Bench Side.
(Numbers refer to annotations in Figure 7).

1. **Measuring system of the Analyzer:** See page 25 for details.

2. **Power Transformer:**

   Supplies AC power to all circuits.

3. **Electrolytic Capacitors:**

   Part of Power Supply circuits.

4. **AC Power Line Fuse (1 Amp):**

MAJOR INTERNAL COMPONENTS

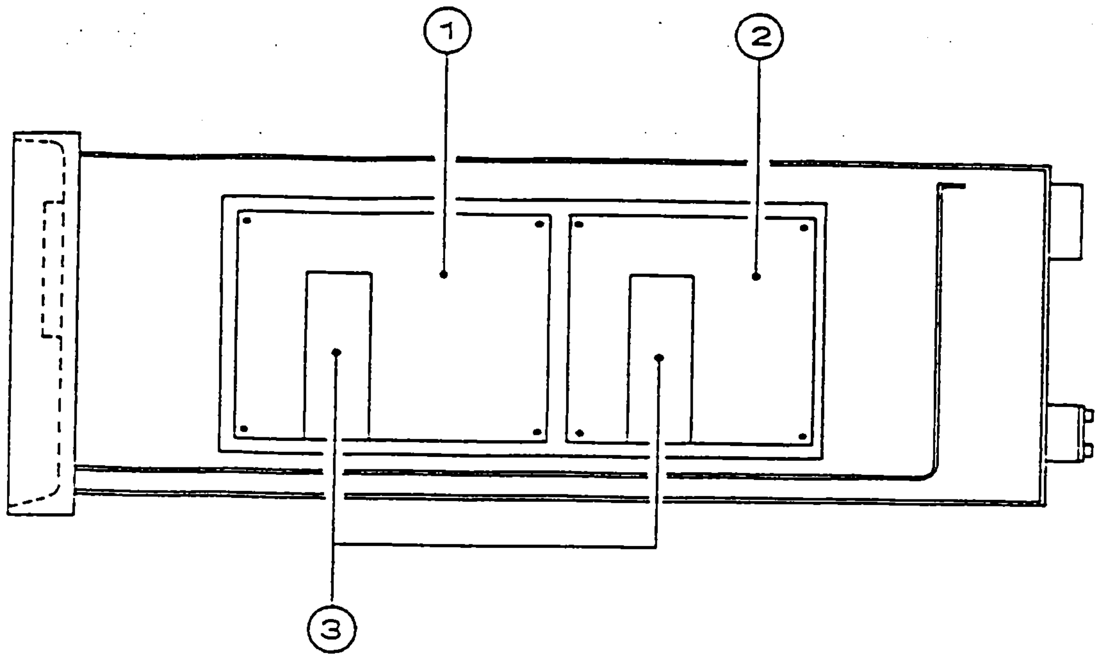


Figure 6: Major Internal Components - Circuit Board Side. (Shown with cover removed).

Major Internal Components - Circuit Board Side (Numbers refer to annotations in Figure 6).

1. **Main Circuit Board:**

   Includes components for processing gas measurements. (For Model 3400, first gas only).

2. **Second Gas Circuit Board:**

   Appears in Model 3400 only. Includes components for processing second gas measurements.

3. **Linearizer Circuit Board:**

   Used to linearize output measurements. Two provided in Model 3400.

IDENTIFICATION OF CONTROLS, INDICATORS AND MAJOR COMPONENTS (Continued)

13. Nameplate for first gas.

14. Nameplate for second gas.

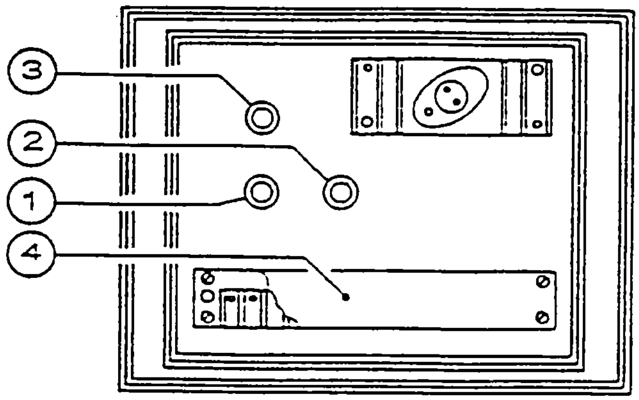


Figure 5: Rear Panel, both models

Rear Panel
(Numbers refer to annotations of Figure 5).

1. **Sample gas inlet:**

   Feeds Sample Gas to the Analyzer. Threaded 1/4-18 NPT.

2. **Sample Gas outlet:**

   Exhaust for Sample Gas. Threaded 1/4-18 NPT.

3. **Purge Gas inlet:**

   For feeding Purge Gas into the instrument, when required. See page 16. Threaded 1/4-18 NPT.

4. **Terminal block for external wiring:**

   See Figure 1, and page 13, Electrical Installation.

IDENTIFICATION OF CONTROLS, INDICATORS AND MAJOR COMPONENTS (Continued)

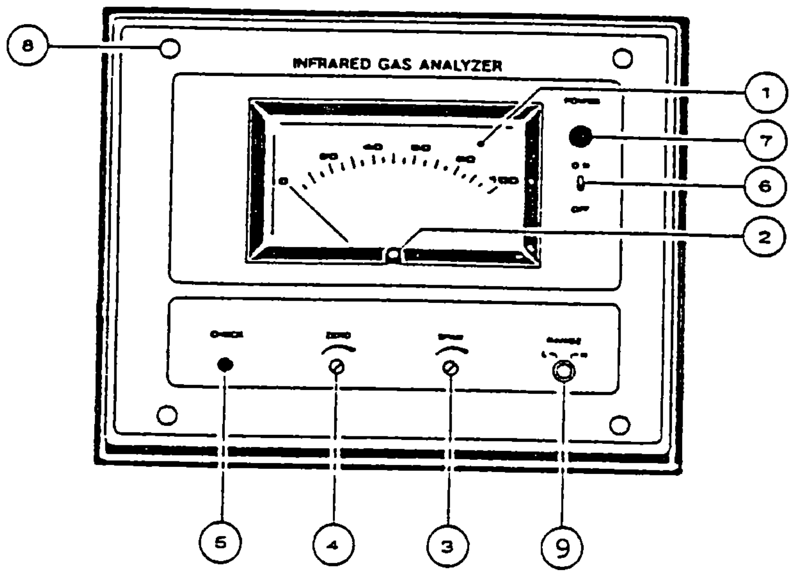


Figure 3: Front Panel Model 3300

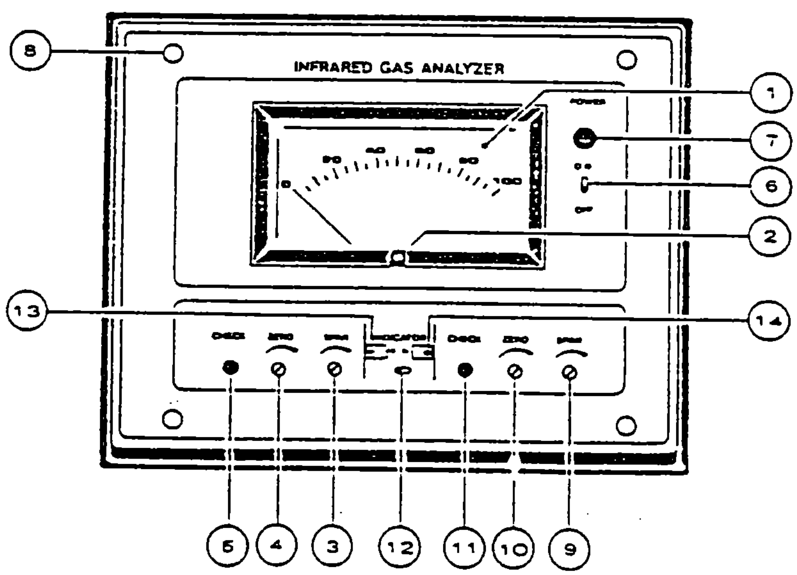


Figure 4: Front Panel Model 3400

SECTION IV

CALIBRATION AND OPERATION

IDENTIFICATION OF CONTROLS, INDICATORS AND MAJOR COMPONENTS

Front Panel
(Numbers refer to annotations on Figures 3 and 4).

1. **Indicator:** Displays analyzer output.

2. **Indicator Zero Set:** Allows mechanical adjustment of indicator pointer to zero.

3. **Span Set Control:** Sets span of instrument. (First gas for Model 3400 Adjusted while Span Gas is flowing, or after depressing the Span Check Switch, with Zero gas flowing through instrument).

4. **Zero Set Control:** Sets electrical Zero level of instrument. Adjusted while Zero Gas is flowing through instrument.

5. **Span Check Switch:** Depressing push-button switch provides synthesized electrical span output to test span circuits.

6. **Power ON/OFF switch:** Turns ON/OFF line power to instrument.

7. **Power ON indicator:** Illuminated while line power is energizing instrument.

8. **Front Panel Retaining Screws:** Four screws holding front panel to instrument casing.

Model 3300 only: (Figure 3)

9. **Range switch:** Allows selection of higher or lower sensitivity measurement ranges.

Model 3400 only: (Figure 4)

9. Span Set Control for second gas.

10. Zero Set Control for second gas.

11. Span Check Switch for second gas.

12. Gas Selector Switch for Direct Reading Indicator.

    Left position - first gas
    Right Position - second gas

SAMPLING CONNECTIONS (Continued)

NOTE

* Teflon is a trademark of DuPont.

3. **Presence of corrosive gases:**

Useful service life of the instrument will be shortened if high concentrations of corrosive gases such as Cl_2, F_2, HCl, etc. are present in the sampled gas.

4. **Gas Temperature:**

When measuring high temperature gases, take care that the maximum rating of the instrument 122 F (50 C) is not exceeded.

5. **Flow rate:**

The gas entering the instrument should flow at a rate of 2 +/- 1 scfh (1.0 + 0.5 liters/min.).

6. **Influence of Atmospheric CO_2 and Purging:**

When measuring low levels of CO_2, the atmospheric CO_2 at the installation site must be constant and at a minimum. Atmospheric CO_2 can penetrate the instrument resulting in measurement errors. When a source of CO_2 is located near the instrument site, or atmospheric concentration varies widely, the instrument should be purged with instrumentation air or N_2. The purging gas must be dry and dust-free and should flow at about 2 scfh (1 liter/min.). A purging gas inlet (1/4-18 NPT) is located on the rear panel.

7. **Sample Gas Outlet:**

A sample gas outlet connector is located on the rear panel (1/4-18 NPT). Pressure at this outlet should be kept at the atmospheric level. If a back pressure does occur, the Zero and Span settings will have to be adjusted for that specific pressure level. This gas should be vented away from the instrument.

GASES

1. Nitrogen (Zero Gas) in pressurized cylinder.
2. Standard Span Gas(es) near full scale concentration with a nitrogen balance, in a pressurized, certified cylinder.

GAS HANDLING EQUIPMENT

1. Pressure regulators for Zero and Span Gas Cylinders.
2. Flow meter, 0 to 5 scfh (standard cubic feet per hour).
3. Corrosive - resistant gas tubing.

GAS CONNECTIONS

The tubing from the sampling system to the Gas Analyzer should be made from corrosive-resistant material such as Teflon *, Stainless steel, or polyethylene. Even when the gases being sampled are not corrosive themselves, rubber or soft vinyl tubing should not be used, since readings may be inaccurate due to gas absorption into the piping material. To obtain fast response, the tube should be as short as possible. Optimum tube internal diameter is 0.16 inch (4 mm). Couplings to the instrument are 1/4-18 NPT.

NOTE

Be sure tubing and joints are Clean. Dust entering the instrument may cause it to malfunction.

SAMPLING REQUIREMENTS

1. **Filtration:**

   Dust must be eliminated completely. Use filters as necessary. The final filter must be capable of removing particles larger than 0.3 micron.

2. **Condensation:**

   Dew point of the sample gases must be lower than the ambient temperature to prevent accidental condensation within the instrument. When water vapor is present, pass the sample through a dehumidifier to reduce the dew point to about 0 C.

   If the sample contains an acid mist, use an acid-mist filter, cooler or similar device to remove all traces of the mist.

INSTALLATION (Continued)

ELECTRICAL (Continued)

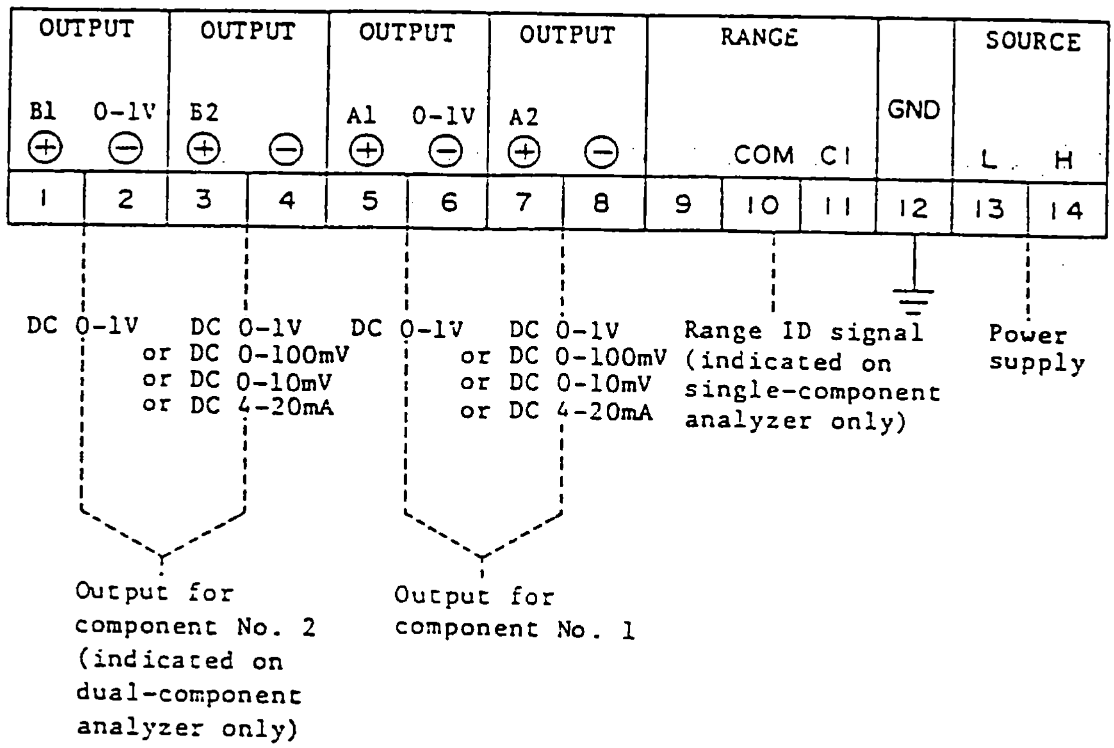


Figure 1: External Wiring Connections

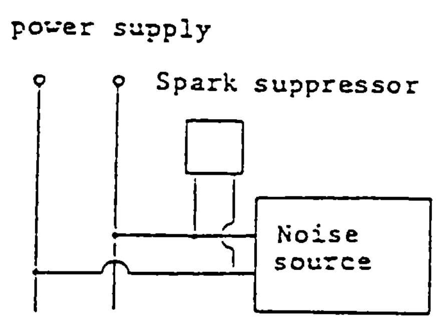


Figure 2: EMI Noise Control

NOTE: (The Spark Suppressor must be placed close to the noise source).

INSTALLATION (Continued)

ELECTRICAL

All wiring is connected to the terminal block at the rear of the instrument. Remove the protective cover and connect wiring as shown in Figure 1. The 115 VAC, 60 Hz power are connected to Terminals 13 and 14. A Safety Ground Line must be connected to Terminal 12.

NOTE

A defective ground may affect the operation of the instrument.

Terminals 5, 6, 7, and 8 are the output signals (for Model 3300, these are the output signals for the first gas, see below). Terminals 5 and 6 are a 0 to 1 Volt signal corresponding to the concentration of the gas being measured. Terminals 7 and 8 are DC outputs that can be internally selected (see page 23) from any of four ranges: 0 to 100mV; 0 to 10 mV (all into a 100 ohm or greater load resistance); or 4 to 20 mA into a 550 ohm or less load resistance.

Terminals 1, 2, 3, and 4 of the Model 3400 provide similar outputs for a second gas. Terminals 1 and 2 are the 0 to 1 V signal, and Terminals 3 and 4 are the selectable output signal. The selectable output signals for each gas are independent.

NOTE

Shielded wiring is recommended for all output signals.

CAUTION

Electromagnetic Interference (EMI) may affect the operation of the instrument. Do not install the instrument in the vicinity of electrical noise (such as high frequency furnaces, electric welding machines, etc.). If the instrument must be installed at such locations, a separate power line must be used. Noise from a relay or solenoid valve should be controlled by the use of a spark suppresser (RC circuit) across the power wiring close to the component (see Figure 2.).

SECTION III

INSTALLATION

GENERAL

The instrument is designed for industrial applications. These installation instructions are for a typical site. Any questions regarding specific installation situations should be directed to the **Technical Service** Department, **ACS, Inc.**

SITE AND MOUNTING

NOTE

The following **precautions** must be carefully observed.

1. Select a site free from direct sunlight, radiation from a high temperature surface, or abrupt temperature variations.

2. When installed outdoors, shelter the instrument from wind and rain.

3. Select a site where the air is clean. Avoid exposing the instrument to corrosive or combustible gases.

4. The instrument must not be subject to severe vibration. If severe vibration is present, use isolation mounts.

5. The instrument is designed for panel-mounting. Mounting hardware is provided. The required panel opening is 8.12 x 6.12 inches (206 x 173 mm). See Figure 20.

   NOTE

   A rear supporting brace or equivalent is required.

6. Do not install near equipment emitting electromagnetic interference (EMI). See page 13.

INTRODUCTION (Continued)

SPECIFICATIONS (Continued)

Response Time:

For 90% indication:

Electrical system - 2, 3, or 5 seconds (selectable using internal jumper, see page 22).

Response to actual gas - 15 seconds maximum including time required to fill Sample Cell (depends on cell length) and sample flow rate.

Front Panel Indicator Meter: Linear divisions. A front panel switch allows selection of second range (3300) or a second gas (3400).

Output Signals:

Output 1: 0 to 1 VDC

Output 2: (internally selectable - see page 22)

a. Standard, 4 to 20ma (into 550 ohms or less)
b. or, 0 to 1 VDC (into 100 ohms or greater)
c. or, 0 to 100 mVDC (into 100 ohms or greater)
d. or, 0 to 10 mVDC (into 100 ohms or greater)

(Outputs 1 & 2 are available simultaneously for each range/gas.)

Internal Span Check:	Manually activated from front panel
Temperature Range:	23 to 113 F (-5 to +45 C)
Ambient Humidity:	Up to 90% relative humidity
Sample Gas Temperature:	32 to 122 F (0 to 50 C)
Sample Gas Flow Rate:	2 scfh (1 liter/min) (when required)

Materials of Construction: Parts in Contact with Gas Stream Measuring Cell - 304 Stainless Steel. Window - CaF_2. Tubing - Polyethylene.

Warm-up:	Two hours (to +/- 2% linearity)
Power Requirements:	115 VAC +/- 10%, 60 Hz, 30VA
External Dimensions:	7.9(H) x 9.8(W) x 21.3(D) inches (200 x 250 x 541 mm)
Weight:	24.2 lbs (11Kg)
Gas Connections:	Tapped 1/4-18 NPT

SPECIFICATIONS OF THE 3300 AND 3400 ANALYZERS

Measuring Principal: Non-dispersive Infrared (NDIR) single-beam method.

Measurable Gases and Ranges, 3300

Gases	Measuring Ranges
CO	0 to 2500 & 0 to 5000 ppm,
CO_2 & CO	0 to 500 & 0 to 1000 ppm,
CO_2, CO & CH_4	0 to 1000 & 0 to 2000 ppm,
	0 to 2000 & 0 to 5000 ppm,
	0 to 0.5 & 0 to 1.0%,
	0 to 1 & 0 to 2 %,
	0 to 2 & 0 to 5 %,
	0 to 5 & 0 to 10%,
	0 to 10 & 0 to 20%,
CH_4	0 to 1 & 0 to 3 %,

Measurable Gases and Ranges, 3400

Gases	Measuring Ranges
CO_2 & CO	0 to 1 % CO_2 & 0 to 3% CO
	0 to 1 % CO_2 & 0 to 5% CO
	0 to 20% CO_2 & 0 to 500 ppm CO
	0 to 20% CO_2 & 0 to 1000 ppm CO
	0 to 20% CO_2 & 0 to 1500 ppm CO
	0 to 20% CO_2 & 0 to 2000 ppm CO
	0 to 20% CO_2 & 0 to 5% CO

NOTE

For data on other gases and combinations of gases, contact our Application Engineers.

Repeatability: +/-0.5% of full scale

Zero Drift: +/-1% of full scale/24 hours
+/-2% of full scale per week

Span Drift: +/-1% of full scale/24 hours

Linearity: +/-2% of full scale

Noise Level: 0.5% of full scale

SECTION II

INTRODUCTION

The ACS Models 3300 and 3400 Analyzers are highly selective, non-dispersive infrared (NDIR) gas analyzers for measuring gas concentrations in industrial applications. The Model 3300 measures a single gas, while the Model 3400 simultaneously measures two gases. These analyzers use a single beam-type optical system and detector with a mass-flow sensor. This technology insures high reliability long-term stability, and excellent accuracy and repeatability, without frequent recalibrations.

The 3300 and 3400 feature dual-cell type detectors that are effective at minimizing the influence of interfering gases. An electrical span check system permits checking span from a front panel switch. The mass-flow sensors have a long service life, low noise level and excellent immunity to vibration. The individual components of the units are of simple design and modular for easy removal when servicing.

The contents of this manual include:

- Electrical specifications;
- Installation requirements, mechanical and electrical;
- Operation and calibration instructions;
- Description of the optical bench, with procedures for disassembly of its component parts;
- Explanation of the function of the electronic circuitry;
- Complete schematic circuit diagrams;
- List of field-replaceable component parts.

SECTION I

UNPACKING INSTRUCTIONS

Open the shipping container and carefully remove the Analyzer from the packing materials. Inspect the instrument for any sign of damage. Remove the Front Panel retaining screws (Item 8, figures 3 and 4. See disassembly instructions Section VI). Withdraw the chassis from the enclosure to the stop and visually check for loose parts or connectors that are not properly seated. If all internal components look normal, slide the chassis back into the case and replace the Front Panel screws.

REPORTING DAMAGE

Should there be any apparent damage to either the inside or outside of the instrument, due to shipping or handling, immediately notify the shipper. Shipping container or packing materials should be saved for inspection by the shipper.

LIST OF TROUBLESHOOTING CHARTS

LIST OF TABLES

LIST OF ILLUSTRATIONS (Continued)

LIST OF ILLUSTRATIONS

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TABLE OF CONTENTS

3300 and 3400 GAS ANALYZERS

INSTRUCTION MANUAL

This manual describes installation, calibration, and operation of ACS Models 3300 and 3400 Gas Analyzers.

To assure correct operation and accurate results, it is recommended that the user carefully read this document.

COLUMBIA SCIENTIFIC
/O # 10495
/16/91

MRC MODEL 3300 NDIR

RANGE "L":	
RANGE "H":	1000 ppm CO
SERIAL NO:	N1A5202T
CELL LENGTH:	250 mm
DETECTOR:	AB120090, CO-L, 6.79V
AMPLIFIER GAIN SET:	G-5

CALIBRATION DATA

CAL. CYL. SPEC.: 1000 ppm CO

ELECT. SPAN CHECK SET RANGE "L":

ELECT. SPAN CHECK SET RANGE "H": .460 VOLTS

CAL. CYL. %	CONCENTRATION PPM	CALCULATED OUTPUT (VOLTS)	ACTUAL LINEARIZER VOLTS IN	ACTUAL LINEARIZER VOLTS OUT
100	1000	1.0	1.58	1.000
90	900	.9	1.49	.904
80	800	.8	1.38	.803
70	700	.7	1.27	.700
60	600	.6	1.14	.602
50	500	.5	1.006	.506
40	400	.4	.848	.408
30	300	.3	.673	.306
20	200	.2	.476	.205
10	100	.1	.255	.104
0	0	0	0	0

COLUMBIA SCIENTIFIC
S/O # 10495
7/16/91

MRC MODEL 3300 NDIR

RANGE "L":	500 ppm CO
RANGE "H":	
SERIAL NO:	N1A5202T
CELL LENGTH:	250mm
DETECTOR:	AB120090, CO-L, 6.79V
AMPLIFIER GAIN SET:	G-5

CALIBRATION DATA

CAL. CYL. SPEC.:	1000 ppm CO
ELECT. SPAN CHECK SET RANGE "L":	.580 VOLTS
ELECT. SPAN CHECK SET RANGE "H":	

CAL. CYL. %	CONCENTRATION PPM	CALCULATED OUTPUT (VOLTS)	ACTUAL LINEARIZER VOLTS IN	OUT
50	500	1.0	1.000	1.001
40	400	.8	.839	.798
30	300	.6	.664	.600
20	200	.4	.468	.398
10	100	.2	.248	.202
0	0	0	0	0

COLUMBIA SCIENTIFIC
/O # 10495
7/18/91

MRC MODEL 3300 NDIR

RANGE "L":
RANGE "H": 20% CO_2
SERIAL NO: N1A5211T
CELL LENGTH: 8mm
DETECTOR: AB120079, CO2-H, 5.5V
AMPLIFIER GAIN SET: G-2

CALIBRATION DATA

CAL. CYL. SPEC.: 25% CO_2

ELECT. SPAN CHECK SET RANGE "L":

ELECT. SPAN CHECK SET RANGE "H": .419 VOLTS

CAL. CYL. %	CONCENTRATION PPM	CALCULATED OUTPUT (VOLTS)	ACTUAL LINEARIZER VOLTS IN	OUT
80	20	1.00	1.350	.999
70	17.5	.875	1.281	.875
60	15.0	.750	1.200	.750
50	12.5	.625	1.103	.611
40	10.0	.500	.986	.483
30	7.5	.375	.842	.362
20	5.0	.250	.658	.242
10	2.5	.125	.407	.122
0	0	0	0	0

COLUMBIA SCIENTIFIC
S/O # 10495
7/18/91

MRC MODEL 3300 NDIR

RANGE "L": 10% CO2
RANGE "H":
SERIAL NO: N1A5211T
CELL LENGTH: 8mm
DETECTOR: AB120079, CO2-H, 5.5V
AMPLIFIER GAIN SET: G-2

CALIBRATION DATA

CAL. CYL. SPEC.: 10% CO2

ELECT. SPAN CHECK SET RANGE "L": .843 VOLTS

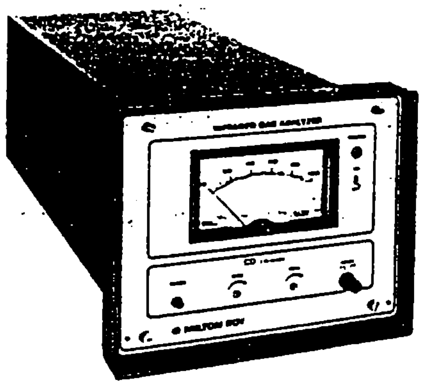
ELECT. SPAN CHECK SET RANGE "H":

CAL. CYL. %	CONCENTRATION PPM	CALCULATED OUTPUT (VOLTS)	ACTUAL LINEARIZER VOLTS IN	OUT
100	10%	1.00	1.000	.998
90	9%	.9	.945	.904
80	8%	.8	.885	.801
70	7%	.7	.819	.692
60	6%	.6	.746	.600
50	5%	.5	.667	.498
40	4%	.4	.574	.398
30	3%	.3	.471	.306
20	2%	.2	.350	.198
10	1%	.1	.202	.117
0	0	0	0	0

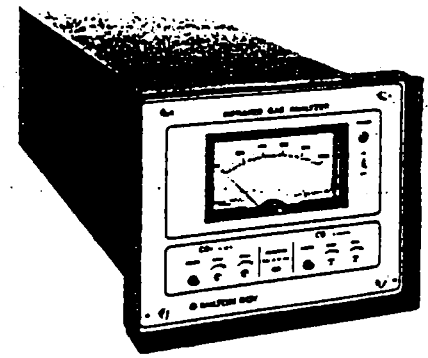
MILTON ROY

INFRARED GAS ANALYZER

MODELS 3300 & 3400



Model 3300
Single Component Dual Range



Model 3400
Dual Component Single Range

No optical or mechanical adjustments ■

Single beam optics ■

nalog or ig Readout ■

Modular nstruction for maintenance ■

sensitivity to vibration ■

The simplicity of single beam optics design — made possible by the Microflow Detector — results in highly stable, reliable analyzers of unmatched analytical performance, requiring no optical adjustments and only the simplest maintenance.

Principle of Operation

The analyzer uses a technique based on the infrared absorption characteristics of gases to measure gas concentration. Use of an efficient single beam design results in good long-term stability.

A single beam of infrared energy is modulated and passed through a sample cell containing the gas to be measured. The beam emerges attenuated by the amount of energy absorbed by the gas(es) in the sample. Changes in the concentration of the gas(es) result in changes of the intensity of the beam. The remaining energy in the beam is passed serially through two cavities of an infrared detector, a mass-flow sensor filled with gas of the type to be measured.

Changes in the intensity of the beam change the pressure differential between the cavities and consequently the balance of the electrical bridge in the detector circuit.

Electronic processing and linearization of the imbalance signal are used to generate an electrical output signal linearly proportional to the concentration of the gas measured.

Sample Applications

Combustion Efficiency
- Burners & Boilers (CO, CO_2)
- Commercial Ovens (CO, CO_2)

Controlled Atmospheres
- Heat treating (CO, CO_2, CH_4)
- Greenhouses (CO_2)
- Fermentation (CO_2)
- Air Liquification (CO_2)

Process Chemical Gas Analysis

Respiration Studies
- Single Breath Lung Diffusion (CO)

Stack Gases

Total Organic Carbon Analysis (TOC)

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PROCESS & ENVIRONMENTAL INSTRUMENTS DIVISION

5. Repairs, replacements, adjustments and service performed out-of-warranty shall be charged to the customer at the then current prices for parts, labor, transportation and subsistence.

6. This warranty attaches to the instrument itself and is not limited to the original purchaser.

7. In no event will CSI have any obligation or liability for damages, including but not limited to, consequential damage arising out of, or in connection with, the use or performance of equipment or accessories. No other warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose will apply to equipment or accessories.

8. This warranty constitutes the full understanding of the manufacturer and buyer, and no terms, conditions, understanding or agreement professing to modify or vary the terms hereof shall be binding unless hereafter made in writing and signed by an authorized official of CSI.

All price revisions and design modification privileges reserved.

WARRANTY

1. Except as otherwise indicated, all instruments and stack systems manufactured and sold by Columbia Scientific Industries Corporation (CSI) are guaranteed for a period of one year from date of shipment from the factory against defects in materials and workmanship of those parts manufactured by CSI, and then, only when operated, serviced and maintained in accordance with the instruction manual. Those parts not manufactured by CSI are guaranteed only to the extent that they are covered by a warranty of original manufacturer. Permeation tubes are warranted for six (6) months. Spare parts and accessories, except expendables, are warranted for ninety (90) days. Expendables such as batteries, sample holders, fuses and indicating lamps are not covered by this warranty.

2. The warranty is voided by the following:

a) Injection into CSI stack systems or CSI ambient air monitoring or calibrating equipment, of gas mixtures containing reactive suspended matter or molecules yielding and depositing liquids, tars, solids and other non-gaseous residues.

b) Injection of caustic solutions into the hydrogen lines of CSI hydrocarbon monitors by a malfunctioning hydrogen generator.

c) Damage to CSI Accelerating Rate Calorimeters or Quantitative Reaction Calorimeters caused by samples that detonate, deflagrate or otherwise escape the confines of the sample holder.

d) Damage to stack sampling probes caused by severe corrosion.

e) Damage caused by incorrect installation, by misuse, or by mishandling.

3. Warranty service requests must be received by CSI within the warranty period. Upon notification by the purchaser, CSI will correct defects coming within the scope of this warranty by repairing or replacing the defective unit either at the CSI factory or at the customer's site, at CSI's option. Return shipment of items to CSI must be authorized by a CSI representative and is at customer's expense.

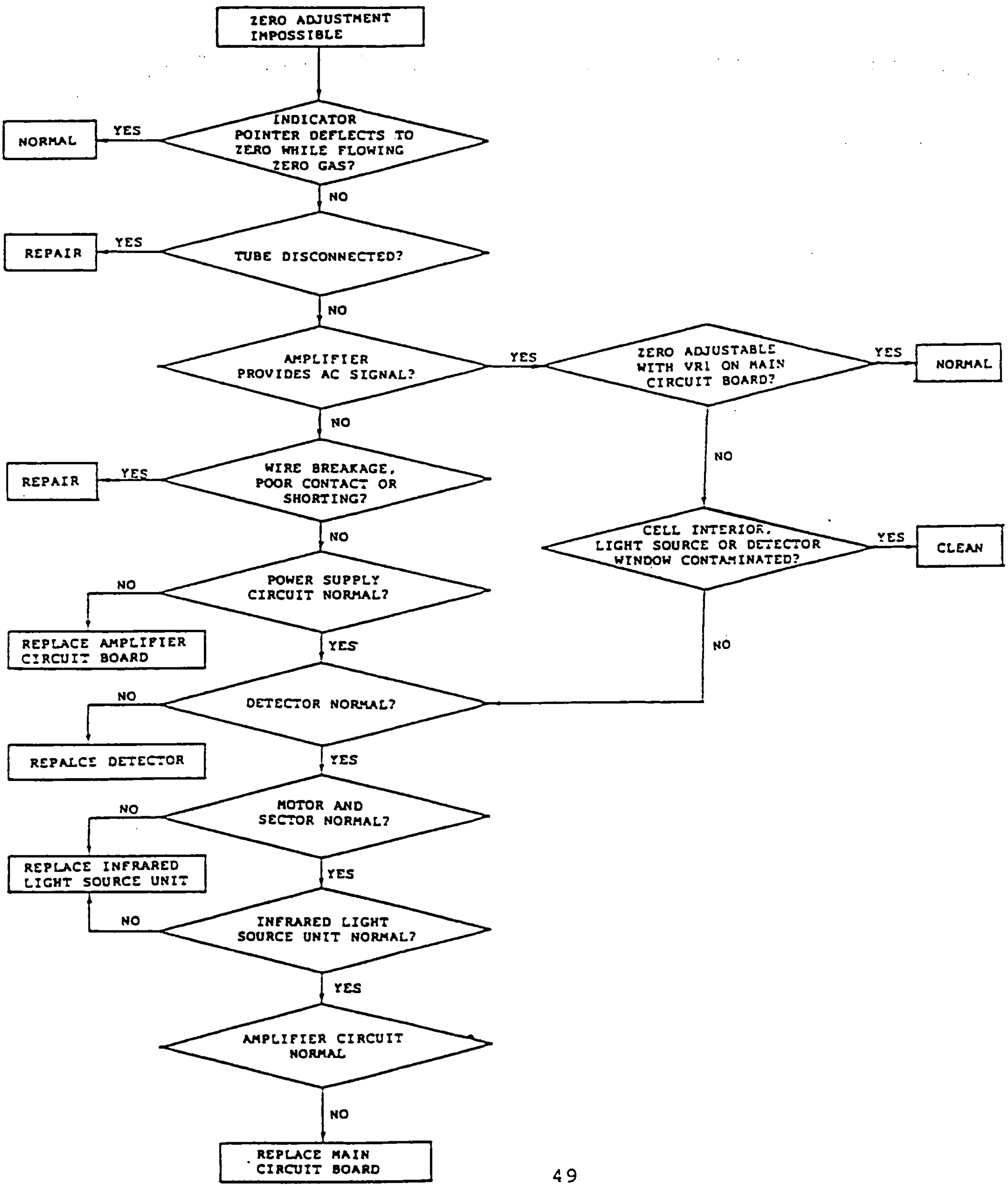
4. Instruments and systems which have been repaired or replaced during their warranty period are themselves guaranteed for only the remaining unexpired portion of their original warranty period. Parts and accessories, including stack probes, umbilicals and permeation tubes, will receive their full warranty period from the date of replacement even if the instrument or system warranty period should expire.

7. WARRANTY

The Warranty Statement appears on the following two pages.

TROUBLESHOOTING CHARTS (Continued)

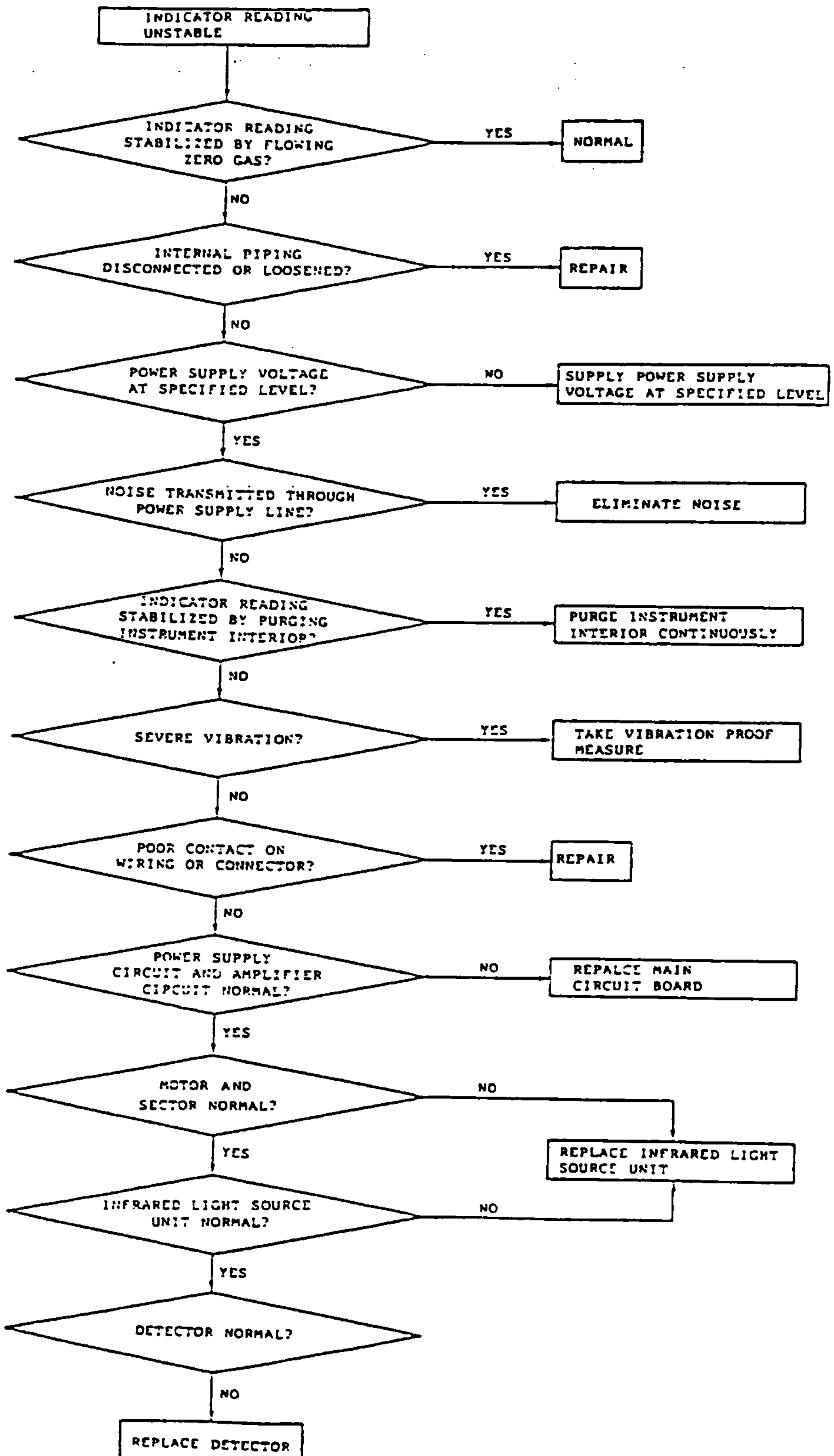
Chart 2: Unable to Adjust Front Panel Zero



TROUBLESHOOTING GUIDE (Continued)

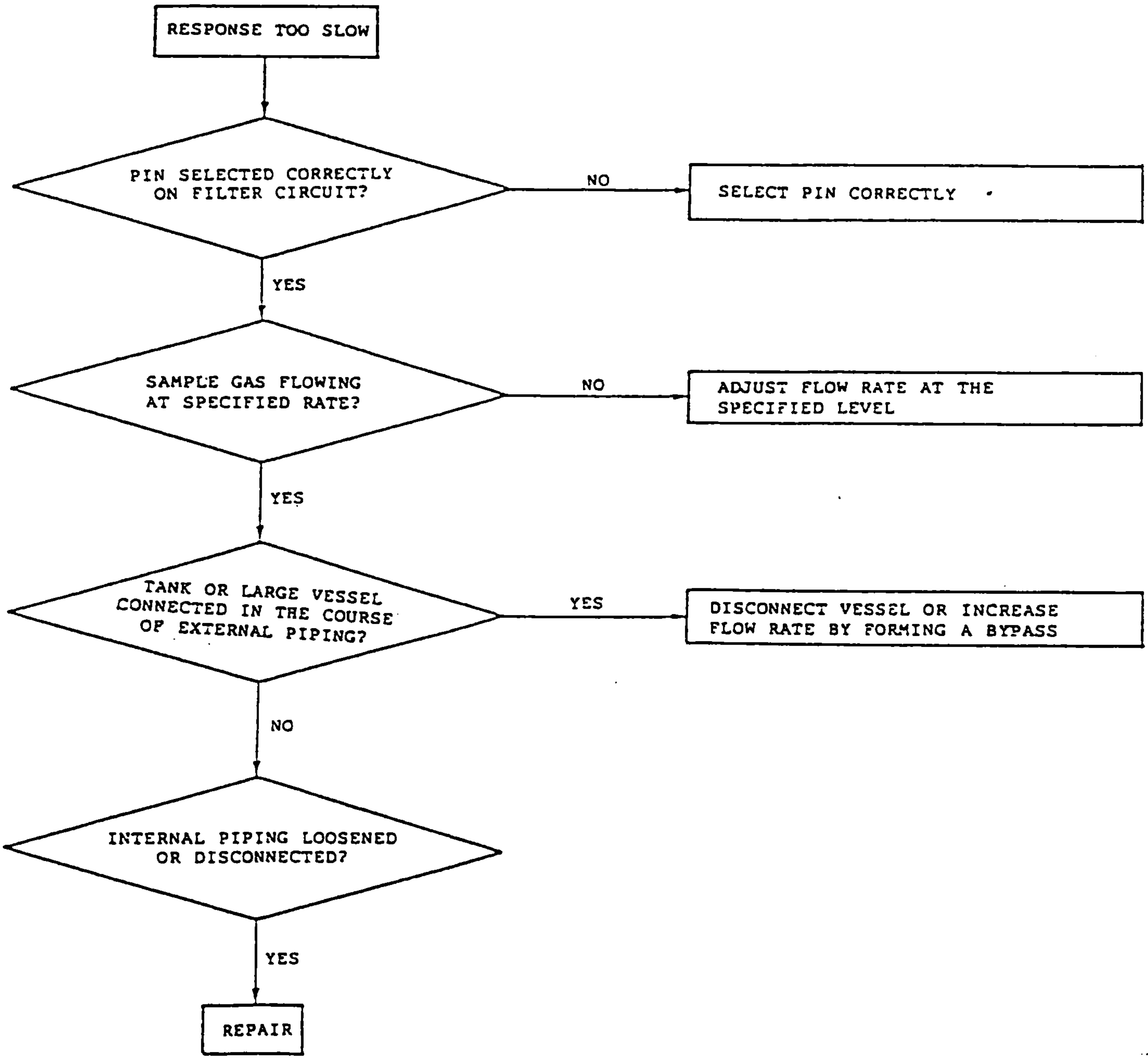
TROUBLESHOOTING CHARTS (Continued)

Chart 3: Unstable Indicator Readings



TROUBLESHOOTING CHARTS (Continued)

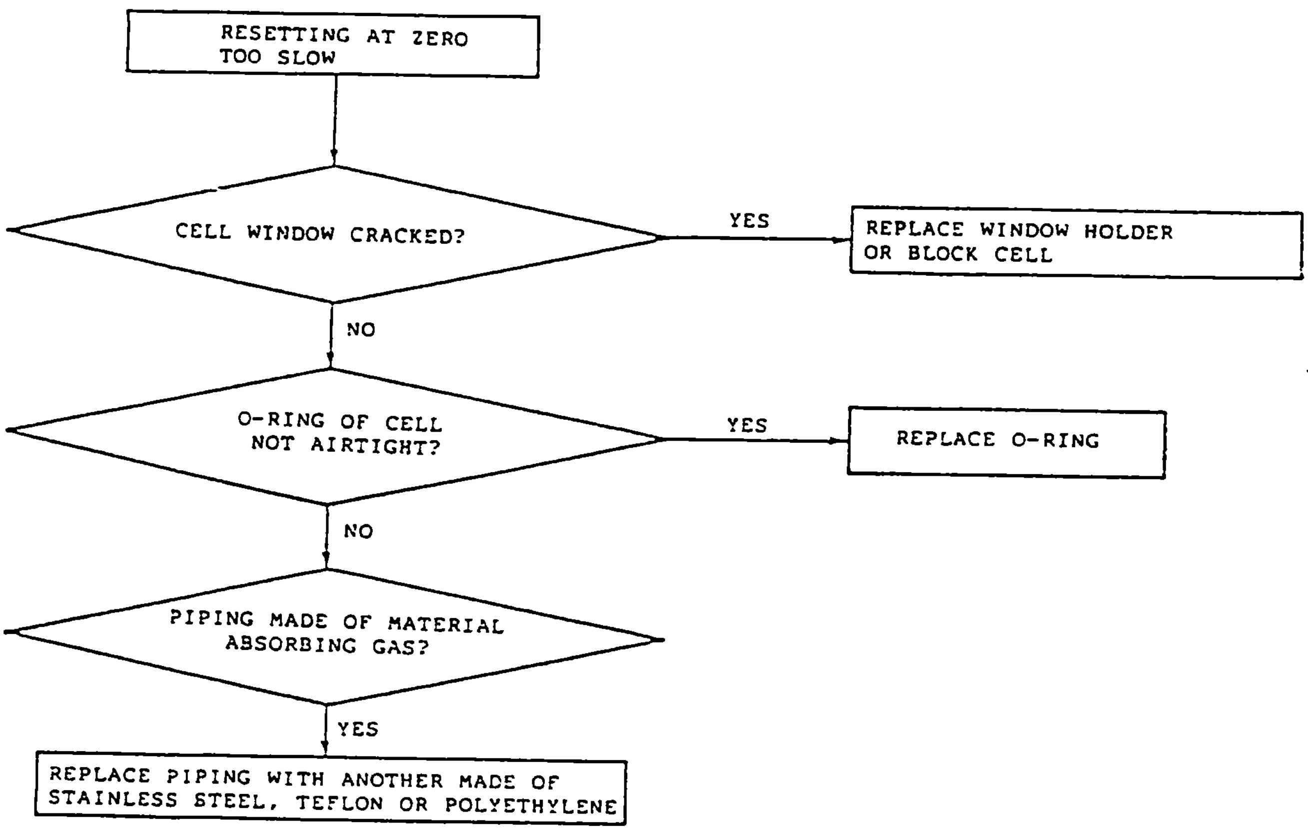
Chart 4: Response Too Slow



TROUBLESHOOTING GUIDE (Continued)

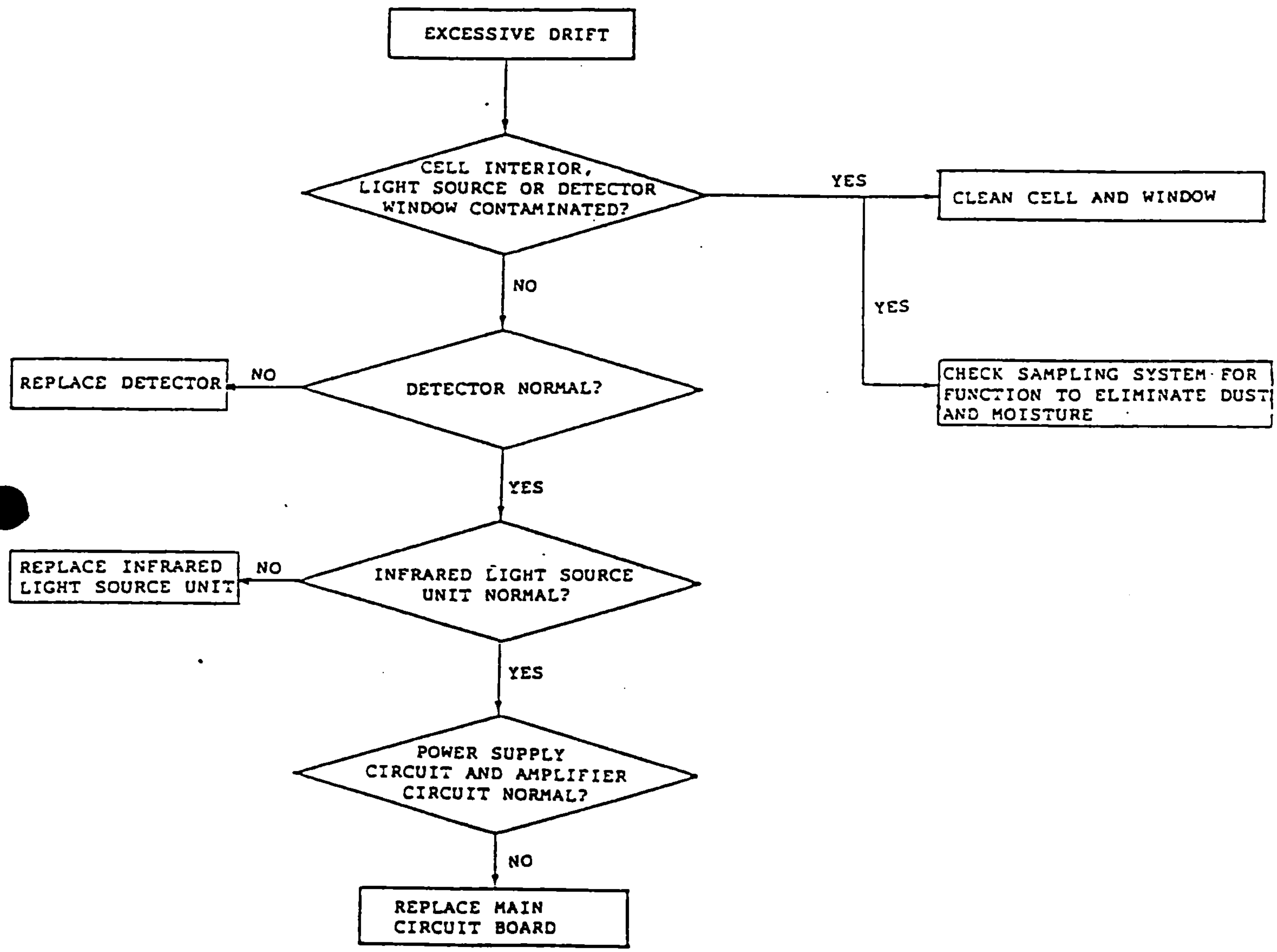
TROUBLESHOOTING CHARTS (Continued)

Chart 5: Resetting at Zero Too Slow



TROUBLESHOOTING CHARTS (Continued)

Chart 6: Excessive Drift



TROUBLESHOOTING GUIDE (Continued)

CHECK OUT AND REPAIR

1. **Detector**
   (Refer to Item 15 of Figure 12)

   Symptom: Unable to adjust Front Panel Zero

   Trouble: Mass flow sensor damaged, Bridge Resistor defective, or Detector leaking gas.

   Tests:

   a. The mass flow sensor and Bridge Resistor (Item 1 16 in Figure 12) are normal when DC voltages of about 1.5 to 2.0 V appear between Terminals 1 and 3, and 2 and 3, on the bridge circuit board. These two voltage readings should be within 0.1 V of each other.

   b. Connect an oscilloscope between Test Points A1 and M2, on the Main Circuit Board. If readings in "A" above are normal, but an AC waveform (of about 10 Hz is not seen at A1, then the gas is probably leaking from the Detector. Detector should be replaced.

   c. If the voltage readings in "A" above are not normal, turn OFF the Power Switch. Uncouple the Detector connector CN1, and disconnect the bridge resistor.

   Test the resistance value of the mass flow sensor by measuring the resistance between the Terminals 1 and 3, and 2 and 3, on the Bridge Circuit Board. If the reading is between 25 and 50 ohms, the mass flow sensor is normal and the Bridge Resistor is probably defective. If the value approaches infinity, the sensor is defective and should be replaced.

Replacement:

a. To replace the Detector Assembly with a new unit refer to Figure 12. With instruments using a Pipe type Sample Cell, the Detector is retained by screws from the bottom. It is necessary to first remove the entire Optical Bench.

b. After replacing the Detector, adjust the detector voltage to the specified value. Readjust Zero and Span.

CHECKOUT AND REPAIR

2. **Infrared Light Source**
(Item 5 in Figure 12, and Figure 13)

Symptom: Readings always negative or output unstable.

Trouble: Infrared Light Source defective or leaking gas.

Tests:

a. Turn the Power Switch OFF. Disconnect one lead from the two pin connector providing power to the Infrared Light Source. Measure the resistance across the Light Source. The reading should be about 38 ohms. If the reading approaches infinity, the Light Source is open. (The instrument output drifts in a negative direction as the resistance decreases).

b. The Indicator may also drift due to gases from the atmosphere leaking into the Light Source.

NOTE

Low concentration CO_2 analyzers may drift due to atmospheric CO_2 penetrating the gaps between the components of the Optical Bench. See page 16, "Influence of Atmospheric CO_2 and Purging".

Replacement:

a. Disconnect both leads from the two pin terminal block. Unplug the Chopper Motor connector. Remove the two screws retaining the Light Source Assembly to the base plate. Separate and replace the Light Source.

b. After replacement, readjust the Zero Level and Span Controls.

CHECKOUT AND REPAIR (Continued)

3. **Chopper**

Symptom: Indicator output unstable, or scale out of calibration.

Trouble: Rotation abnormal.

Tests:

a. Turn the Power Switch ON. Listen for rubbing noises as the blade rotates. Remove the Infrared Light Source and protective cover. If necessary, bend the blade slightly to prevent contact with adjacent component. Take care not to damage the blade as it is manufactured from very thin material. No adjustment is normally required.

b. With the Power ON, and the motor shaft does not rotate, disconnect the motor power supply connector and check that 100 VAC is being supplied to the connector. If present, check the motor shaft and rotor for contact with an adjacent part. If the motor rotates freely by hand, but still does not rotate under power, the motor itself is defective.

Replacement:

a. When the Chopper Motor is defective, the Light Source Assembly as a whole must be replaced.

4. **Sample Cell, Detector Window, & Infrared Light Source Window**

Symptom: Zero adjustment impossible.

Trouble: Cell or Window badly contaminated.

Test:

a. Remove the Sample Cell. Check the cell and Windows for contamination. If contamination is seen, carefully wipe off contaminant with a soft cloth soaked with alcohol. Take care not to injure the windows as they are very fragile. (See also Section VI, Disassembly Procedures).

5. **Tubing**

Symptom: Indicator reading unstable or response too slow.

Trouble: Tubing loosened, disconnected, or clogged.

Tests:

a. Firmly reconnect the disconnected or loosened tubing or connections.

b. With tubing disconnected from Sample Cell, use clean high pressure air to blow out restriction.

6. **Main Circuit Board**

A. **Power Supply Circuits**

Tests:

a. Output voltages from the Power Transformer should read approximately 18 VAC and 100 VAC (See Figure 26 or 27).

b. DC voltage on the aluminum electrolytic capacitor of the Power Supply should be approximately 22 V.

c. Positive Power Supply line voltage between Test Points A6 and M1 should be 14V +/- 0.05 VDC (See Figure 23).

d. Negative Power Supply line voltage between Test Points A7 and M1 should be -15 V +/- 1.0 VDC.

e. Detector Power Supply voltage between Test Points A8 and M1 should be the voltage level specified for that specific Detector.

B. **Amplifier Circuits**
(Refer to Figure 23 or 24)

Tests:

a. Verify the the power supply circuits are as specified above.

b. AC Amplifier:

1. Connect an Oscilloscope across Test Points A2 and M1 and observe the AC waveform. Flow Zero Gas and adjust VR1 for about 6V peak to peak (see Figure 18).

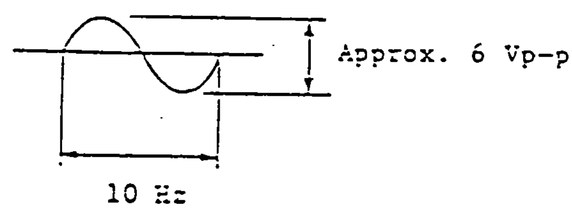


Figure 18: Test Waveform - AC Amplifier

2. If no signal is present at A2, or the signal is not as described in Figure 18, check between Test Points A1 and M1. A 10 Hz AC signal (V1) should be seen. If this is normal, then the AC amplifier Q1 is normal and the AC amplifier Q2 or VR1 is defective.

3. If an AC waveform is not seen across A1 and M1, measure the voltage Vd between Terminals 4 and 5 of the Bridge Circuit Board on the Detector Assembly. Compare with the voltage V1 measured between Test Points A1 and M1. If jumpers J1 to J2 and J4 to J5 are connected, V1 should equal Vd x 22. If J1 to J3 and J4 to J6 are connected, V1 should equal Vd x 100. If Q1 appears normal, check the Detector.

CHECKOUT AND REPAIR (Continued)

c. Demodulator Circuit

With Zero Gas flowing, the waveform across Test Points A3 and M1 should be as in Figure 19.

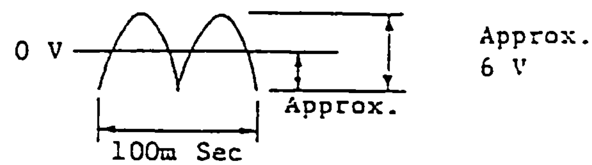


Figure 19: Test Waveform - Demodulator Circuit

d. Dc Amplifier Circuit

Flow Zero Gas and depress the Front Panel Span Check Switch. Voltage across Test Points A4 and M1 should be approximately 0.9 VDC. If the AC amplifiers and demodulator are working normally, and this voltage is not present, DC Amplifier Q4 is probably defective.

e. Buffer Amplifiers

Flow Zero Gas and depress the Front Panel Span Check Switch. Voltage across Test Points A5 and M1, and Output Selection Jumper E4, and Test Point M1 should both be approximately 0.9 V. If either of these voltages is not present, and the previous tests "a" through "d" are normal, the Buffer Amplifier Q5 is probably defective.

SECTION VIII

SCHEMATIC AND ASSEMBLY DIAGRAMS

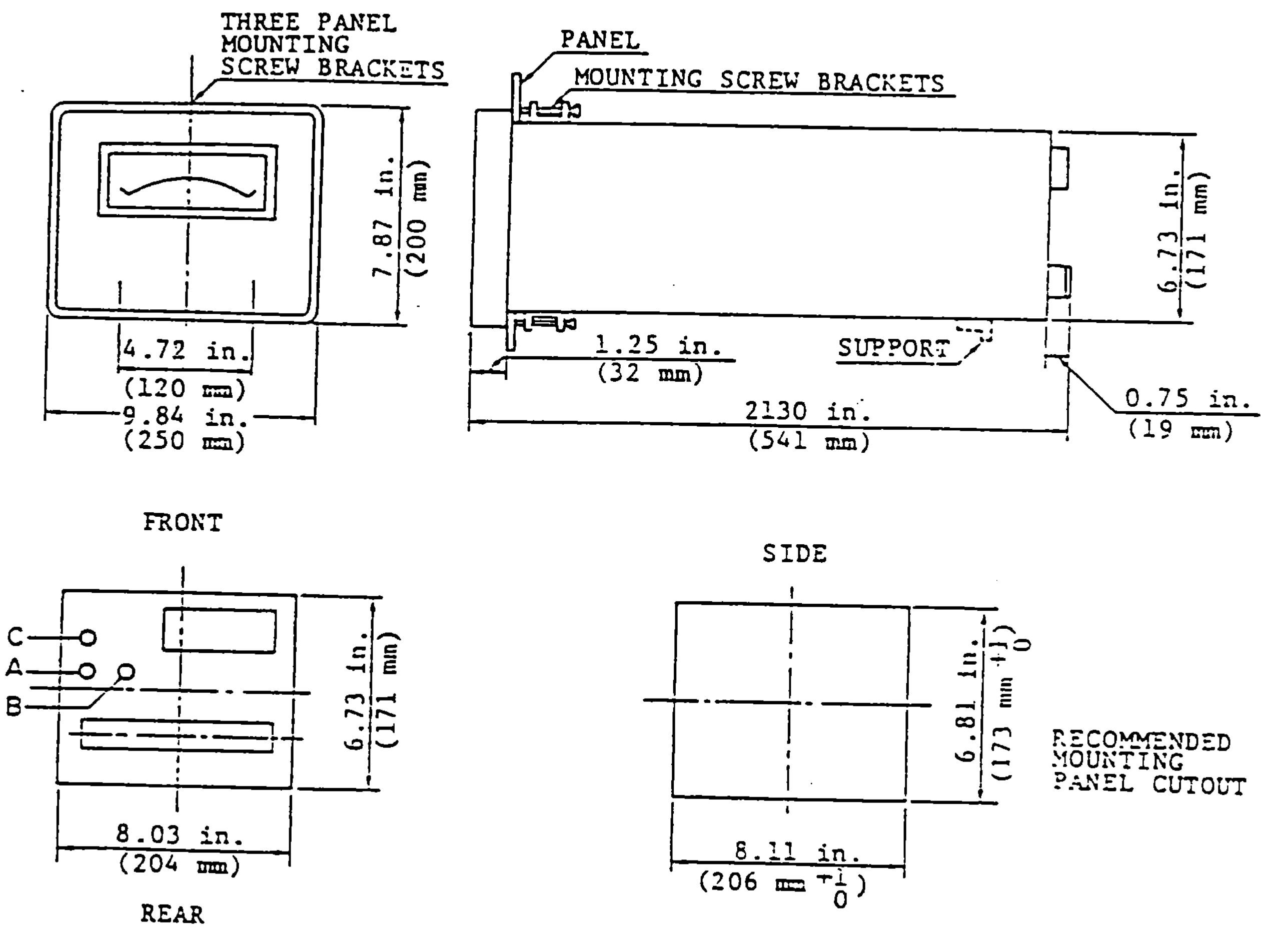


Figure 20: Outline and Mounting Dimensions

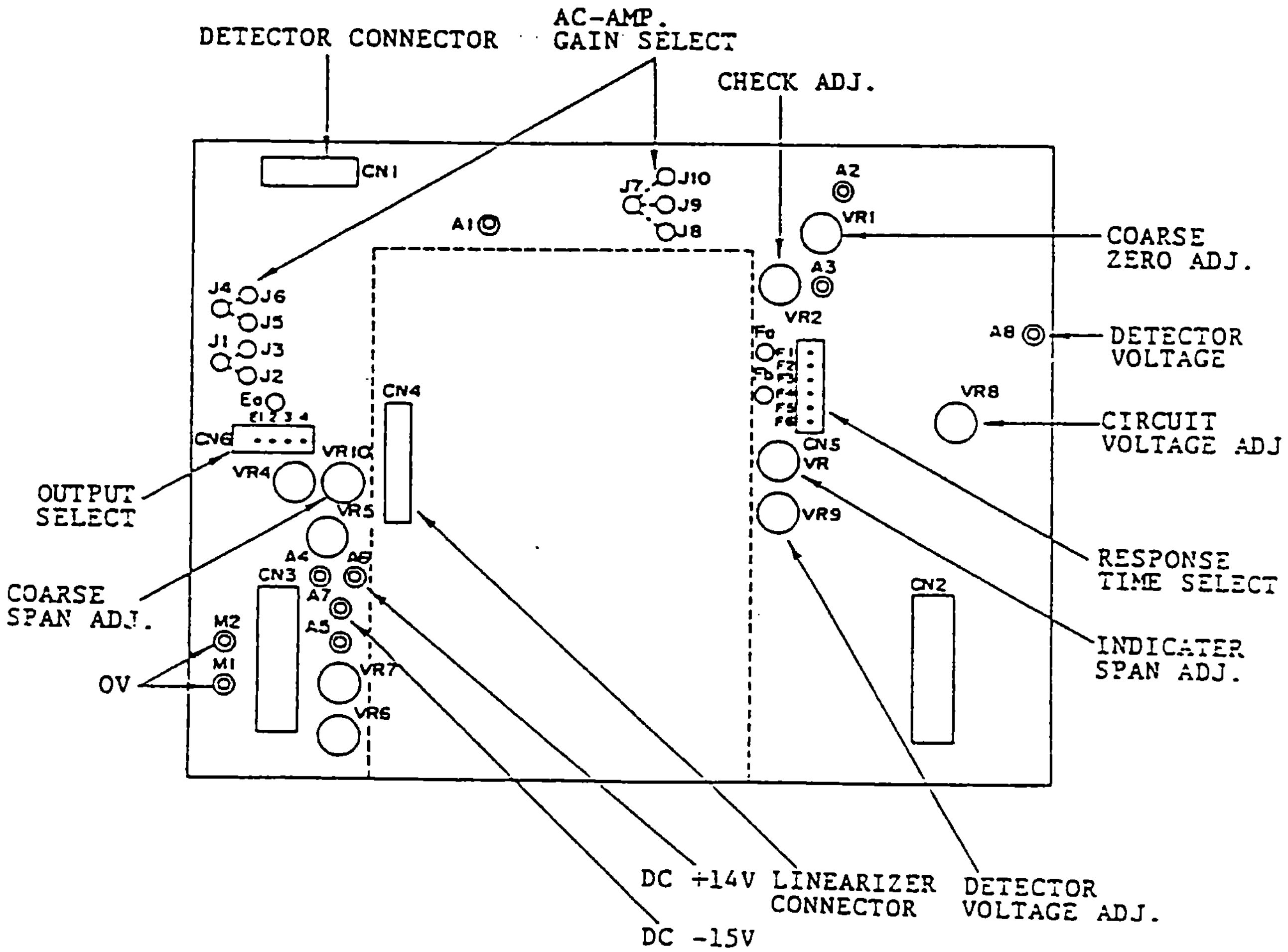


Figure 21: Main Circuit Board Layout (3300 and 3400)

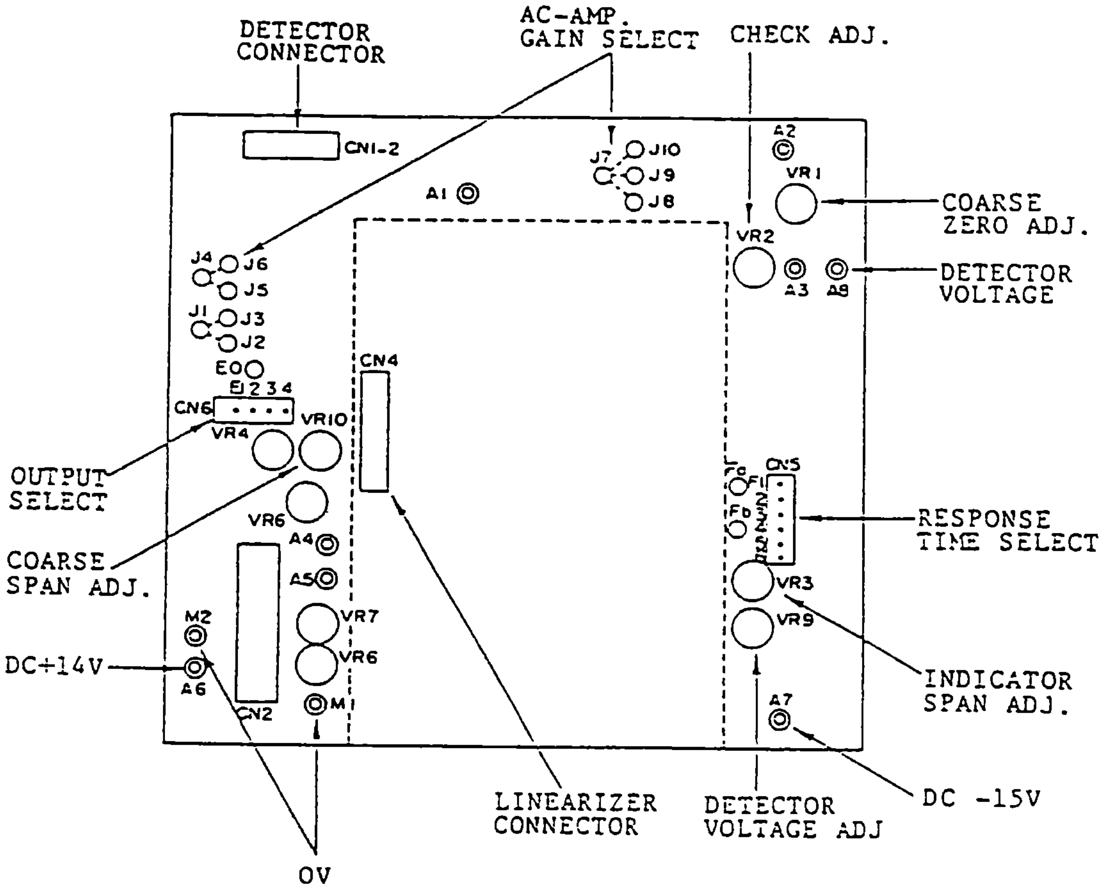


Figure 22: Circuit Board Layout for Second Gas Component (Model 3400 Only)

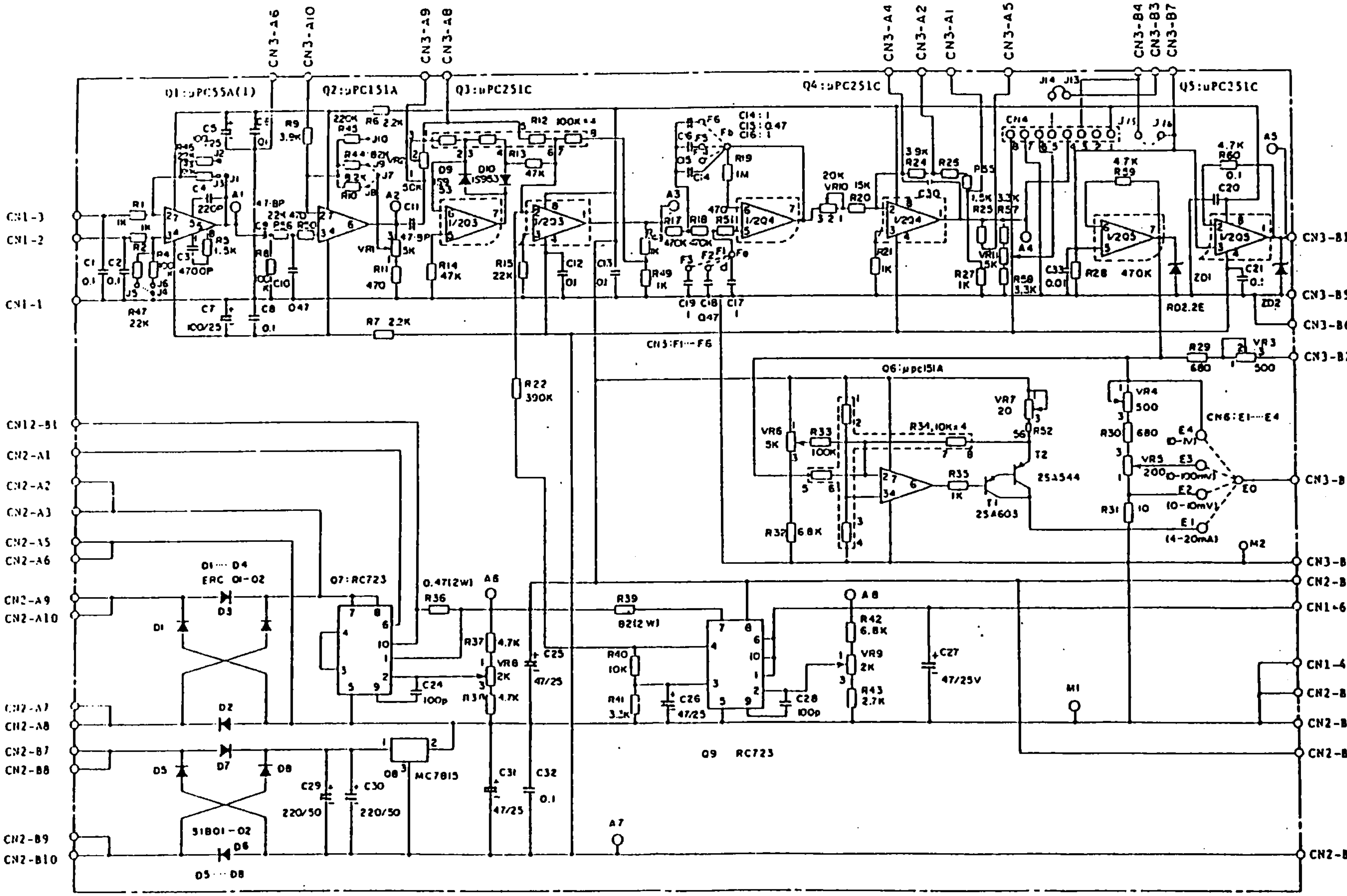


Figure 23: Detailed Schematic Diagram of Main Circuit Board
(3300 and 3400)

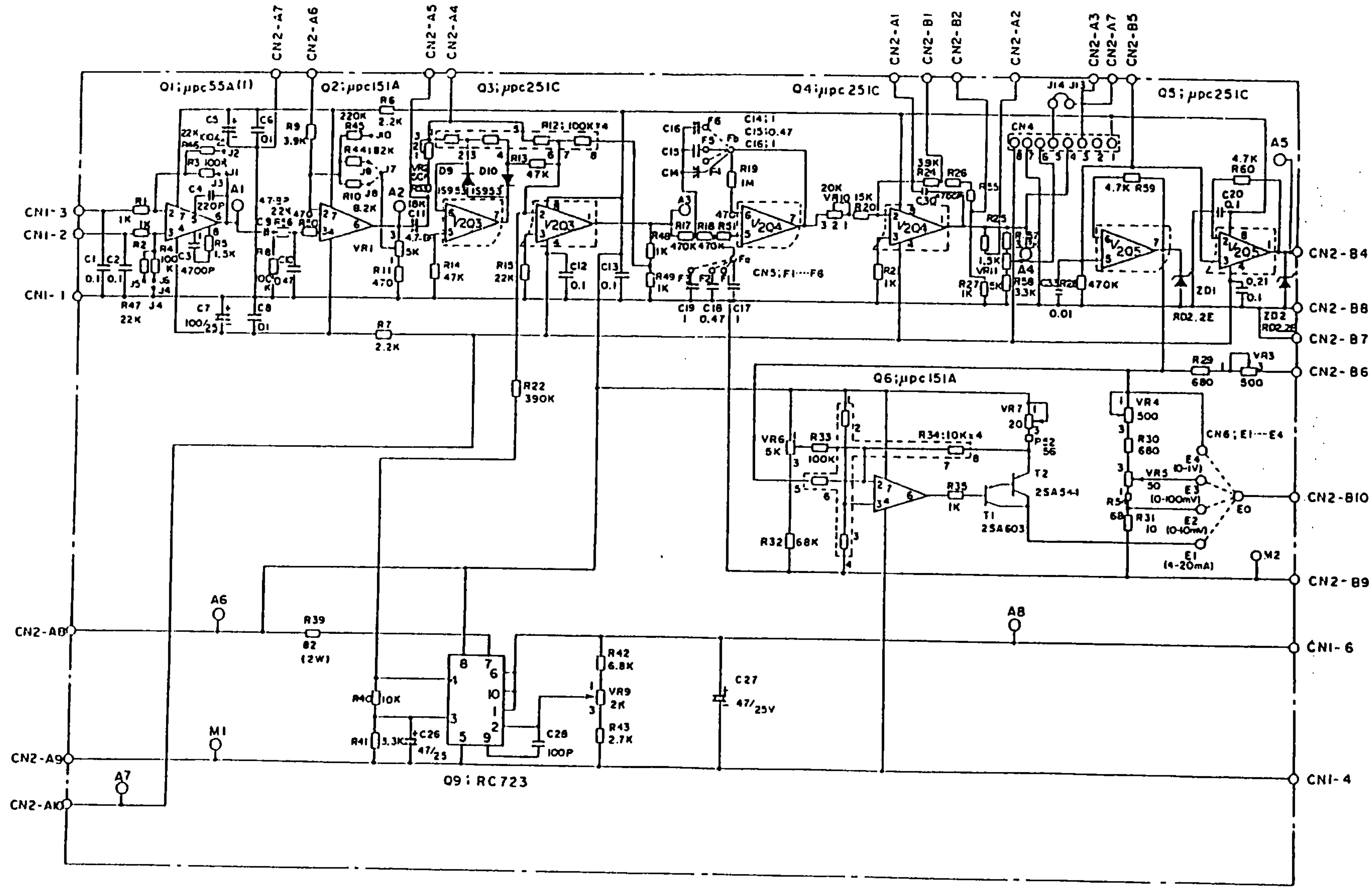


Figure 24: Detailed Schematic of Second Gas Component Circuit Board (Model 3400 only)

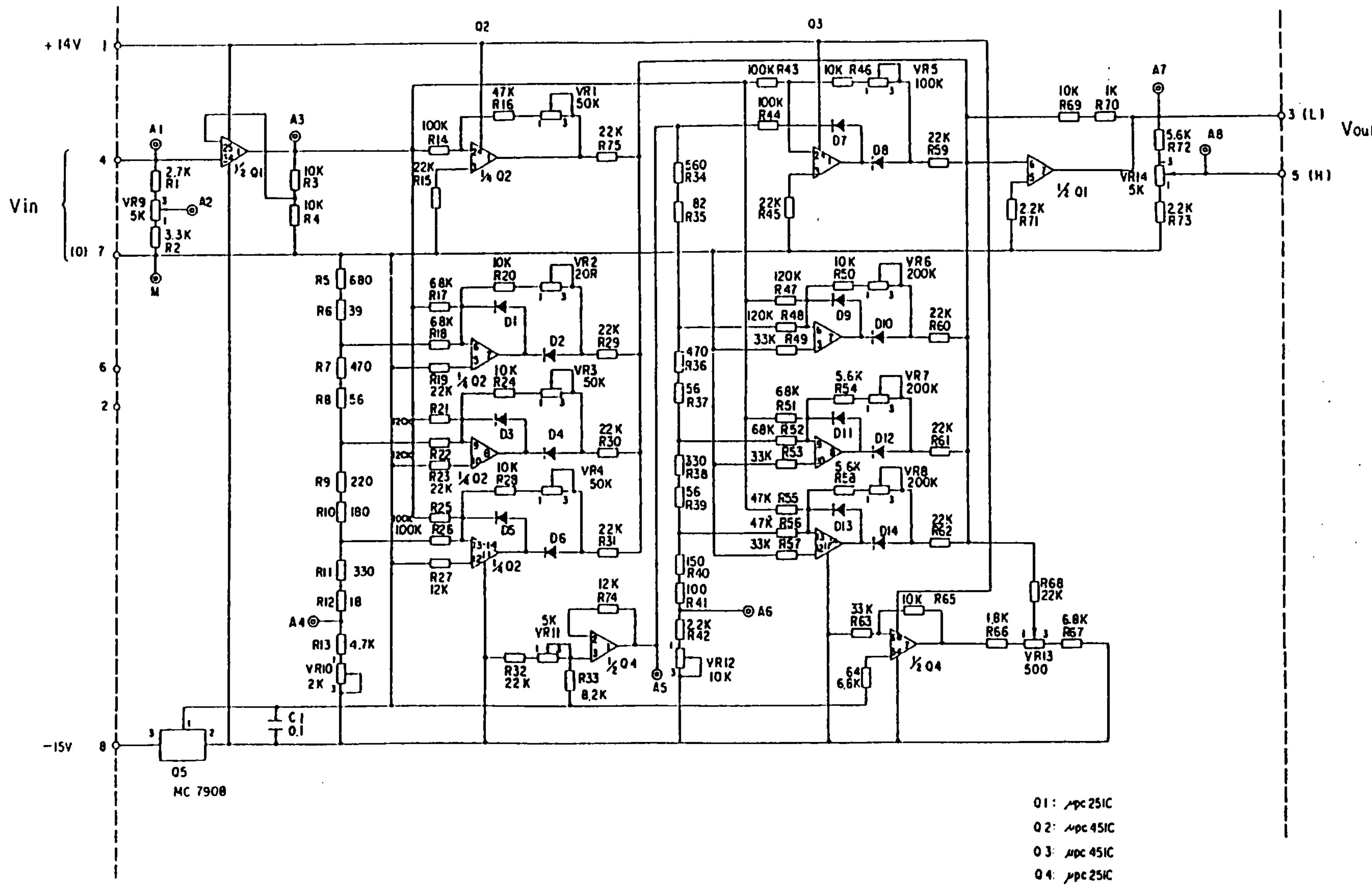


Figure 25: Detailed Schematic Diagram of Linearizer Circuit Board

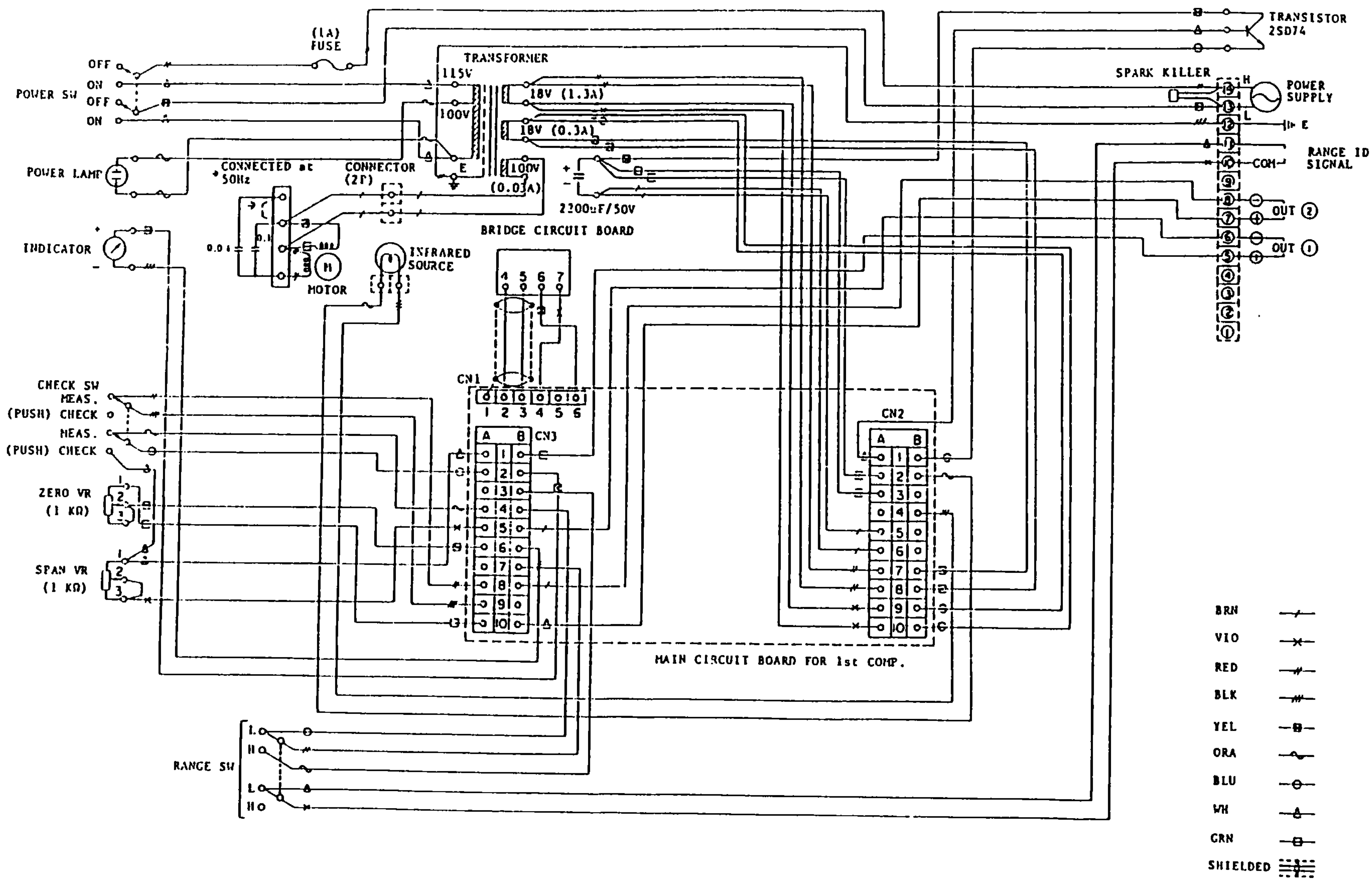


Figure 26: Detailed Schematic Diagram of Chassis Wiring (Model 3300)

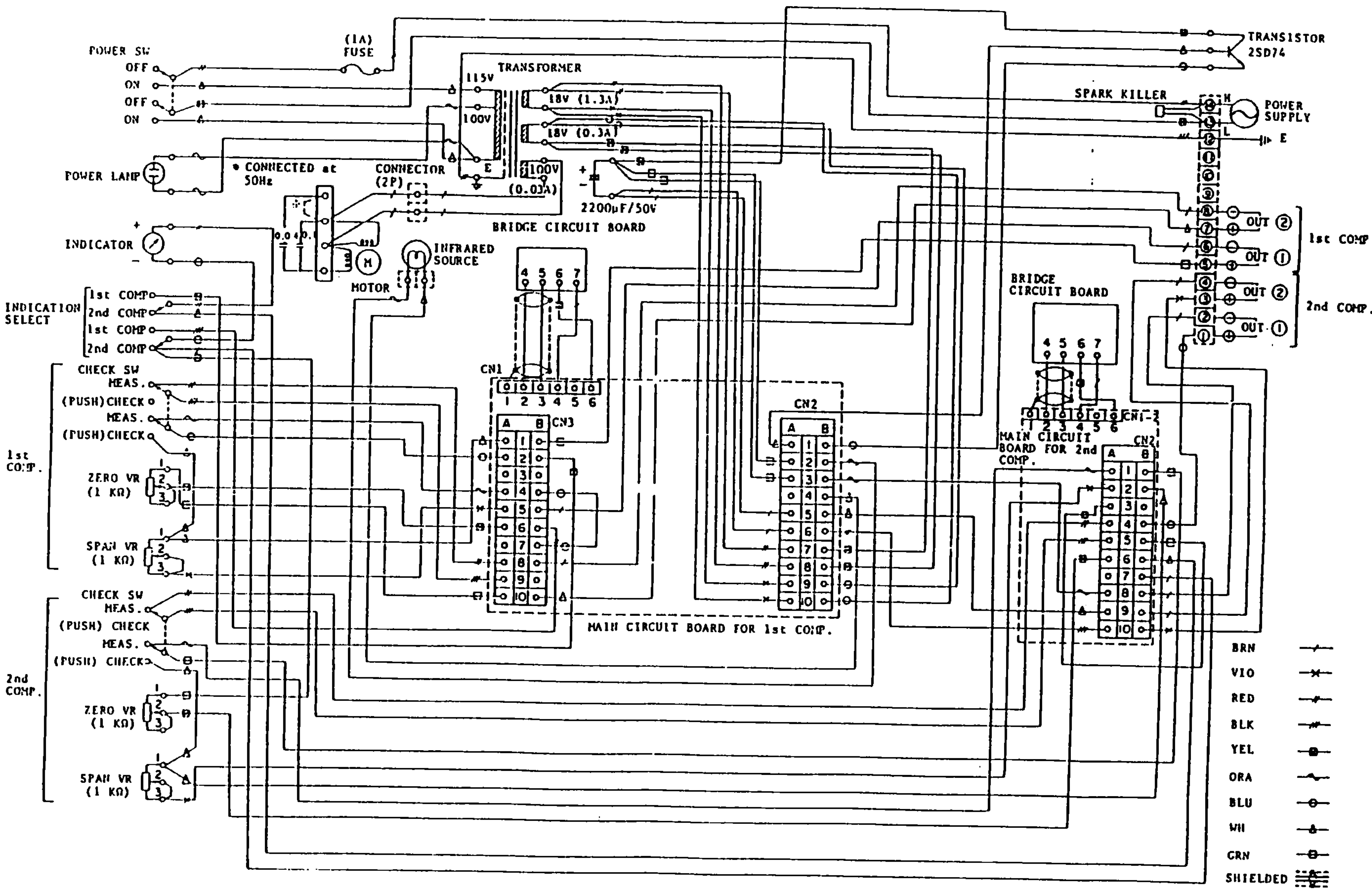
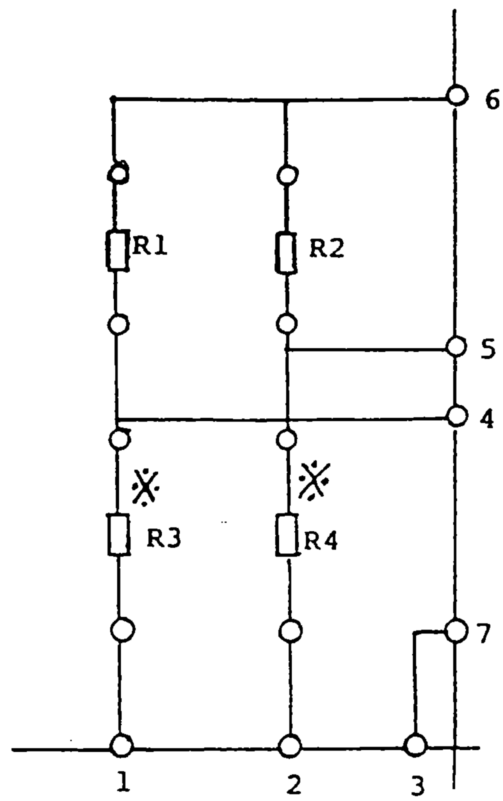


Figure 27: Detailed Schematic Diagram of Chassis Wiring (Model 3400)



※ R3 and R4 are for balance adjustment and shorted if unnecessary.

FIGURE 28

Figure 29

Comp.		Range (%)	Range Ratio	Cell Length (mm) 4	8	16	32	64	125	250	Detector	Optical Filter
CO	1	0-0.05/0.1	1:2							0	CO - L	0
	2	0-0.1 /0.2	1:2							0	M	0
	3	0-0.2 /0.5	1:2.5						0		M	0
	4	0-0.5 /1	1:2					0			M	0
	5	0-1 /2	1:2				0				M	0
	6	0-2 /5	1:2.5		0						M	0
	7	0-5 /10	1:2	0							M	0
	8	0-10 /20	1:2			0					H	0
CO_2	1	0-0.05/0.1	1:2							0	CO_2 - L	
	2	0-0.1 /0.2	1:2					0			L	
	3	0-0.2 /0.5	1:2.5				0				L	
	4	0-0.5 /1	1:2			0					L	
	5	0-1 /2	1:2		0						L	
	6	0-2 /5	1:2.5	0							L	
	7	0-5 /10	1:2			0					H	
	8	0-10 /20	1.2		0						H	
CH_4	1	--------	-----	-	-	-	-	-	-	-	--------	------
	2	0-0.1 /0.2	1:2							0	CH_4 - L	0
	3	0-0.2 /0.5	1:2.5							0	M	
	4	0-0.5 /1	1:2						0		M	
	5	0-1 /2	1:2					0			M	
	6	0-2 /5	1:2.5			0					M	
	7	0-5 /10	1:2		0						M	
	8	0-10 /20	1:2	0							M	

Note 1: Cell and detector for each measuring range should be selected according to the above table. If the ranges are not in the same zone enclosed by the wide line, it is necessary to change the detector besides the cell in changing the range.

1420B

Oxygen Analyser Instruction Manual

Ref No. 01420/001B/0
Order as part No. 01420001B

Servomex

Section 1. DESCRIPTION

1.1 General

The Servomex 1400B series of gas analysers comprises two base units, the 1410B analyser using dual wavelength, single beam infrared technique and the 1420B oxygen analyser using paramagnetic technology. This manual describes the 1420B oxygen analyser.

The 1400B series may be fitted into a twin unit 19" rack mounted case, a bench top case or a single unit case for flush panel mounting.

The 1420B has voltage and current outputs, multiple ranges, oxygen level alarms, flow alarm and remote range indication.

A version of the analyser is available for oxygen purity measurements.

Included with the analyser are the following accessories:

Fuses	- 2531-0526
Filters	- 2377-3608
'D' connectors	
Manual	- 01420001B
IEC Power connector.	

A 31/2 digit green LED indicates the oxygen content to 0.1% resolution.

> **WARNING**
>
> This analyser is not suitable for use in hazardous areas or for measuring flammable sample gases.

1.2 Principles of Operation

The 1420B oxygen analyser measures the paramagnetic susceptibility of the sample gas by means of a magneto-dynamic type measuring cell.

Oxygen is virtually unique in being a paramagnetic gas, this means that it is attracted into a magnetic field. In the Servomex measuring cell the oxygen concentration is detected by means of a dumb-bell mounted on a torque suspension in a strong, non-linear magnetic field. The higher the concentration of oxygen the greater this dumb-bell is deflected from its rest position. This deflection is detected by an optical system and twin photo-cells connected to an amplifier. Around the dumb-bell is a coil of wire. A current is passed through this coil to return the dumb-bell to its original position. The current is measured and is proportional to the oxygen concentration.

1.4 Use With Toxic or Flammable Gases

1.4.1 Toxic Gases

If the analyser is used with sample gases which may be toxic, asphyxiant or otherwise harmful to health then adequate precautions should be taken to ensure safe installation and operation.

These precautions could, for example, include ensuring good quality sample piping to reduce the possibility of leaks, regular leak checking of the analyser and sample piping, minimum sample pressure, adequate ventilation of enclosed spaces and the possibility of monitoring for toxic levels.

The analyser vent should be piped to a well ventilated area.

1.4.2 Flammable Gases

WARNING

This analyser is not suitable for use in hazardous areas or for measuring flammable sample gases.

Consult Servomex for details of analysers which may be more suitable for measuring sample gases which can be toxic or flammable.

1.5 Specification

Performance Specification (typical)

Repeatability:	Better than ±0.1% O_2 under constant conditions (measured at the IV electrical output).
Temperature coefficient:	±0.005% O2 ±0.04% of reading(on display) per degree C change from calibration temperature.
Response Time:	Less than 15 seconds to 90%. At point when flow alarm is triggered the response time will be approximately 50 seconds

Electrical

AC Supply:	88 to 264V, 47 to 440Hz.
Power required:	50VA.

Environmental Limits

Operating ambient temperature:	0 to +45°C (32 to 113°F) 0 to 40°C (32 to 104°F, bench top case)
Storage temperature range:	-20 to +70 C (-4 to 158 F)
Relative humidity:	0-85%, non-condensing.
Sunlight:	Protect from direct sunlight which may cause the interior of the analyser to overheat.
Vibration:	Protect the analyser from excessive vibration.
EMC:	Complies with EN 50022(1987) CLASS A for conducted interference and radiated electric field.

1.6 Product Identification

A label is fitted to the rear panel giving the model and serial numbers. It is of the form 1420B/701/NNNN where NNNN is the serial number

SECTION 2. INSTALLATION

Installation Overview

2.1 Unpack the analyser

2.2 Set-up output ranges and oxygen level alarm functions

2.3 Install analyser

2.4 Make electrical connections

2.5 Make gas connections

2.6 Calibrate

2.1 General

Unpack the instrument and inspect the unit for signs of damage during transit. If any damage is evident, inform Servomex or their agents immediately

Accurate and secure installation will minimise maintenance and instrument breakdown and will provide reliable service.

The location should be vibration free and be subject to minimal fluctuations in ambient temperature.

> **WARNING**
>
> The installer must be satisfied that the analyser installation conforms to the relevant safety requirements and that the installation is safe for any extremes of conditions which may be experienced in the operating environment of the analyser.

2.2 Setting-up Ranges and Alarm Functions

It is necessary to set links inside the analyser to set the desired ranges of the analogue output and the correct operation of the oxygen alarms.

Note: The analyser display will always indicate 0-100% O_2.

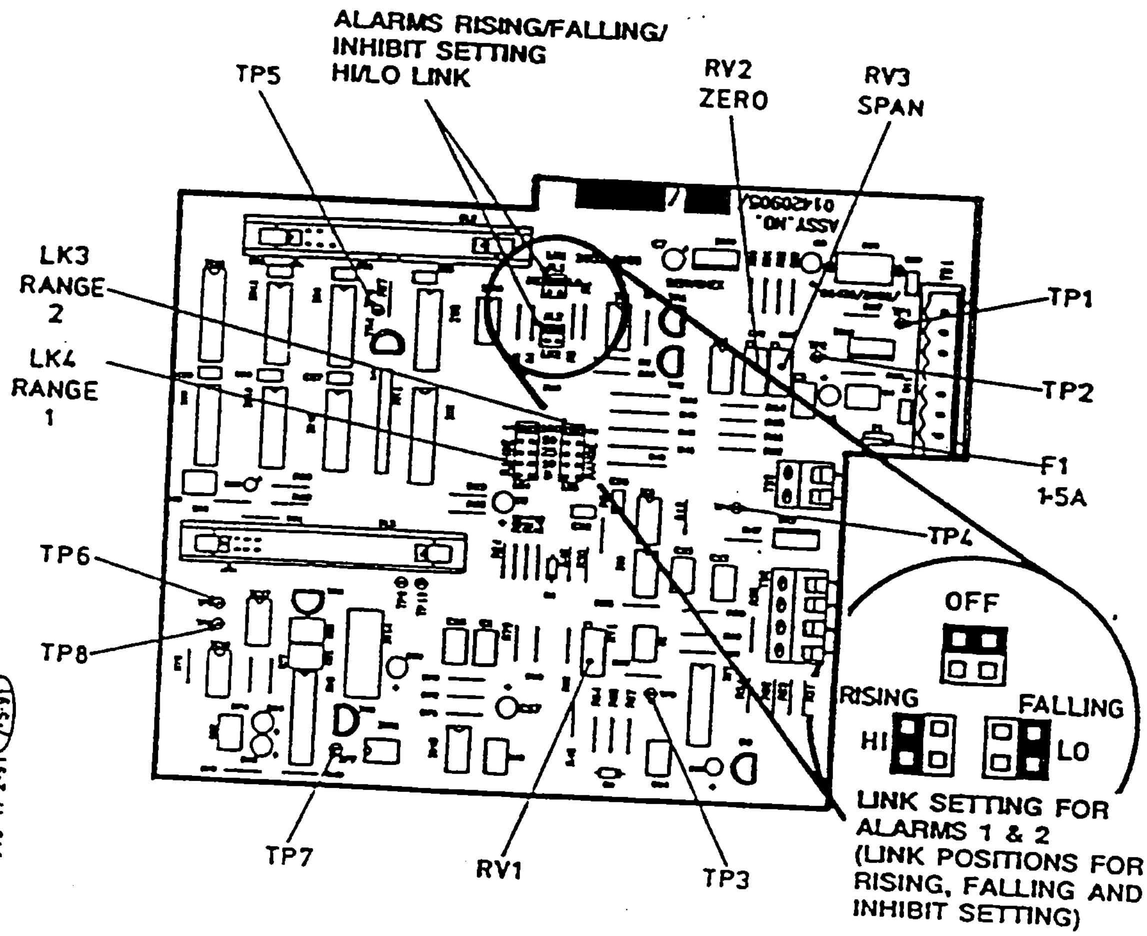


Figure 2.1 Range Changing and Alarm Function Setting

2.3 Installation

The analyser can be installed in a 19in relay rack, flush panel mounted or in a bench top case. See figure 2.2 for dimensions.

The location should be vibration free and be subject to minimal fluctuations in ambient temperature.

There should be access to the rear of the analyser for making gas and electrical connections.

If the analyser is being used to measure sample gases which are toxic then the analyser should be well ventilated to prevent a high concentration of dangerous gas occurring. It may also be advisable to fit appropriate monitoring equipment to warn of sample leaks.

2.4 Electrical Supply Connections

> **WARNING**
>
> Since an isolating switch is not fitted to this instrument it is necessary to ensure that the electricity supply is fitted with a switch to disconnect the instrument. The instrument cases must be connected to earth (ground) at all times.

Electrical supply connection is made to the IEC type connector on the rear of the analyser. The supply voltage can be in the range 88 to 264V, 47 to 440Hz. There is no voltage setting required. If a centre tapped electrical power supply is used (eg 55-0-55V) then both poles must be switched and fused.

On installations where the electrical supply is not referenced to ground an isolating transformer must be fitted and its secondary winding suitably grounded.

When installed in the Servomex 19 inch rack case it is necessary to earth (ground) the case to one or both of the analysers using the earth connections and earth studs on the rear of the instrument.

2.4.2 Alarm Connections

Alarm connections are made to the 'D' plug on the rear of the analyser. See Figure 2.4 for details. Contacts are rated at 1A/110Vac max, non-inductive.

The alarm relay contacts (PL5) must not be connected to a supply exceeding 110V ac rms, and careful wiring within the 'D' connector is required to maintain the insulation and clearances.

Ensure case is earthed (grounded) when relays are connected to a supply exceeding 50V ac or 120V dc.

2.5 Sample Gas Connections

Pipework and fittings used for gas connections should be degreased and suitable for oxygen service.

Connections are made to the pipes on the rear of the analyser. 'Sample In' and 'Sample Out' are labelled.

Gas connection can be made with flexible tubing suitable for the push-on 6.4mm (1/4in) OD connector. Sample gas connections can also be made with 1/4in compression fittings.

Note that response time will be increased by long lengths of sample tubing.

Sample pressures are given in the specification - see Section 1.5. Pressure regulation should be incorporated in the sample line to ensure these values are not exceeded.

If the gas being sampled is excessively dusty or has high humidity it will be necessary to install external filters or dryers.

2.6 Analyser Exhaust

The exhaust from the analyser must not be constricted. If the exhaust is piped away then, to avoid a backpressure in the measuring cell, the diameter of the piping used should be greater than the inlet piping.

If the analyser exhausts into a confined space there may be a danger of a build-up of harmful gases. In such cases the analyser vent should piped to a place with good ventilation.

2.7 Calibration Gases.

WARNING

Nitrogen is an asphyxiant and must not be used in confined spaces without adequate ventilation.

All gas cylinders must be fitted with a regulator to limit the delivery pressure to the values above and an appropriate output pressure gauge. This will prevent serious over pressurising of the analyser and damage to the measuring cell.

All gas cylinders must be fastened securely.

SECTION 3. OPERATION

3.1 Controls

See Fig 3.1 for location of the controls.

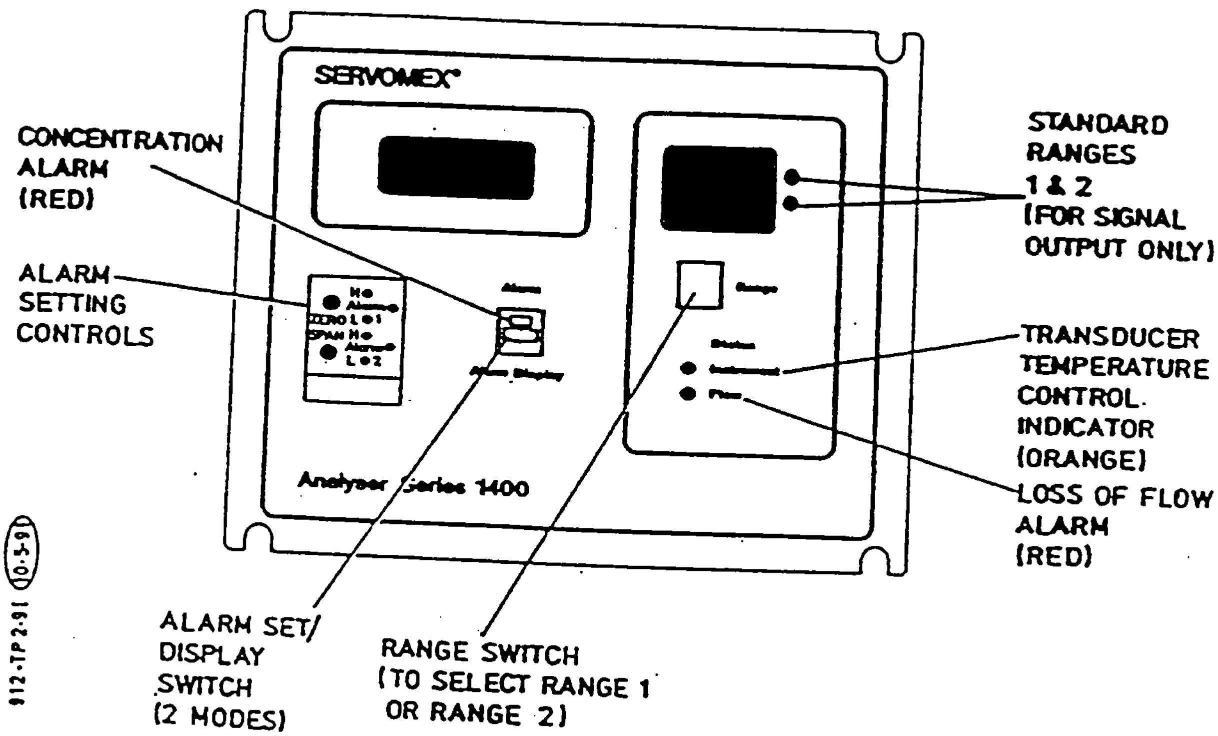


Figure 3.1 Front Panel Controls and Indicators

3.2 Calibration

The analyser should be allowed to warm-up for 3 hours before it is calibrated.

3.2.1 Setting the Zero

Introduce zero gas (normally high purity nitrogen) at a pressure of less than 10 psig to the gas inlet on rear panel of the analyser. Adjust the Zero control, located behind the flip down panel below the display, to give a reading of 0.0 on the display. If the range of adjustment is inadequate then the transducer zero will need resetting (See Section 4.2.4).

3.2.2 Setting the Span

Introduce clean, dry air at a pressure of less than 10 psig to the gas inlet on the rear panel. Adjust the Span control, located behind the flip down panel below the display, to give a reading of 20.9 on the display.

If using a calibration gas other than air then set the span calibration to the value of the calibration gas.

In the alarm condition the red LED incorporated in the alarm switch will flash. The LED beside the relevant alarm control will also flash. The upper LED indicates a high oxygen alarm, the lower LED indicates a low oxygen alarm. The relevant relay will also go to the alarm condition.

Alarms are cleared when the oxygen concentration returns to a non-alarming value.

3.5 Flow Alarm.

The analyser incorporates a pressure switch to detect satisfactory sample flow. If the flow fails or the sample inlet or outlet becomes blocked then the yellow 'Flow' LED will flash and the 'Flow' alarm relay will go to the alarm condition.

This alarm is cleared when flow returns to normal.

3.6 Instrument Status

The measuring cell is heated. The red LED on the front panel illuminates when the heater is on. During warm-up the lamp remains on continuously, but will flash when the temperature has stabilised.

3.7 Vent Pressure

The pressure at the analyser vent connection is the same as that in the measuring cell. The analyser determines the partial pressure of oxygen. Pressure changes occurring since the last calibration cause a proportional change in the oxygen reading unless the back pressure regulator is fitted.

See Section 2.6 for information about safe venting of exhaust gases.

3.8 Routine Maintenance

Frequency Of Calibration

The frequency of calibration required will depend upon the operating requirement for accuracy and upon environmental conditions. The following is a guide which can be modified in the light of operating experience in particular circumstances.

Weekly: Adjust the Span.
Monthly: Adjust the Zero then the Span.

Changing The Filter

Check the filter. The filter element is removed by unscrewing the large filter knob on the rear panel of the analyser. Discard the old element if dirty or wet and fit a new filter element (part no. 2377-3608) then check that sample pre-conditioning is adequate.

FID TOTAL HYDROCARBON ANALYZER
MODEL HC500-2D

Operation, Maintenance, and Parts Manual

P/N 972-9001

COLUMBIA SCIENTIFIC INDUSTRIES CORPORATION
11950 Jollyville Road
P.O. Box 203190
Austin, Texas 78720

Phone: 512-258-5191

February 1990
Rev --

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TABLES

1. INTRODUCTION

The Columbia Scientific Industries Corporation (CSI) Model HC500-2D Total Hydrocarbon Analyzer is a self-contained system for monitoring ambient concentrations of total hydrocarbons.

Sample air is introduced directly into an FID detector to yield a total hydrocarbon reading which is stored in an electrical circuit.

The hydrocarbon detection system utilizes the well established technique of flame ionization. Hydrocarbons passing through the hydrogen rich flame are converted to ions. An electrostatic field in the burner causes these ions to migrate and collect on an electrode. An electric current is produced which is proportional to the concentration of ions collected.

The design of the Model HC500-2D was implemented with the emphasis focused on obtaining stable and reliable performance and ease of service and maintenance. Precise pneumatic and thermal control of critical elements and the utilization of proven solid state circuitry contribute to the performance characteristics of the instrument.

In addition to the basic HC500-2D, CSI provides a variety of options and accessories to meet most user's requirements. Section 10 describes these.

2. PRINCIPLE OF OPERATION

The CSI Flame Ionization Detector (FID) is based on the ionization of hydrocarbon molecules in a hydrogen hyperventilated flame. Hydrocarbons are fragmented by the flame to carbon radicals, e.g. CH . These radicals react with oxygen radicals to form positive carbon ions and electrons. The positive ions can undergo further reactions with water molecules to produce hydronium ions.

The following equations summarize some of the possible reactions:

$$CxHy \longrightarrow CH\cdot$$

$$CH\cdot + O\cdot \longrightarrow CHO^{+} + e^{-}$$

$$CHO^{+} + H_2O \longrightarrow H_3O^{+} + CO$$

An 84 volt battery is used to produce an electrostatic field between the ionization probe inside the burner chamber and the burner block. This causes the electrons to migrate to the positively charged probe, and the positive ions to the burner block. The resulting current is proportional to the ions collected. An electrometer amplifier converts the current to voltage which is fed to the amplifier output recorder jacks.

The FID detector is designed to optimize the sensitivity and stability of these reactions. Sample air is drawn into the detector block by means of a vacuum pump. Hydrogen is supplied under a slight pressure from a cylinder or hydrogen generator. Both these gas streams are controlled and regulated to provide stable flow rates to the burner.

3. SPECIFICATIONS

Performance Specifications

	Hydrocarbon FID Detector
Ranges:	0-10 ppm 0-50 ppm 0-100 ppm 0-500 ppm 0-1000 ppm
Minimum Detectable Sensitivity:	0.1 ppm CH_4
Noise:	±0.05 ppm CH_4
Lag Time:	Less than 15 seconds
Rise Time to 90%:	Less than 30 seconds
Fall Time to 10%:	Less than 30 seconds
Updating Time (Switching Time):	5 minutes
Total cycle time:	10 minutes
Precision:	±1% FS
Zero Drift:	±2% FS/day ±3% FS/3 days
Span Drift:	±2% FS/day ±3% FS/3 days
Linearity:	±1% FS
Selectable Time Constants:	1 second or 10 seconds

Operational Specifications

Unattended Operation: (No adjustment of flow or electrical systems)	7 days
Sample Flow Rate:	Approx. 200 ml/min
Hydrogen Flow Rate:	Approx. 140 ml/min
Power Requirements:	115 ±10 Vac (50-60 Hz) 250 watts
Recorder Outputs:	0-100 mV 0-1 V 4-20 ma (optional) 0-10 V (optional)

Relative Humidity:	5-95%
Ambient Temperature Range:	10-40 deg C

<u>Configurational Specifications</u>

Weight:	40 lbs. (18 kg)
Case Dimensions:	17"W x 20"L x 12 1/4"H (43cm W x 51cm L x 31.1cm H)
Mounting Available:	Bench Rack (optional)
Sample Pump:	Internal (external w/230 V option)

4. DESCRIPTION

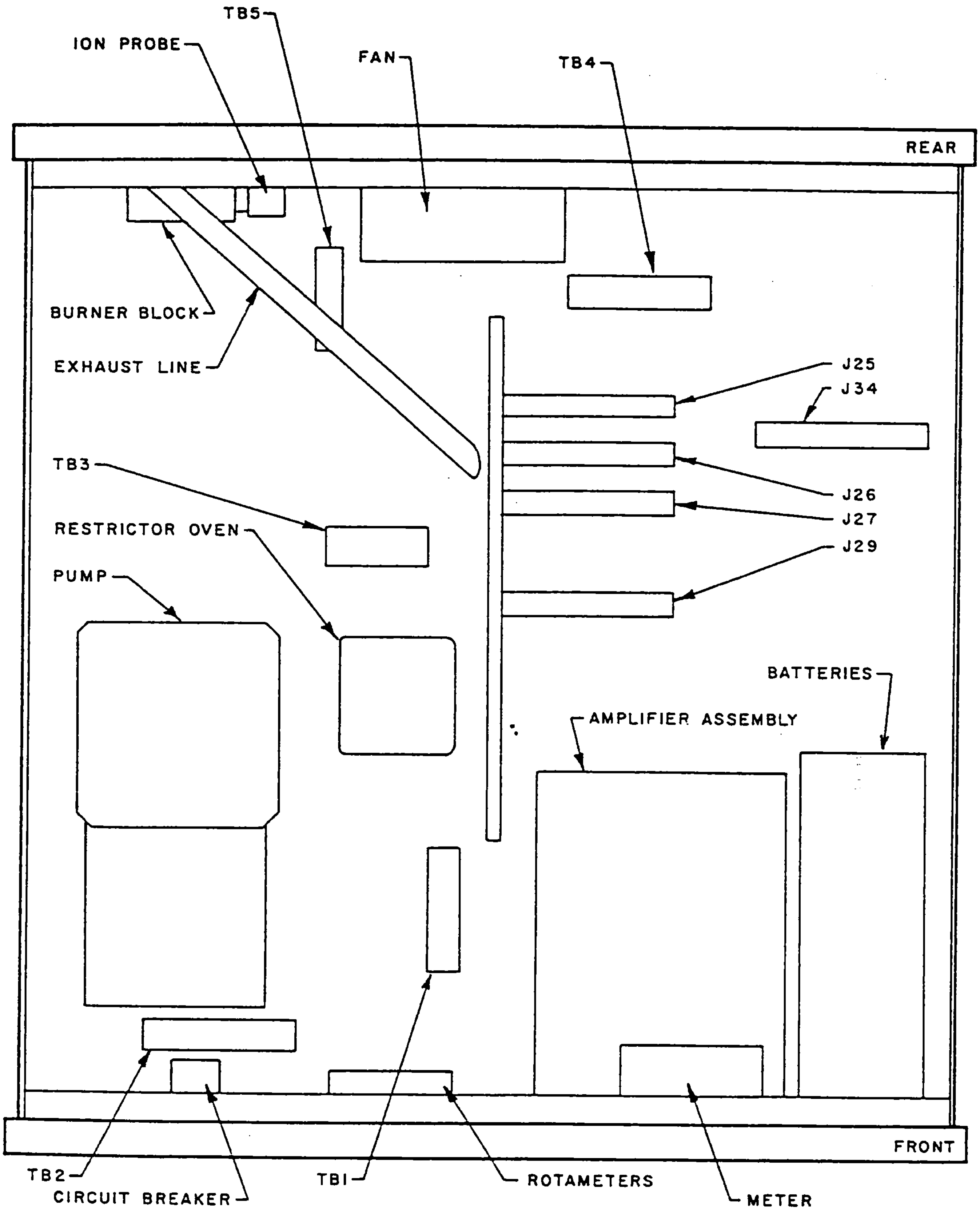
The analyzer is a completely self-contained unit comprised of three basic subsystems: 1) the pneumatic network, 2) FID burner assembly, and 3) the associated electronics. Figure 4.1 is a top view of the analyzer interior illustrating these subsystems and some of the major components. The subsystems described below, together with the front and rear panels.

4.1 Pneumatic Network

Figure 4.2 presents the pneumatic network of the analyzer without any options. Sample air can be introduced into the analyzer by two paths. In one case, the sample enters through the rear panel port marked "METERED INLET" and flows through a calibrated rotameter to a tee. In this mode the rotameter can cause hold-up of some hydrocarbons and produce a longer response time. Therefore it is recommended that this pneumatic path is used only during setting up of the analyzer and to check the air flow rate.

In the normal sampling mode, the sample is introduced through the port marked "SAMPLE INLET" which by-passes the rotameter and goes directly to the tee. (Note: One of these ports must be capped for proper operation.) From the tee the sample air passes through a pneumatic line into the burner block to yield the total hydrocarbon analysis. Hydrogen, from a 60 psig source, enters through the rear panel port marked "HYDROGEN". The hydrogen passes through a flow controlling pressure regulator, capillary combination and then through a calibrated rotameter to the burner block. The burner block exhaust gas passes through a heated and temperature controlled needle valve which controls the exhaust gas flow rate. Air is drawn into the analyzer from a hypodermic needle inserted in the "DILUTION AIR" port. This air mixes with the exhaust gases downstream of the valve to prevent condensation of moisture in the exhaust system and reduce the hydrogen gas concentration. The pump expels the burner and dilution air gas mixture out the "EXHAUST" port.

Figure 4.3 shows the Pneumatic Network with Options. Both SV1 and SV2 are supplied with Option HC26A, Remote Manual Zero/Span with Status,and HC-11B, Automatic Zero/Span/Sample Control. With the Mode switch in the "SAMPLE" position, sample air comes into the sample inlet, passes through the de-energized SV1 then directly to the burner block. Either by placing the mode switch in "ZERO" or pressing the air flow button, SV1 will be energized, closing the sample inlet. This causes air to travel from the "ZERO AIR" inlet through the rotameter, through the de-energized SV2, SV1, and then directly to the burner block. When the Mode switch is in "CALIBRATE" position SV1 and SV2 are energized causing the gas at the "SPAN GAS" port on the rear panel to be drawn into the analyzer and through the burner block.



Fiqure 4.1 Internal Top View of HC500-2D

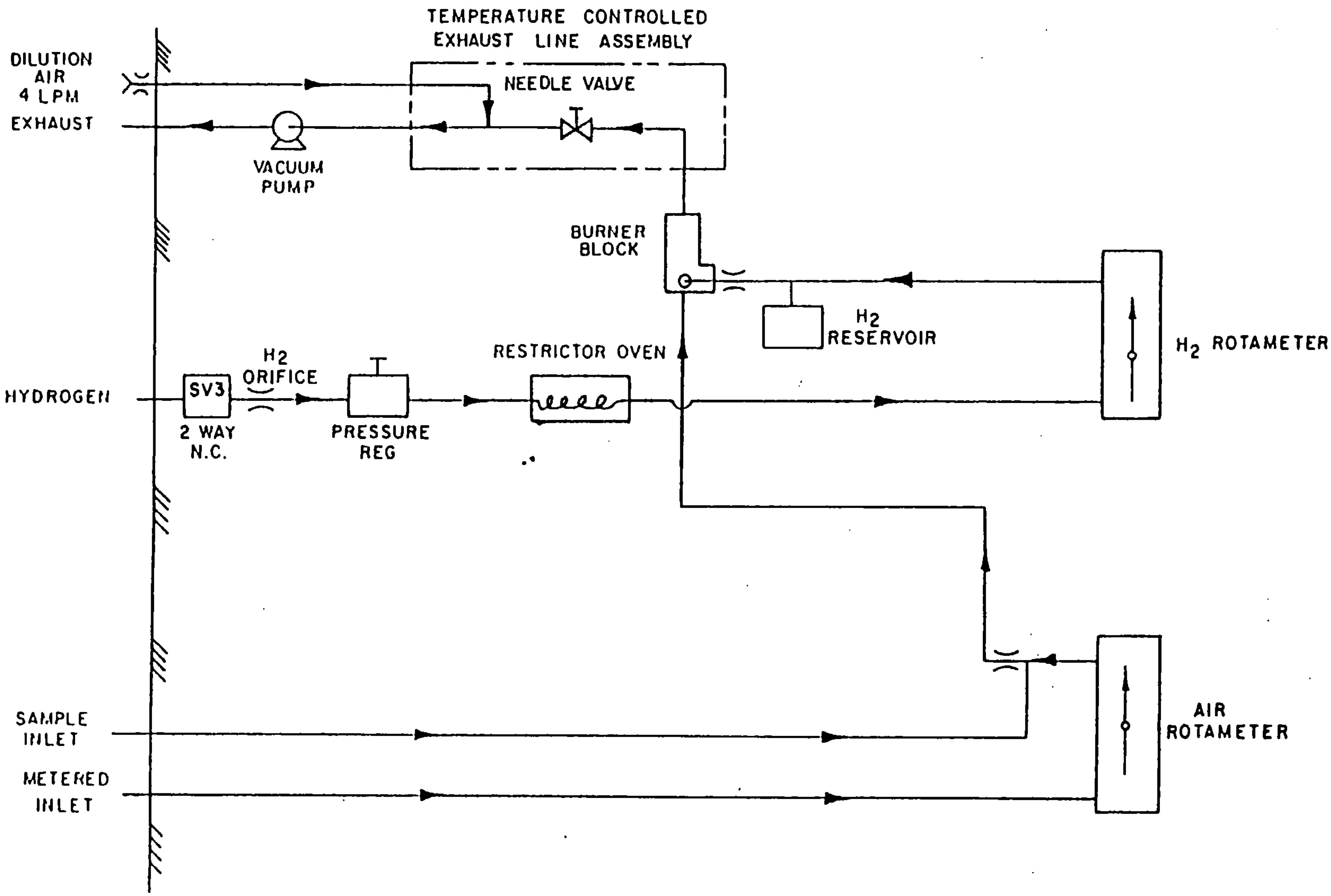


Figure 4.2 Pneumatic System of HC500-2D w/o Options

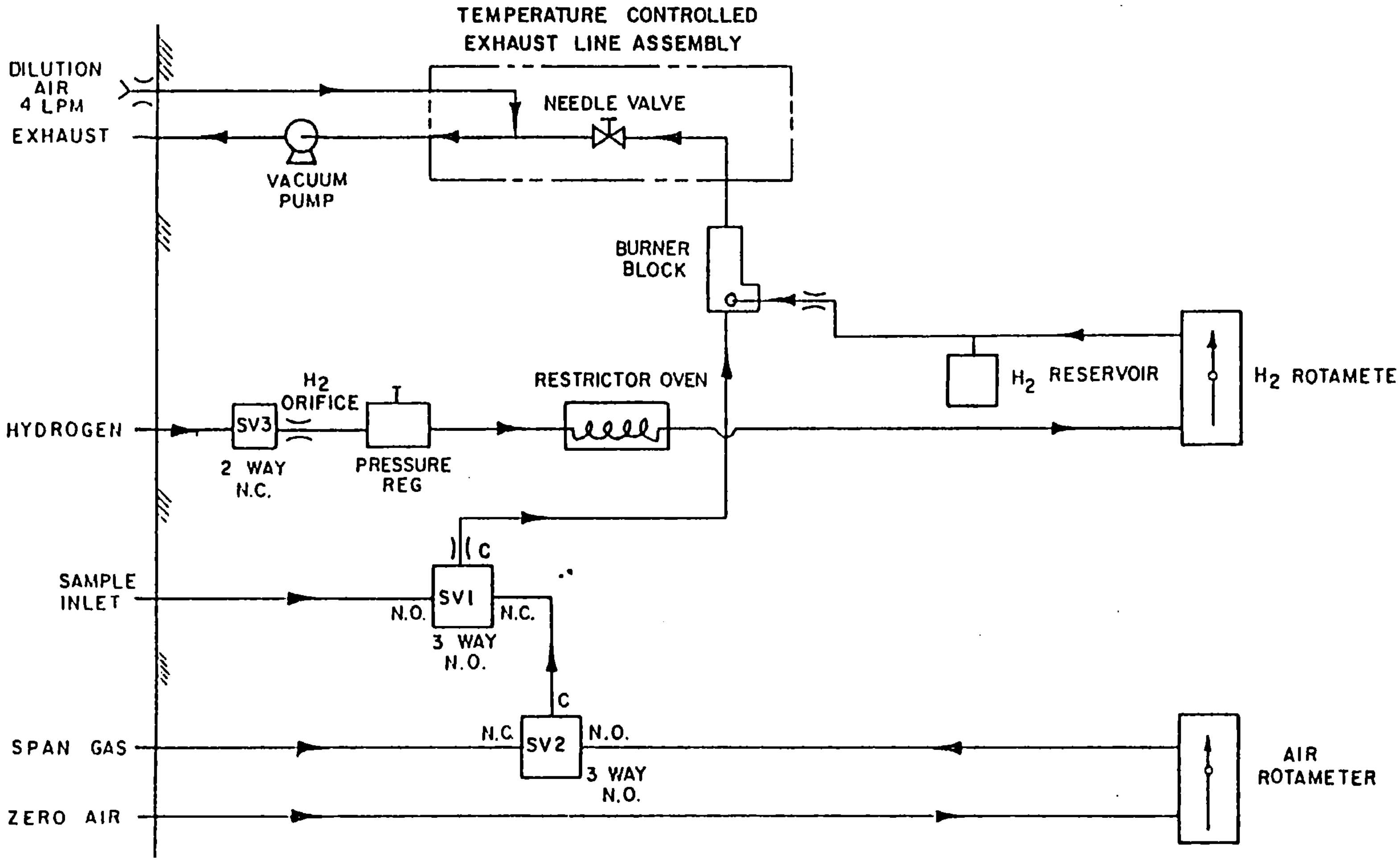


Figure 4.3 Pneumatic System of HC500-2D with Options

(1) Pneumatic Lines

The sample stream lines are 1/8" OD standard wall Teflon* tubing with stainless steel connectors. The hydrogen stream lines are 1/8" OD Teflon and stainless steel lines. Exhaust lines from the burner block are 1/4" OD stainless steel and polyethylene tubing. The stainless steel line from the burner block to the needle valve is heated and temperature controlled to avoid moisture condensation and to provide stable flow conditions.

(2) Rotameters

Flow rate measurement by rotameters is provided for both air and hydrogen streams. The rotameters are calibrated at the factory for the recommended flow setting. The setting value is printed on the rotameter glass cover near the bottom of each rotameter and also on the calibration curve supplied with each analyzer. Figures 4.4 and 4.5 illustrate typical flow rate vs rotameter curves.

(3) Needle Valve

The needle valve is used to set and control the gas flow rate from the burner block to exhaust. The valve functions as a heated and temperature controlled critical orifice to provide stable flows in the burner block. The temperature is approximately 105 deg C to prevent moisture condensation. An iron-constantan thermocouple is provided to monitor this temperature at the rear panel.

(4) Dilution Air System

The dilution air system consists of a 1/4" OD stainless steel line in which the inlet is capped with a rubber septum pierced with a #18 one inch long hypodermic needle. This system supplies approximately 4 lpm of dilution air into the exhaust system, for H2 dilution to a non-combustible mixture.

(5) Hydrogen Pressure Regulator

The HC500-2D uses a hydrogen regulator to set the hydrogen flow rate and also maintain a constant down-stream pressure. This regulator is a special model which maintains a constant pressure from ambient temperatures of 10 to 40 deg C. The regulator should not be disassembled nor cleaned by flushing with solvent or air.

*DuPont registered trademark

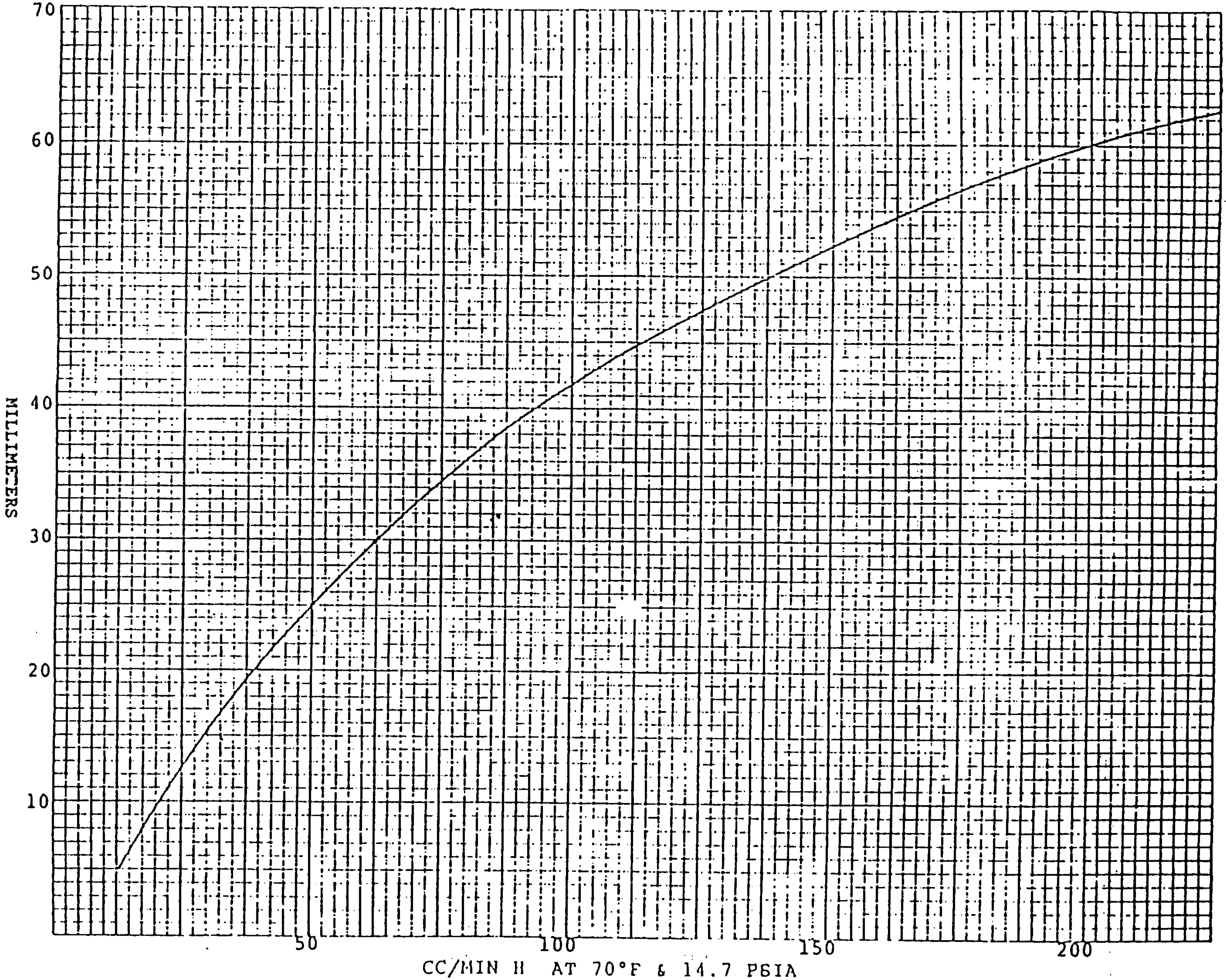


FIGURE 4.4 Hydrogen Calibration Curve (Nominal)

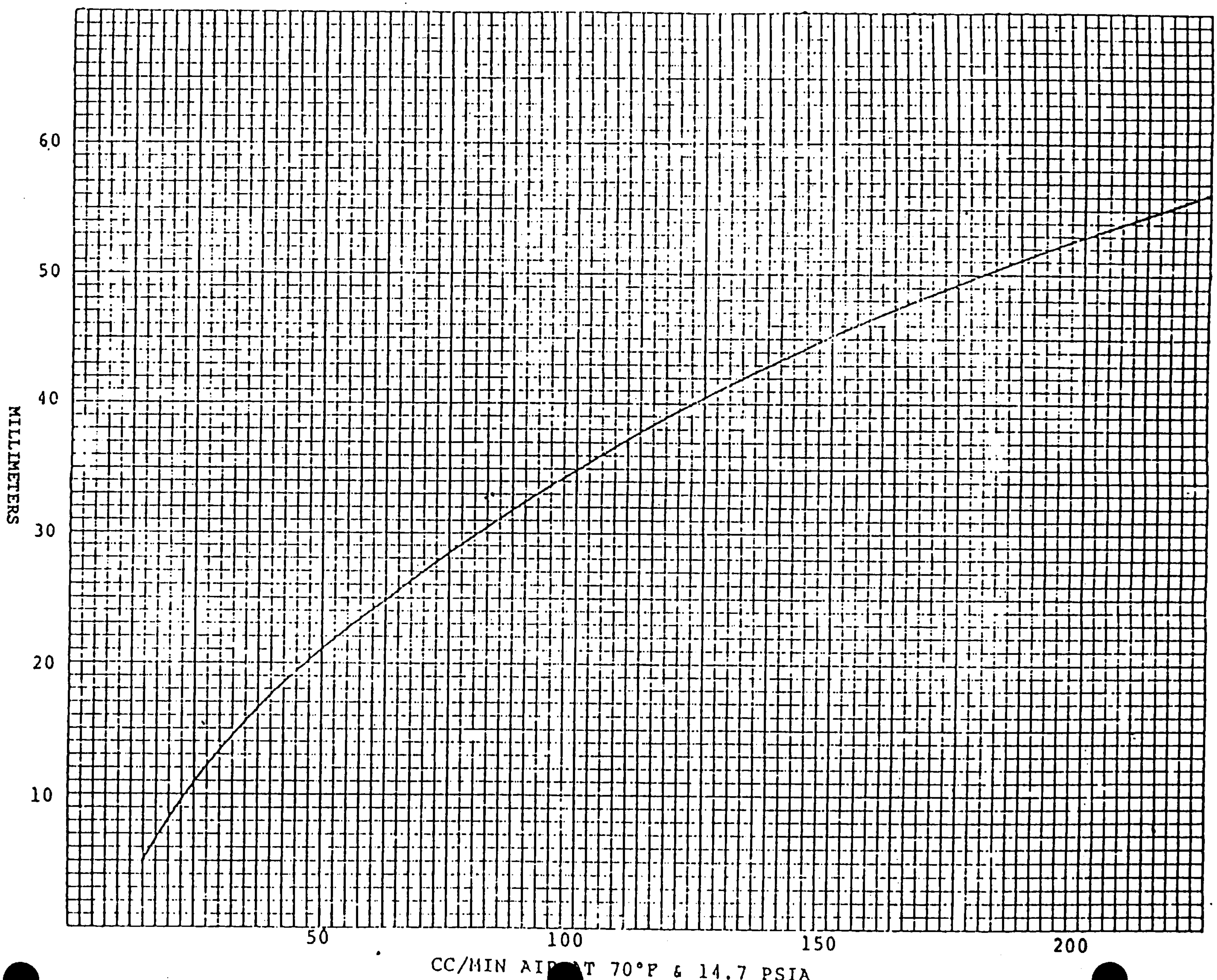


FIGURE 4.5 Air Calibration Curve (Nominal)

(6) Flow Restrictor Capillary

The hydrogen flow is further controlled by a stainless steel restrictor capillary. The capillary is temperature controlled to provide stable flow within the specified ambient temperature range. An iron-constantan thermocouple is provided to monitor this temperature at the rear panel.

(7) Hydrogen Solenoid Valve

A normally closed, 50/60 Hz, 115 Vac solenoid valve (SV3); located on the rear panel is used to provide internal shut-off of the hydrogen flow if the flame is not lit or if there is a power failure. It is energized when the ignitor button is pushed or a flame-on condition is indicated.

(8) Hydrogen Flow Limiter

The elbow connected to the outlet of the hydrogen solenoid contains an orifice to limit the hydrogen flow should a leak develop within the analyzer and a filter to protect the hydrogen flow system from particulate contamination.

4.2 FID Burner Assembly

Figure 4.6 shows an interior view of the FID burner block. Its function is to produce a stable burning condition for the flame to promote the formation of ions from hydrocarbon molecules. Sample air is introduced through the bottom inlet and hydrogen through the side inlet of the burner block. The two gas streams pass through a special burner tip where they mix and provide a stable diffusion flame. The combustion products are exhausted out of the top of the block. An ignition plug is positioned just above the hydrogen inlet port. A cartridge heater is inserted into the block just below the hydrogen inlet and maintains the block at approximately 105 deg C. Its temperature is monitored by a thermocouple attached to the block.

The ionization probe for collection of the ions is inserted into the block on the side opposite ignition plug.

A flame-out sensor, consisting of a thermocouple mounted on a round metal plate, is attached to the backside of the block. The front side of the block is covered by a metal plate.

4.3 Associated Electronics

Figure 8.1 gives the wiring schematic for the analyzer including the options. Figure 4.7 shows the position of the electronic boards with pin locations.

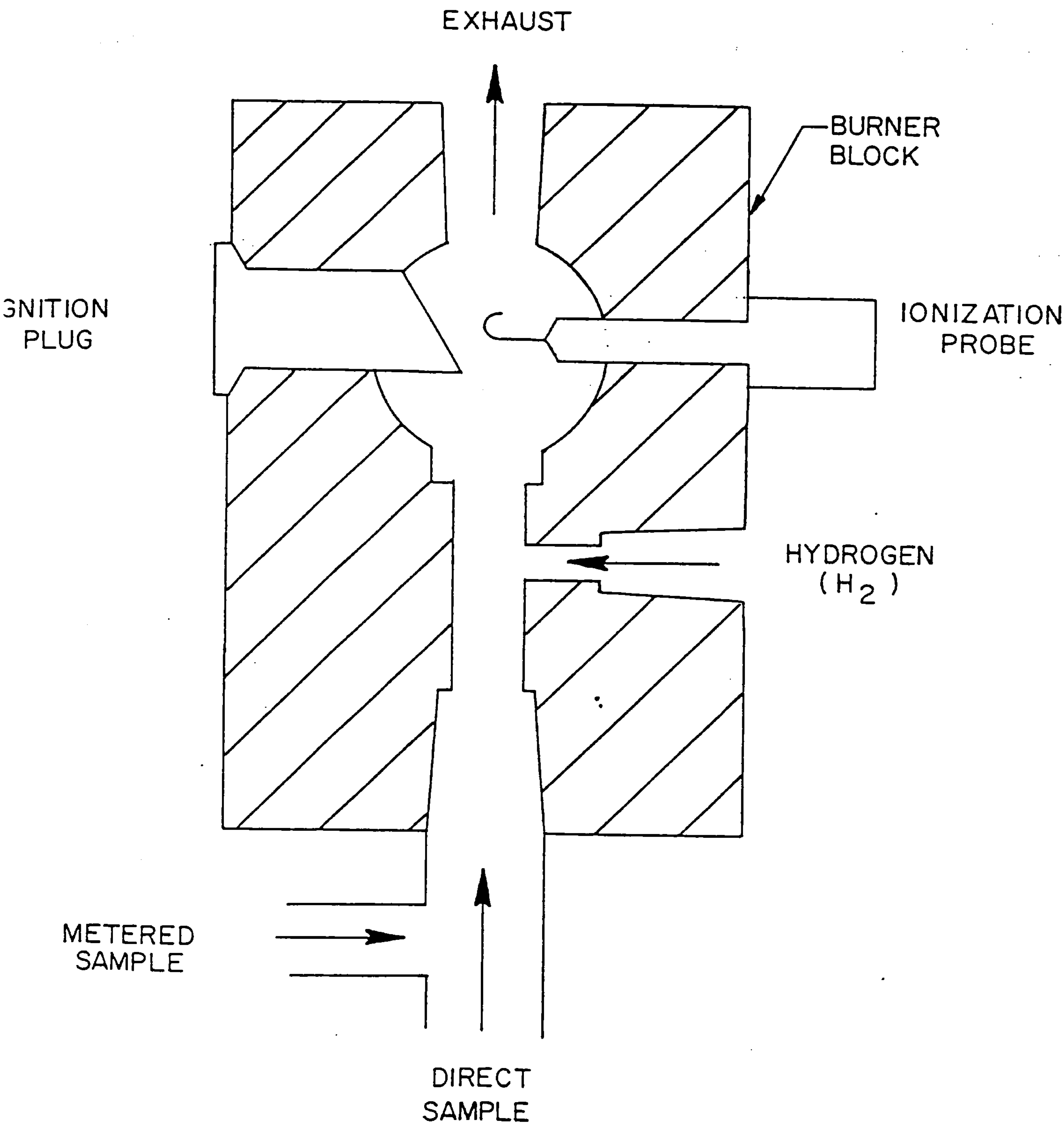


Figure 4.6 Interior View of the Burner Block

The basic tasks of the analyzer electronic system are to process the signal emanating from the FID detector for readout, to temperature-control the air and hydrogen pneumatic systems, to supply power to the subsystems, and to detect flame-out condition.

A functional block diagram of the electronic system is shown in Figure 4.8. A well regulated low voltage power supply provides ±15 Vdc for the electrometer amplifier, flame-out indicator, and output amplifier.

In the FID electrical system mercury batteries are used to apply an 84 volt positive potential to the ionization probe. The current produced at the probe is fed via the battery to an electrometer amplifier (J1) which converts the current to a voltage. The amplifier is adjustable so that the output may represent up to 5 decades of input current. The amplifier output is fed through the output Amplifier circuit for the total hydrocarbon analysis.

(1) Temperature Controllers (J26, 27)

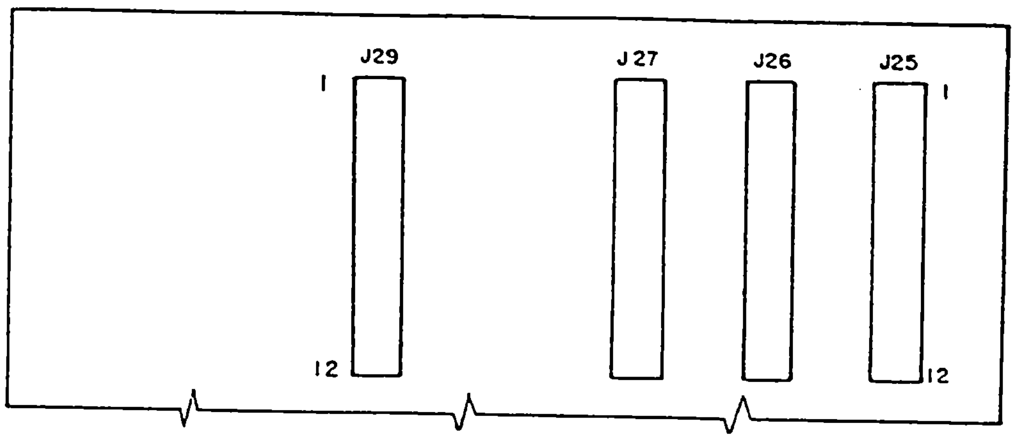
The temperature control boards utilize a local oscillator, controlled by a thermistor sensor to supply a drive signal for an a.c. switching device and thus provide proportional control. Switching of the triac is performed at the zero a.c. level to reduce R.F.I. effects. Each board has an adjustable resistor (R6) to set the temperature control point. The J27 board controls the temperature of the exhaust gas line and provides power to the heaters for both the burner block and exhaust assembly. The J26 board controls the temperature of the hydrogen capillary oven.

(2) Flame-out Detector (J29)

The flame-out detector circuit is a multi-function device. It detects the absence of a flame through the amplification of a thermocouple signal and contains circuitry for a re-light signal.

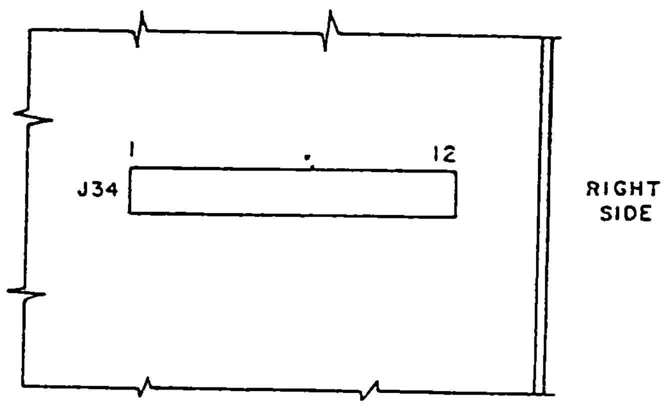
(3) Auto Reignite

A timer and relay in the instrument initiate the automatic ignition sequence after a flame-out has occurred. When flame-out is detected, a signal from the flame-out board (J29) causes K3 to de-energize. This activates the 10 minute timer motor. Cams connected to the motor shaft set the ignition sequence by controlling the closure of switches. The sequence gives switch closure for 30 seconds and switch open for 2.8 minutes. When the flame is on, K1 and K3 are energized. This stops the operation of the motor and ignition sequence. The wiring for this function is shown in Figure 8.1.



J25 — ±15VDC POWER SUPPLY
J26 — RESTRICTOR OVEN TEMP CONTROLLER
J27 — EXHAUST TEMP CONTROLLER
J29 — FLAME OUT INDICATOR

VIEWED FROM RIGHT SIDE OF UNIT



J34 — OUTPUT AMPLIFIER

VIEWED FROM TOP OF UNIT

Figure 4.7 Electronic Boards with Pin Locations

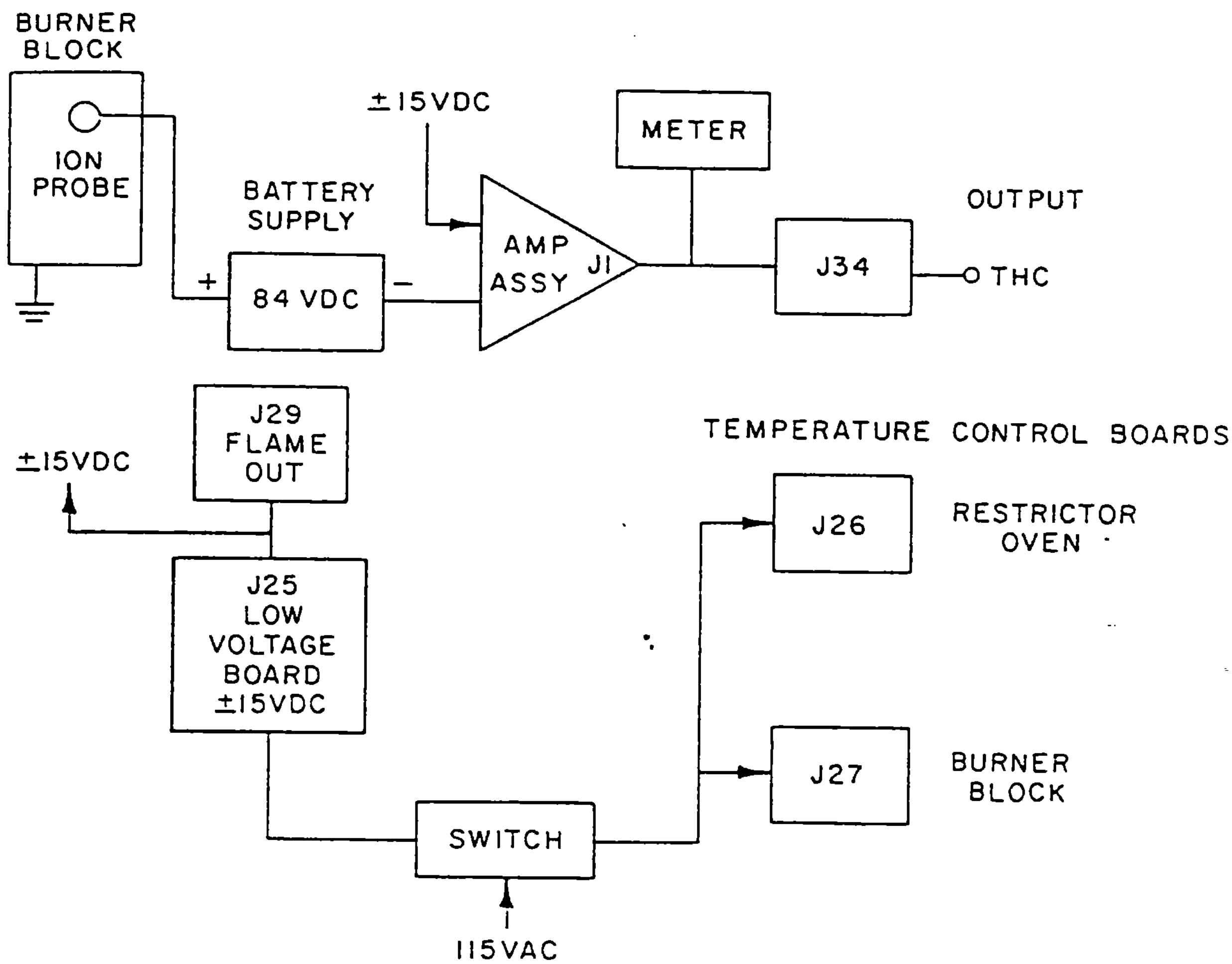


Figure 4.8 Block Diagram of Electronic System

(4) Power Supply (J25)

A low voltage supply (±15 Vdc) comprises the power supply subsystem. The ±15 volt supply provides power to the bulk of the electronic systems.

(5) FID Battery Source

The FID battery source consists of two 42 volt mercury batteries connected in series to provide the 84 Vdc potential in the FID detector circuit.

(6) FID Amplifier (J1)

The FID amplifier is a current to voltage converter which has a high input impedance characteristic. It is capable of providing a 1 volt output for 1×10^{-12} amps of input current with low noise and drift. This amplifier provides a 0-10 volt output level. The input zero adjust (R15) is used to adjust any voltage offset of the input amplifier (A1) to zero.

(7) Output Amplifier (J34)

This board employs a simple voltage divider network which takes a 10 Vdc input on pin 12 and supplies a 100 mV output on pin 4 and a 1.0 Vdc output on pin 5. This board is in the signal path between the Amplifier Assembly and the recorder output on the rear panel of the HC500-2D.

4.4 Front Panel

Figure 4.9 shows the front view of the analyzer with optional features included.

(1) Power Switch/Circuit Breaker

The power switch/circuit breaker is circumscribed by the region labeled "POWER" at the lower left hand corner of the panel. In the "ON" position, the switch is lit and provides 115 Vac to the analyzer. An internal circuit breaker will automatically turn the power off if a short occurs in the analyzer.

(2) Mode Switch (Option HC-26A or HC-11B)

The analyzer operational mode is controlled by the three position switch circumscribed by the region labeled "MODE" directly above the power switch. With the switch in "SAMPLE" position air introduced into the "SAMPLE INLET" port is analyzed. In the "ZERO" position, air is introduced into the analyzer through the "ZERO AIR" port. In the "CALIBRATE" position, air introduced into the "SPAN GAS" port is analyzed. Indicator lights are provided to show the position of the switch.

(3) Flow Controls and Indicators

All controls and indicators for making gas flow adjustments and measurements are circumscribed in the region labeled "FLOW".

a) Hydrogen Flow Adjust

The hydrogen flow is adjusted by the knob labeled "H ". Clockwise turn increases the flow rate.

b) Hydrogen Rotameter

The hydrogen flow rate is indicated by the rotameter labeled "H ". The flow rate is set properly when the center of the ball is at the value marked near the bottom of the rotameter or given on the calibration curve.

c) Air Flow Adjust

The air flow is adjusted by the knob labeled "AIR". Clockwise turn decreases the flow rate.

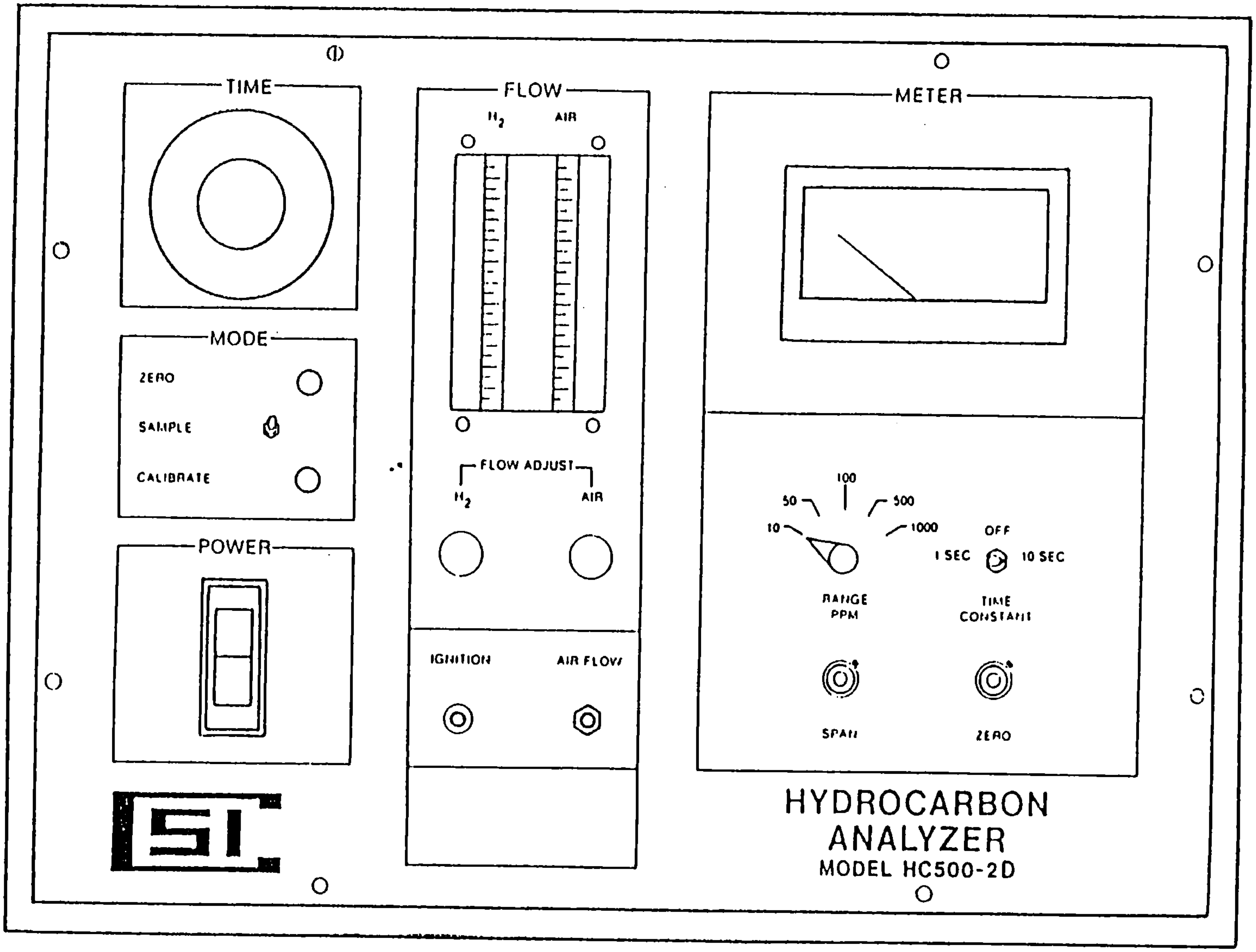


Figure 4.9 Front View of Analyzer

d) Air Rotameter

The air flow rate is indicated by the rotameter labeled "AIR". The flow rate is set properly when the center of the ball is at the value marked near the bottom of the rotameter or given on the calibration curve.

e) Air Flow (Option HC-26A or HC-11B)

This button is used when the air flow rate is to be read. Depressing and holding the button in energizes solenoid valve SV1, and causes air from the "ZERO AIR" port to pass through the "AIR" rotameter to the detector system.

(4) Ignition Button

The button marked "IGNITION", located in the circumscribed "FLOW" region, is used to ignite the flame. Depressing the button supplies power to the ignition plug in the burner block. When the indicator light in the button is lit, there is a "flame-out" condition, that is the flame is not burning. This button should not be pushed until the operation procedure is read.

(5) Electronic Controls and Indicators

Controls and indicators for making electronic adjustments or readings are circumscribed in the region labeled "METER".

a) Meter

The meter is used to indicate the hydrocarbon concentration in ppm of the air being burned in the analyzer. It is a 0-50 ua meter.

b) Range

The "RANGE" selector switch is used to set the output of the FID system. There are five selectable ranges 0-10, 0-50, 0-100, 0-500 and 0-1000 ppm hydrocarbon.

c) Time Constant Switch

A three position toggle switch is located at the right of the "RANGE" switch. It is used to minimize the output noise of the FID system when using the sensitive scales. The center "OFF" position bypasses this function. The "1 SEC" and "10 SEC" positions introduce a time constant into the output circuitry. The "10 SEC" position provides the lowest noise level in the output.

d) Zero

The "ZERO" knob, located to the bottom right of the "RANGE" is used to set the baseline for the FID output. This control is a ten turn potentiometer that provides 2 x 10 amps of buckout or suppression. Turning clockwise will increase the baseline signal. A locking device on the right side of the knob should be released, by pushing the lever counterclockwise, when setting this knob.

e) Span

The "SPAN" knob is used to adjust the output of the analyzer to the value of the span or calibration gas when that gas is being introduced into the analyzer and after the zero has been set. Turning clockwise will increase the gain or span output. A locking device on the right side of the knob should be released, by pushing the lever counterclockwise, when setting this knob.

(6) Timer Control (Option HC-11B)

The indicator dial located in the area labeled "TIME" is used to set the time to initiate the automatic calibration cycle. The dial is marked off in divisions representing 24 hours. When the "0" on the dial is adjacent to the mark under the word "TIME" the cycle will begin.

4.5 Rear Panel

Figure 4.10 shows the rear view of the analyzer.

(1) Electrical Connectors

a) Temperature Output Jacks

The jacks labeled "THERMOCOUPLES" are provided to monitor the temperature of the exhaust line, capillary oven and burner block. The temperature outputs are iron-constantan thermocouples. [Iron (white wire) is positive and constantan (red wire) is negative].

b) Power Cord

The analyzer power cord is located at the lower left hand corner of the rear panel. It can be plugged into a 110 ±10 Vac, 50/60 Hz source.

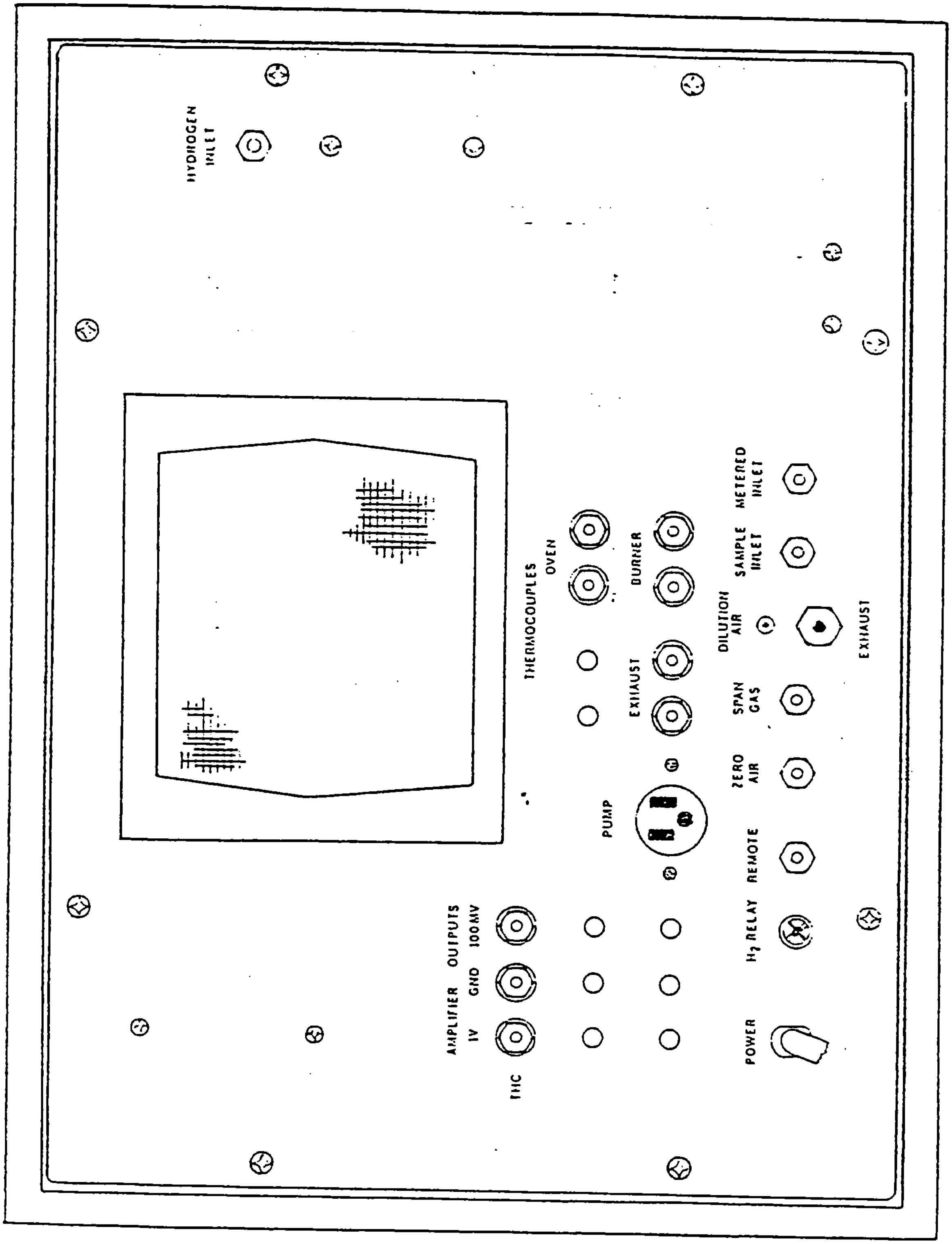


Figure 4.10 Rear View of Analyzer

c) Recorder Outputs

There are three jacks for the total hydrogren channel. The jacks are color coded: The black jack (common or ground) is used with either the red or white jacks for 0-1 volt or 0-100 mV full scale output, respectively.

d) Hydrogen Shut-Off Valve Connector

A 9-pin electrical connector labeled "H Relay" is provided for energizing an external hydrogen shut-off solenoid valve. Wiring of the connector is shown in Figure 8.1.

(2) Gas Line Connectors

a) The hydrogen gas inlet fitting is located near the upper right-hand corner and labeled "HYDROGEN INLET".

b) The sample air inlet is the fitting labeled "SAMPLE INLET".

c) Analyzers without Option HC-26A or HC-11B are provided with the fitting labeled "METERED INLET". This is used to determine the air flow rate.

d) The calibration gas inlet fitting (provided only with Option HC-26A or HC-11B) is labeled "SPAN GAS".

e) The zero air inlet fitting (provided only with Options HC-26A or HC-11B is labeled "ZERO AIR".

f) The analyzer exhaust 1/4" fitting is located at the center bottom edge of the rear panel and labeled "EXHAUST".

g) The dilution air enters through the tube opening at the center bottom edge of the rear panel and labeled "DILUTION AIR". This must be capped with a septum and a hypodermic needle inserted in the septum before operation.

(3) Cooling Fan

The cooling fan with screen is located at the center upper half of the rear panel.

5. OPERATION

Operation of the analyzer is a relatively simple task after initial set up. It requires only readout and operational adjustments for continuous operation.

5.1 Set-Up Procedure

Prior to start-up and operation of the analyzer, it is essential to prepare the system as follows:

1. Place Power Switch in "OFF" position. Remove analog meter shorting clip. Reinstall clip when shipping analyzer.

2. Connect 1/8" OD Teflon sample line to port on rear panel marked "METERED INLET". Analyzers with options HC-26A or HC-11B, connect sample line to port labeled "SAMPLE INLET".

3. If analyzer has Option HC-26A or HC-11B connect 1/8" OD Teflon line from zero and span sources to respective ports on rear panel marked "ZERO" and "SPAN".

    NOTE: These sources ("SAMPLE", "METERED", "SPAN" and "ZERO") must be vented sources or have close to one atmosphere pressure to avoid damage to analyzer.

4. Connect 1/8" OD hydrogen supply line to port on rear panel marked "HYDROGEN INLET". If an external hydrogen shut off valve is to be used, connect wires to electrical plug located on rear panel marked "H2 RELAY". See wiring diagram for pin connections.

CAUTION: HYDROGEN IS A FLAMMABLE GAS. USE METAL TUBING AND CHECK FOR LEAKS AT ALL CONNECTIONS. USE A HYDROGEN CYLINDER REGULATOR WITH A LIMITING ORIFICE. IF THE HYDROGEN CYLINDER IS NOT IN AN OPEN AREA, THE REGULATOR SAFETY RELIEF PORT SHOULD BE VENTED TO THE OUTSIDE.

5. Cap rear panel port marked "DILUTION AIR" with rubber septum cap and insert hypodermic needle supplied with instrument through center of septum.

6. If desired, vent analyzer exhaust to another location. Connect 1/4" OD line to port on rear panel labeled "EXHAUST".

7. Connect recorder or other readout device to corresponding output jacks on rear panel.

8. Connect power cord to 115 Vac, 50/60 Hz power source.

5.2 Start-Up Procedure

After completion of the set-up procedure, the analyzer is ready for start-up as follows:

1. Set front panel functional switches as follows:

a) "RANGE" to 1000 ppm.
b) "TIME CONSTANT" to "OFF" position.
c) "ZERO ADJUST" to 10.0 position (fully clockwise).

2. With hydrogen source shut off, push "POWER" switch to "ON" position. The "POWER" and "IGNITION" switches should light.

3. Adjust air flow so that the "AIR" rotameter ball is set at 6.0.

<u>NOTE:</u> With Options HC-26A or HC-11B place the calibrate switch in "ZERO" position to read the air flow.

<u>CAUTION:</u> The Air Control is a metering control only and should not be used as a shut-off valve. If the control is used to close off flow, particularly while the unit is warm, the valve may be damaged. The air control should <u>always</u> be left open.

4. Allow the burner chamber assembly to warm up for 15 minutes. The automatic temperature controller is factory set to warm up the assembly and maintain the proper operating temperature level.

5. Adjust the hydrogen supply inlet pressure to 60 psig.

6. Readjust the air flow rate to an "AIR" rotameter setting of 6.0.

7. Depress the "IGNITION" button, after a couple of seconds quickly set the hydrogen flow to read approximately 5.0 on the "HYDROGEN" rotameter and after a couple of seconds release the "IGNITION" button. The "IGNITION" button should not be lit.

<u>NOTE:</u> The analyzer will automatically light itself, however both the hydrogen and air flows must be set manually as above. The ignition button will not be lit during automatic ignition attempts. It will remain off if lighting is successful and come back on if unsuccessful.

<u>CAUTION:</u> When turning the hydrogen off, close the flow control only to the point that the ball just attains a zero reading. If the flow control valve is closed beyond this point, the valve may be damaged.

<u>NOTE:</u> If the "IGNITION" button is still lit, the flame is not burning. Repeat steps 3 through 7.

CAUTION: Never push the "IGNITION" button with the hydrogen flowing as this may cause an explosion in the burner chamber which could damage the ignitor.

NOTE: If ignition does not occur after several attempts, open the air valve another full turn counterclockwise prior to repeating the start-up procedure.

5.3 Operating Procedure

At the conclusion of the start-up procedure the analyzer is ready for operation.

1. After ignition, set the air and hydrogen flows to the values listed on the calibration curves supplied with the analyzer or printed on the front panel near the bottom of each rotameter.

2. Allow 15 minutes for the internal temperature of the instrument to stabilize and reset the hydrogen and air flows as before.

3. Set the Range and Time Constant switches to the desired positions.

4. Set the zero baseline as follows: with the zero air entering sample inlet (or with Option HC-26A or HC-11B the Mode switch in "ZERO" position and zero air line connected to the "ZERO" inlet) set the meter on the front panel to read zero with the "ZERO" adjust pot on the front panel.

5. Connect the sample air line to "SAMPLE INLET" port and securely cap the "METERED INLET" port (place "MODE" switch in the "SAMPLE" position with analyzers having Option HC-26A or HC-11B).

6. If the analyzer has Option HC-11B set "TIME" dial to desired position (see instructions for setting switch in section 10).

7. The analyzer is now ready for sampling. The "SPAN" has been preset at the factory and should not be adjusted unless the analyzer is to be calibrated. A dynamic calibration of the analyzer may be performed as described in section 5.4.

5.4 Calibration Procedures

Each individual analyzer is calibrated at the factory prior to shipment and calibration curves supplied with it. These curves contain operating conditions specific to the unit. Typical curves are shown in Figures 5.1 and 5.2.

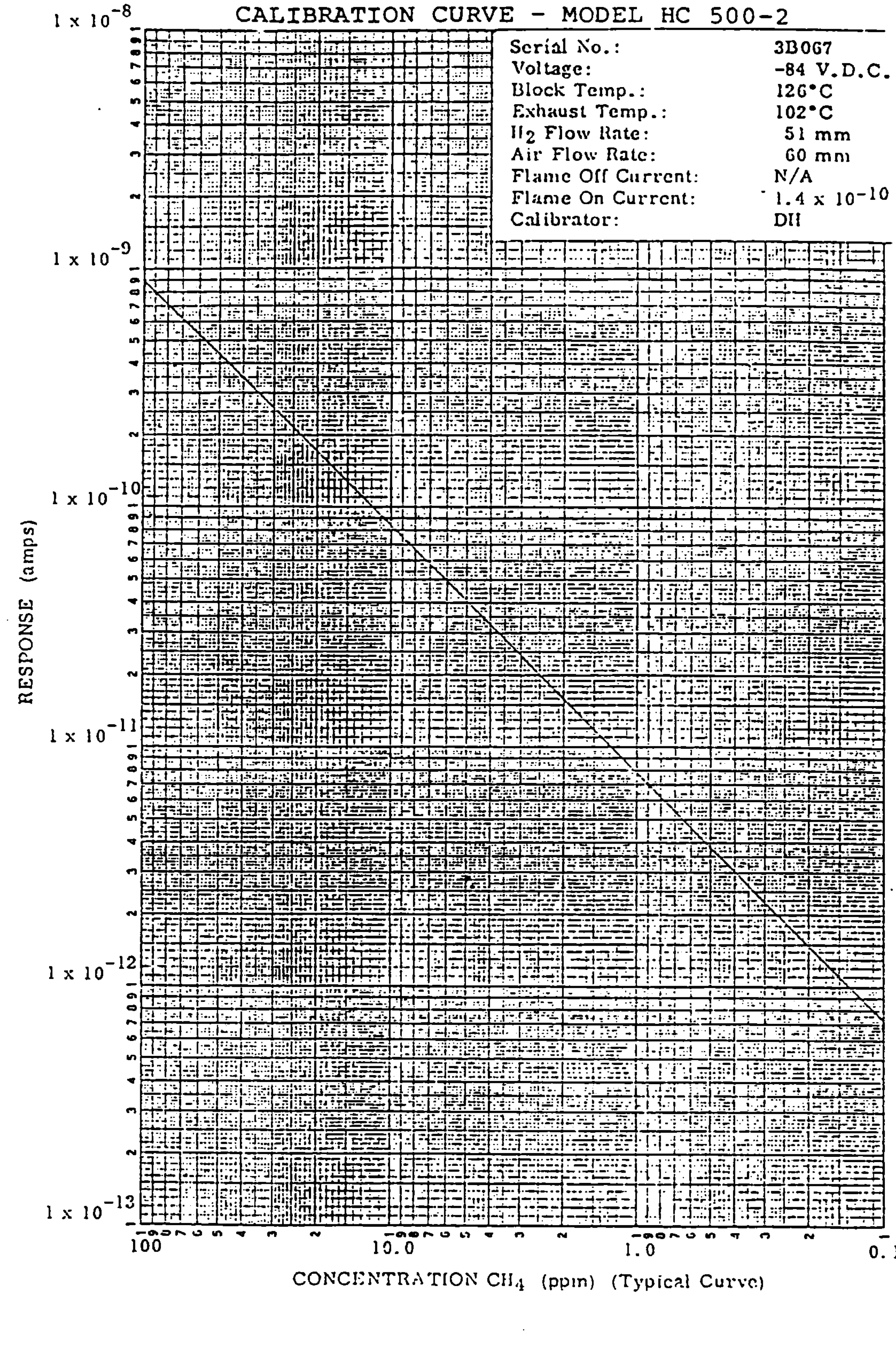


Figure 5.1 Typical FID Calibration Curve
(0.1 to 100 ppm methane)

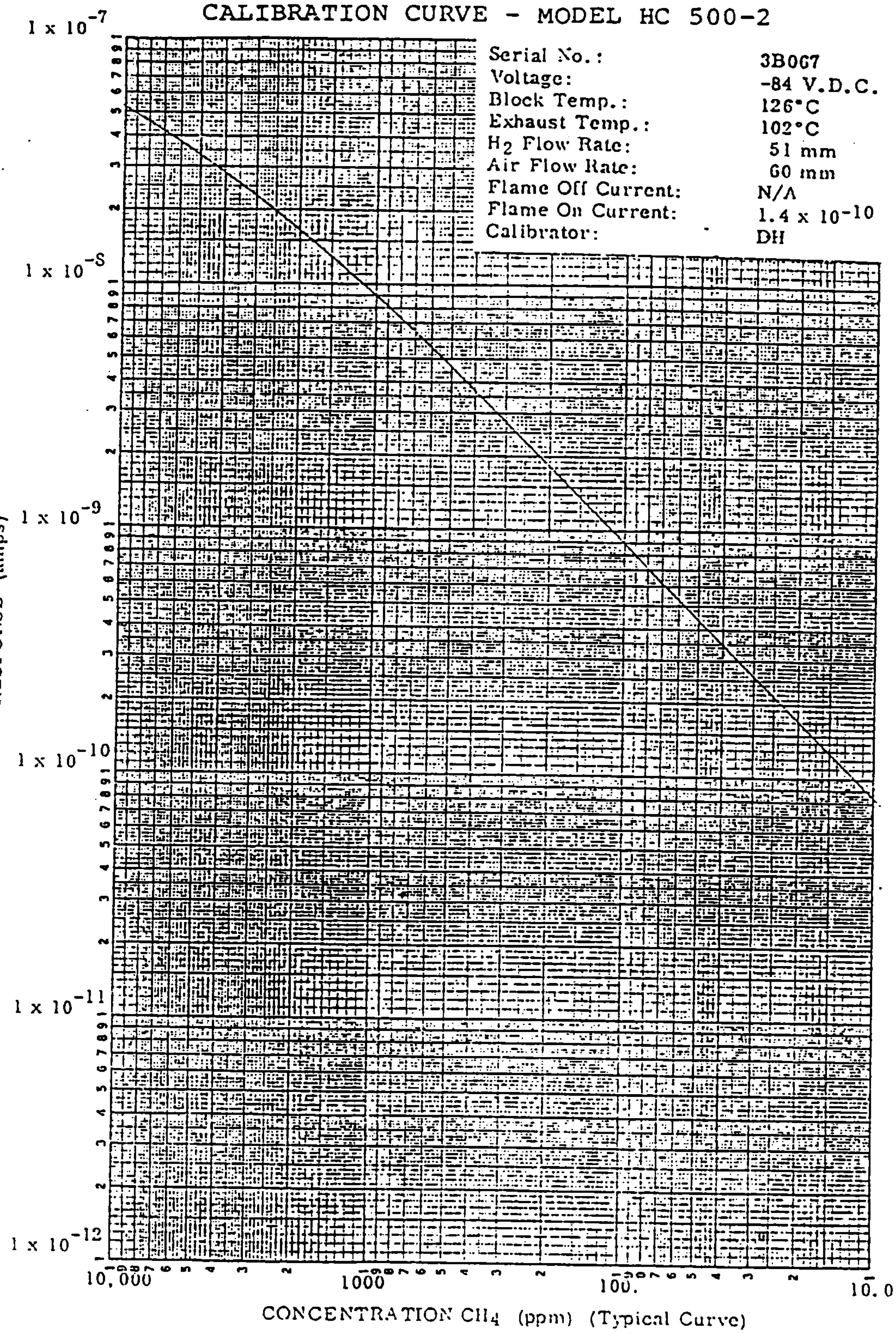


Figure 5.2 Typical FID Calibration Curve (10.0 to 10,000 ppm methane)

(1) <u>Calibration Curve</u>

The calibration curve is the ion probe current response to sample hydrocarbon concentration levels referenced to "ZERO AIR", i.e. air scrubbed of hydrocarbon compounds.

<u>NOTE:</u> Air supply lines usually contain hydrocarbons unless filtered. A list and definition of the calibration curve parameters are given below:

a) Serial No. - Number assigned to the specific analyzer. Number also given on rear panel of analyzer.

b) Voltage - The voltage of the ion probe.

c) Oven Temperature and Exhaust Temperature - the temperature of the restrictor oven and exhaust line can be measured. Thermocouples are iron-constantan.

d) H Flow Rate and Air Flow Rate - the recommended rotameter settings for hydrogen and air.

e) Flame-Off Current - the analyzer residual baseline with the flame off.

f) Flame-On Current - the analyzer residual baseline reference established by sampling "ZERO AIR". Flame-on current must be subtracted from signal reading to obtain a high degree of accuracy at low hydrocarbon concentrations. If no buckout or "ZERO" control is used, the flame-on current specified is directly subtracted from the analyzer output to obtain the hydrocarbon concentration level. In setting the "ZERO" control, zero air must be introduced into the analyzer. This is required because room air contains small amounts of hydrocarbon compounds which increase the actual reading. This zero air reading may then be reduced by using the "ZERO" control and establishing a new baseline.

g) Calibrator - initials of person who performed the test.

(2) <u>Dynamic Calibration</u>

The instrument can be calibrated dynamically by using a zero air source and methane span gas source. The procedure is as follows:

a) Set air and hydrogen flows to the settings given on the specification sheets.

b) Introduce zero air to analyzer. (Mode switch in zero position with Option HC-26A or HC-11B).

c) While in the direct mode use "ZERO" adjust pot to set THC output.

d) Set "RANGE" switch to appropriate position for concentration of methane span gas to be used.

e) Introduce methane span gas to analyzer. (Mode switch to calibrate position with Option HC-26A or HC-11B).

f) Adjust span knob so that output reads methane value.

g) Repeat steps b, c, d and e several times until zero and span are repeatable.

5.5 Shut-Down Procedure

To shut down the unit for a short time, turn off the hydrogen flow at the hydrogen tank. Do not switch off sample pump until all hydrogen has been bled from system. The electronics may be left on. For longer periods of time turn off the main power switch. If the unit is to be moved, shipped, or stored, disconnect the gas lines and electrical connections on the rear panel. Protect the ports, both from thread damage and dirt in the lines. Swagelok caps are suggested. Remove the #18 hypodermic needle from the dilution port to keep it from being bent. This can be taped to the unit to prevent loss. The shipping box the unit came in or its equivalent is recommended for optimum protection.

6. MAINTENANCE

The analyzer maintenance requirements are primarily associated with the pneumatic subsystem and the burner assembly. The recommended maintenance schedule is given in Table 6.1. The cleaning and replacement procedures are given below.

6.1 Pneumatic Sampling Network

Under most operating conditions, the sample cleanliness level determines the maintenance frequency. The wearout or replacement times of the elements listed below are rated for continuous operation of the analyzer in a reasonably clean environment.

(1) Teflon Lines

The Teflon lines must be periodically replaced or cleaned. Over long term continuous operating periods the sample line may accumulate deposits which can impede the sample air flow rate and/or interact with the sample gas. The frequency of replacement is dependent upon the average condition of the sample ingested. However, CSI recommends replacement or cleaning every 12 months.

If lines are replaced, remove all lines with their fittings. Cut new lines to the same dimensions as the old lines and use new fittings when installing the new lines. The lines can be cleaned by removing them and pulling a good, fresh degreasing solvent (e.g. Freon) through the lines at a high velocity. Thoroughly dry lines before reassembly.

NOTE: Use only Teflon tubing for replacement that has been purged of impurities.

CAUTION: Be sure all hydrogen gas has been flushed with air before removing the lines and all new lines are properly retightened.

(2) Flow Restrictor Capillary

It is important that the flow restrictor capillary be free of dirt to maintain a stable flow. The capillary should be replaced only when hydrogen flow cannot be maintained and other components are proven to be functioning correctly. Be sure the hydrogen source flow and detector temperature are stable, the hydrogen and exhaust orifices are clean, and there are no leaks, before replacing the capillary.

Table 6.1 Recommended Maintenance Schedule

ITEM	ANNUAL MAINTENANCE	BIENNIAL MAINTENANCE
Pneumatic Sampling System:		
Teflon Lines	Replace*	
Flow Resictor Capillary	Replace	
Rotameters	Clean*	
Hydrogen Regulator		Replace
Dilution Air Orifice	Replace*	
FID Burner Assembly:		
Burner Chamber	Clean*	
Chassis, Fan Assembly:		
Air Filter	Clean*	
FID Detector Batteries	Replace	
Pump		Replace

*NOTE: These items may require maintenance more often, depending on cleanliness of its environment and the exposure rate.

(3) Rotameters

Rotameters should be cleaned every 12 months, or when the ball does not move freely when adjusting the flow. To clean, remove both inlet and outlet lines and flush with Freon or similar degreasing solvent.

(4) Hydrogen Regulator

The hydrogen regulator should be replaced every 24 months. To replace, remove inlet and outlet lines and the front panel securing nut. Remove regulator and replace new one in reverse manner. Replace with only a regulator from CSI as this is a special regulator.

CAUTION: Be sure to flush all hydrogen from lines before removing the lines and that all lines are properly retightened.

(5) Dilution Air Orifice

The orifice is a size #18 hypodermic needle 1 inch long, which controls the 4 liters/min flow of dilution air. The needle and septum should be replaced every 12 months.

6.2 FID Burner Assembly

(1) Burner Chamber

The burner chamber will periodically require cleaning. If loss of sensitivity is noticed it should be suspected that the unit is dirty. Some units have functioned continuously for over 30 months without cleaning being necessary. To clean the detector, follow this procedure:

a) Remove the ac power supply cord from the electrical power source. Unlock the eight screws from the sides of the cover and lift the cover off.

b) Disconnect the hydrogen inlet, air inlet and exhaust air outlet line at the burner block and cap the hydrogen inlet with a Swagelok plug (P/N 200-P).

c) Connect to the burner exhaust port a liquid suction apparatus, such as a water aspirator with a suitable trap, to flush the liquid through the burner chamber.

d) Inject distilled water into the burner block (a length of Teflon line with a 1/8" Swagelok fitting will help in this step).

e) repeat the purging operation using reagent grade acetone.

f) Connect a clean air supply to the air inlet and purge the system for a period of approximately 10 minutes or until no trace of acetone is detectable in the exhaust.

g) Plug in the ac power supply to a power source, place "POWER" switch to the "ON" position, and continue clean air flushing.

CAUTION: Disable Auto Re-ignite function (remove K3). Do not actuate the ignition switch during the cleaning procedure, as this may cause damage to the glow plug.

h) Allow the unit to operate for one (1) hour. This should completely dry out all internal components in the burner chamber and sample and exhaust lines.

i) Following the drying period, reconnect the hydrogen line to the burner chamber. Perform a leak test by removing the exhaust line from the top of the burner block and capping it. Also cap all the air inlet ports. Attach a hydrogen* supply line to the "HYDROGEN INLET" port. Adjust inlet pressure to 5 psig and open the hydrogen flow control valve. Any displacement of the float in the H rotameter indicates a leak in the system. An initial displacement and return of the float to 0 mm is normal when the H valve is opened and does not indicate a leak.

j) After finding and stopping the leaks, if any, reconnect the lines as before. The analyzer is now ready for start-up procedure.

6.3 Chassis, Fan Assembly

(1) Air Filter

The air filter for the chassis ventilating fan should be cleaned every 12 months or as needed. Shut off the power to the analyzer and remove the filter. Wash it in warm detergent solution and recoat with ROTRON filter oil or equivalent.

6.4 Electronics

The electronics of the analyzer are essentially trouble free and, except for the FID batteries, should not require periodic maintenance. However, should the amplifier need replacing it will need recalibration. The recalibration should be attempted only by qualified people with the proper equipment.

*Helium may be substituted for hydrogen for purposes of safety, though no problem has been encountered to date using hydrogen and exercising general safety practices.

(1) Battery Replacement

The two mercury batteries should be replaced every 12 months. Replace batteries by the following procedure:

a) Unplug analyzer from wall socket and remove cover.

b) Remove two screws on top cover of battery holder (located on bottom right side just behind front panel).

c) Remove holder cover and lift out Teflon wrapped batteries. Care must be taken not to break the resistor attached to the snap-on connectors.

d) Remove Teflon protective insulation and disconnect batteries from snap-on connectors.

e) Replace new batteries in reverse order.

(2) Electronic Alignment

All voltages are measured with respect to chassis ground unless otherwise noted.

a) Turn on power and remove the analyzer cover.

b) Set the ZERO control on the front panel fully clockwise and the RANGE control to the 500 ppm position.

c) Connect a current source (KEITHLEY MODEL 261 or equivalent) to the amplifier input jack (J2). Set the current for zero or any current less than 1 x 10 amps.

d) Monitor pin 12 of J34 with a d.c. digital voltmeter (Fluke Model 801 or equivalent) and adjust R15 on the amplifier board (J1) for 0.000 volts.

e) Set the RANGE control on the front panel to 10 ppm and set the current source for a reading of 10 volts on the DVM at J34, pin 12.

f) Adjust R24 of the amplifier board (J1) until the front panel meter reads full scale.

g) Measure voltage at J15 rear panel and adjust R4 on output amp board (J34) for 1.000 Volt, and adjust R3 for 100mV at J17 on rear panel.

This completes the electronic alignment. Disconnect the current source and digital voltmeter, connect the cable from the battery to the amplifier at J2. The instrument is now ready for operation.

7. TROUBLE SHOOTING PROCEDURES

The analyzer is designed to provide trouble-free continuous operation. However, in the event of a problem or malfunction, the trouble shooting procedure listed below presents an orderly sequence of tasks to locate and correct the instrument malfunction.

Symptom	Probable Cause	Corrective Action
1. Power switch "ON" but does not light.	No power to analyzer.	Check power at 115 Vac outlet. Be sure plug is securely in outlet.
	Defective fuse.	Replace fuse.
	Burnt out indicator bulb.	Replace power switch.
	Defective transformer.	Replace isolation transformer.
2. Power switch will not stay in "ON" position.	Short in electrical system.	Find and fix electrical problem.
3. Ignition switch does not light with flame out.	Defective light.	Replace ignition switch.
	Open circuit.	Repair loose or broken wires.
	Defective relay (K1).	Replace relay if it does not make a click sound when "IGNITION" button is pushed
	Loose or defective flame-out board.	Check to see if board is properly set in place. Replace defective board.
	Defective transformer.	If secondary output of T1 transformer is not 6.3 Vac, replace transformer.

	Defective temperature sensor.	Disconnect lines to thermocouple. If higher than 500 ohms, replace thermocouple.
4. Ignition button remains lit after being pushed.	Flame not burning.	See symptom #7, "Analyzer fails to ignite".
5. Air flow absent, incorrect, or unstable.	Defective vacuum pump.	Check vacuum system (should be capable of maintaining 5 l/min flow rate at 370 Torr), if not, replace pump.
	Wrong flow setting.	Set air flow to recommended value.
	Dirt in flow system.	Isolate source by disconnecting, starting at analyzer inlet and working towards pump.
	Leak in flow system.	Retighten fittings and caps. Check lines for small holes.
	Moisture in exhaust line.	If exhaust line is warm (about 90 deg C at thermocouple) allow analyzer to run for 10 min to dry line; if not dry replace exhaust line.
	Defective flow control valve(s).	Replace valve(s)
	Dilution air orifice clogged or septum leaking.	Replace needle and/or septum.

	Loss of temperature control.	See symptom #12 "No or incorrect temperature control".
6.Hydrogen flow absent, incorrect or unstable.	Hydrogen source empty or not producing sufficient hydrogen.	Replace hydrogen source or its regulator. Set regulator on hydrogen source at 30 psig and open all related valves.
	Hydrogen shut-off valve not energized.	Check voltage for 110 Vac to valve when "IGNITION" button pushed.
	Internal hydrogen regulator defective.	Replace regulator.
	Flow system problems.	See discussion above on air flow problems.
7.Analyzer fails to ignite.	Improper hydrogen or air flow.	Set flow as recommended.
	Insufficient purge.	Open flow control valves until rotameters are set at 6.0, and allow gases to purge for 30 seconds.
	Temperature too low.	Check temperature by inserting temp. indicator into thermocouple terminals at rear of instrument. The exhaust temperature should read above 90 deg C, and block temperature

		above 90 deg C. If temperature indicator is not available, remove instrument cover and feel exhaust line which should be warm.
	Ignitor glow plug defective.	Remove flame-out indicator board from J29 connector and measure resistance between pin 11 on J29 connector and chassis (ground). If resistance is not in the order of 20 ohms replace ignition plug and O-ring.
	Loose or defective flame-out board.(J29).	Be sure board is properly in its socket. Measure voltage between test point on board and chassis(ground). If flame is off, voltage should be -1.5 to -2.0 volts. If flame is on, voltage should be 4.0 volts or higher. Adjust R3 for proper voltage or replace board If voltage is not between 5-10 Vdc, when flame is lit replace board.
8.No output at meter but power switch lights.	Flame not burning.	If "IGNITION" button is lit relight flame per instructions

Loose electronic board or connections.	Insure all boards are securely in place. Check for loose wires or connectors.
Defective meter.	If the recorder output and current across terminal leads to meter are good, replace meter.
No power to low voltage power supply board.	Remove low voltage power supply board from J25 connector. Measure across pin 4 and pin 9 for 115 Vac, if missing check for loose wire at connector or electrical leads to connector.
Defective low voltage power supply board.	Check J25 connector (with board in place) for +15 Vdc across pin 11 and chassis (ground) and for -15 Vdc across pin 2 and chassis. If missing either voltage, replace board.
Defective batteries.	Remove "PROBE" (+) and "AMP"(-) connectors from battery holder (located at bottom front right). Measure voltage between the center pins of the two connectors on battery holder. If not 80 $\pm$5 Vdc replace batteries inside holder.

	Defective amplifier assembly.	Connect an external calibrator to the amplifier input to determine if amplifier functions.
9. No output to recorder.	Defective output amplifier.	Replace amp board or look for broken wires
10. Loss of analyzer sensitivity and/or noisy operation.	Flows not set properly.	Set air and hydrogen flows to recommended values.
	Leaks in flow system.	Retighten fittings. Check lines for small holes.
	Dirty burner block.	Clean burner block per instructions.
	Impure hydrogen.	Replace source if noise increases greatly with small increase in hydrogen flow rate.
	Loss of temperature control.	See symptom #12 "No or incorrect temperature control".
11. Unstable or incorrect zero.	Zero or span source spent or incorrect.	Verify or replace source.
	Leak in zero air system.	Locate leak and fix.
	Solenoid valve(s) defective for analyzers with Options HC-26A or HC-11B.	Replace valve(s)
	Contaminated or clogged air lines.	Replace or clean air flow lines.

	Flows set improperly.	Set air and hydrogen flows to recommended values.
	Zero and span controls not set up properly.	Recalibrate instrument per instructions.
	Dirty burner block.	Clean burner block per instructions.
	Defective battery.	See symptom #3 "No Output".
12. Temperature control inoperative or incorrect.	Defective heaters.	A) Burner block heater: Disconnect plug P4 (located on burner assembly) Measure resistance between connector contacts H and F If there is no continuity or resistance is greater than 500 ohms, replace heater. B) Exhaust heater: Remove temp controller from connector J27 and unplug P4. Measure the resistance between pins H and F on the plug. If there is no continuity or resistance is greater than 500 ohms, replace heater. C) Restrictor Oven: Remove low temp controller from connector J26. Measure resistance between TB3-3 and TB3-4. If

	there is no continuity or resistance is greater than 500 ohms, replace heater.
Defective thermistor.	A) Exhaust Thermistor: Remove high temp control board from connector J27. Measure resistance across contacts 1 and 9. If resistance is not approx. 100K ohms at 25 deg C replace thermistor. B) Restrictor Oven: Remove low temp control board from connector J26. Measure resistance between contacts 1 and 9. If resistance is not approx. 4K ohms at 25 deg C replace thermistor.
Defective temperature control board.	The exhaust temp control (J27) and capillary oven (J26) boards may be checked as follows: Measure the input voltage 115 Vac, between contacts 2 and 10 (neutral) for each board connector. If missing, check for broken or loose wires. If present, measure the voltage

between contacts 6 and 10 (neutral) or each connector. The voltage should show variations during one min. of measuring. If not, replace board.

NOTE: Heaters and thermistor should be checked and found good before this step.

8. SCHEMATICS

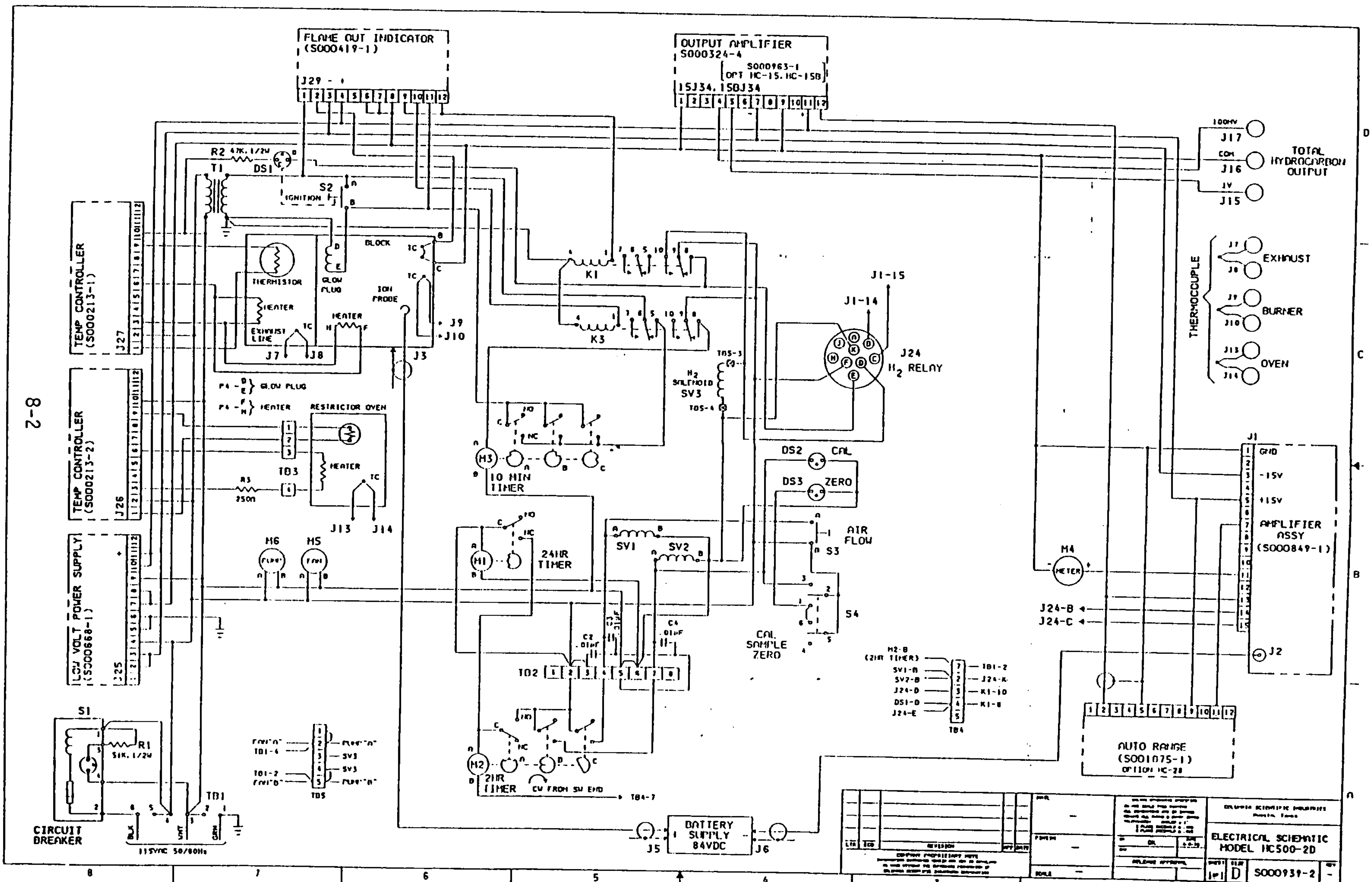
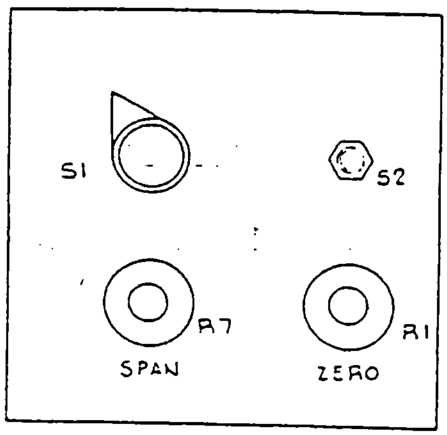
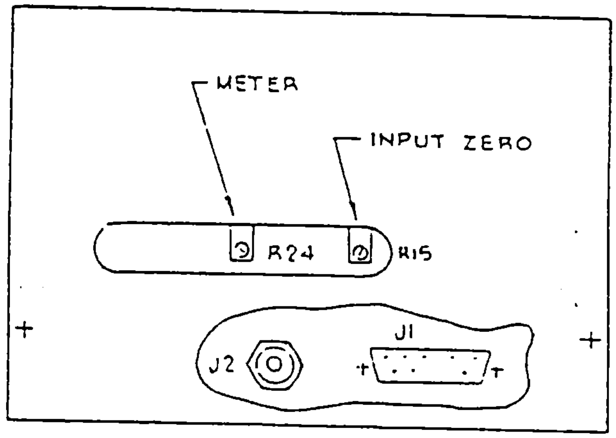


Figure 8.1 Wiring Schematic for HC500-2D



FRONT VIEW



SIDE VIEW

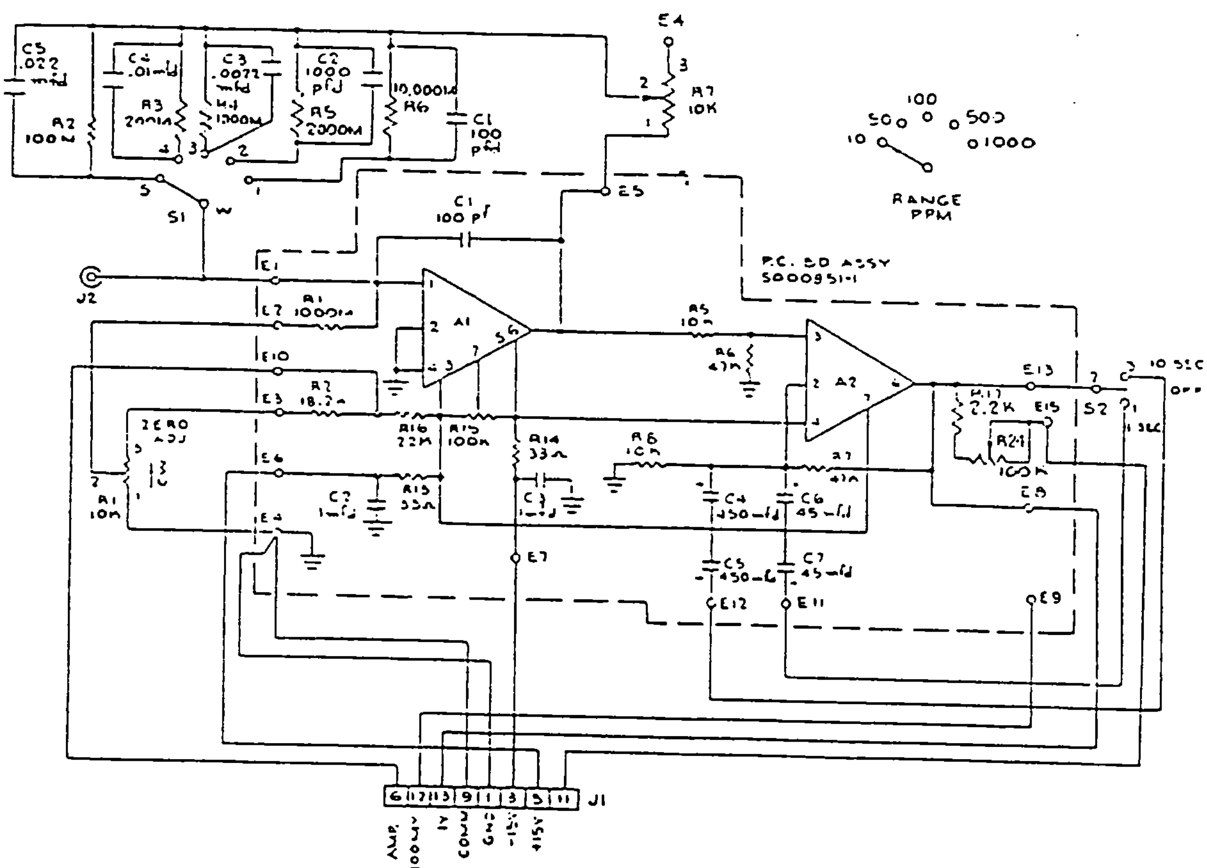
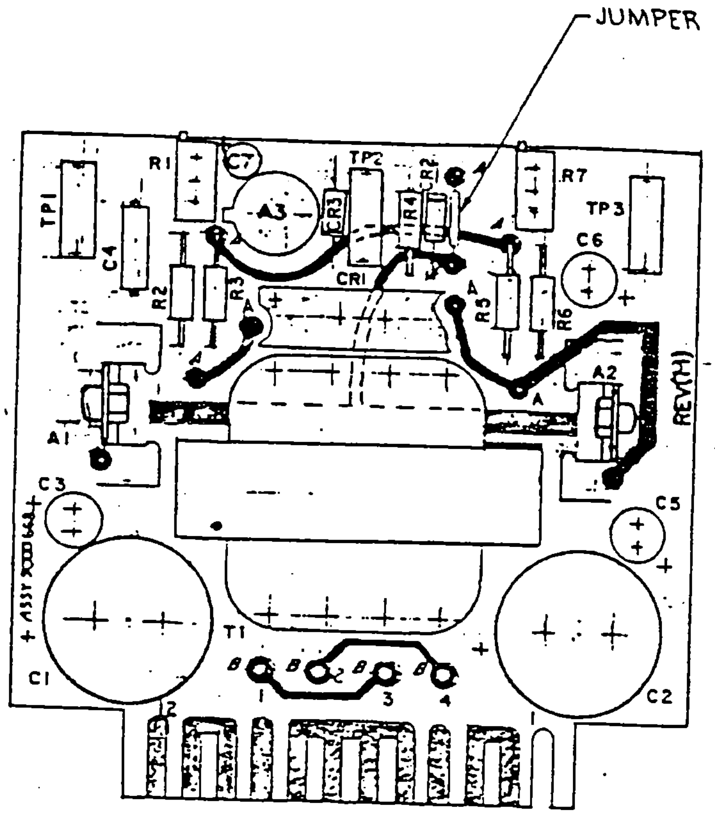
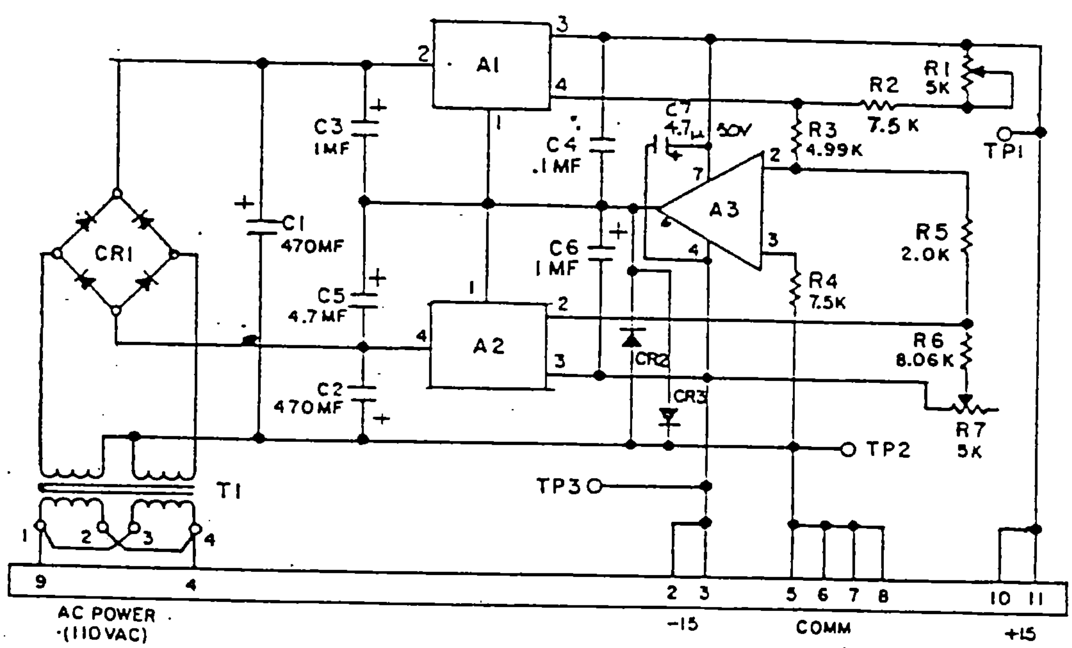


FIGURE 8.2 Amplifier Assembly



COMPONENT SIDE



ELECTRICAL SCHEMATIC
(DASH -1)

FIGURE 8.3 ±15 Vdc Power Supply Board

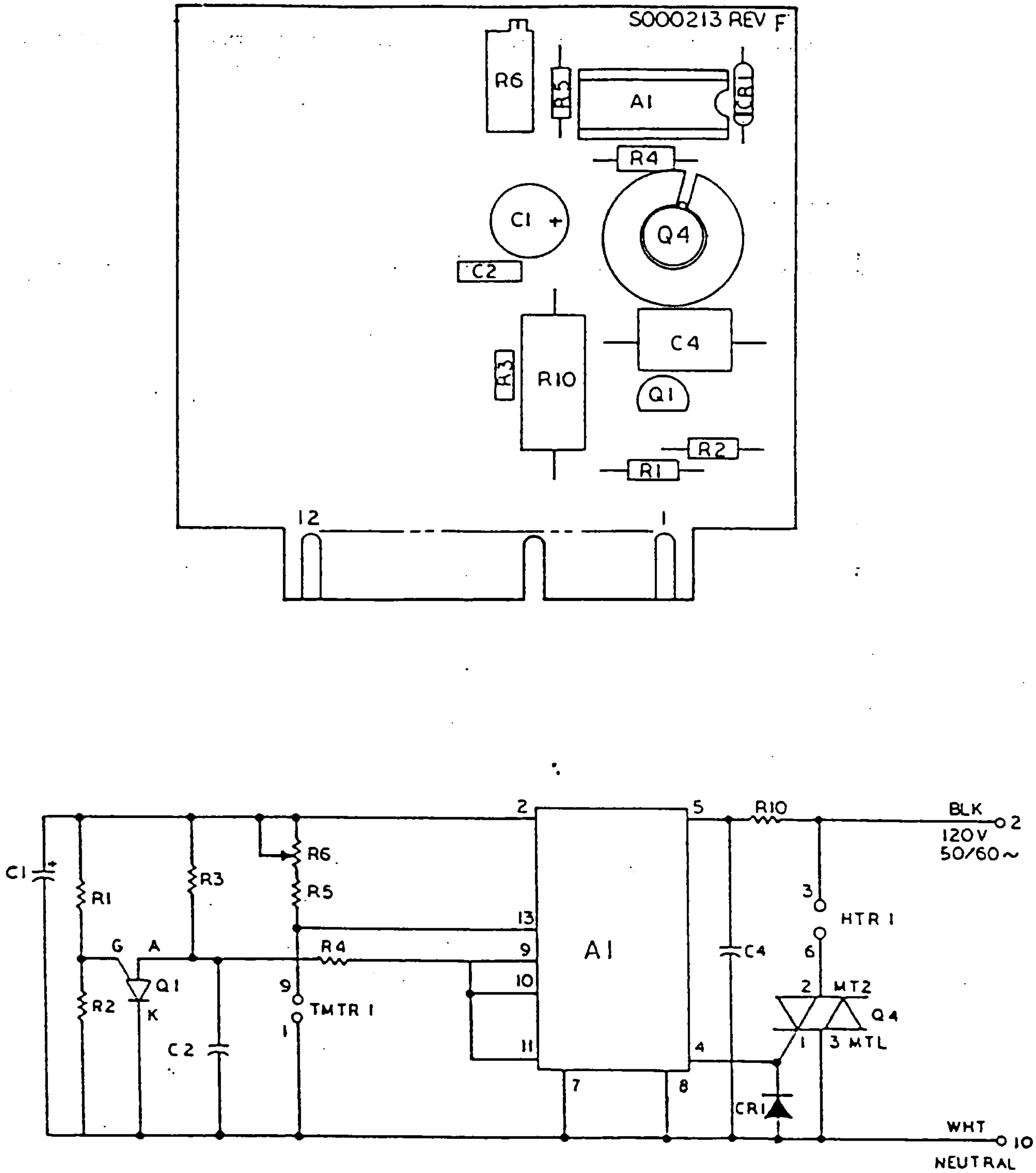


FIGURE 8.4 Temperature Control Module

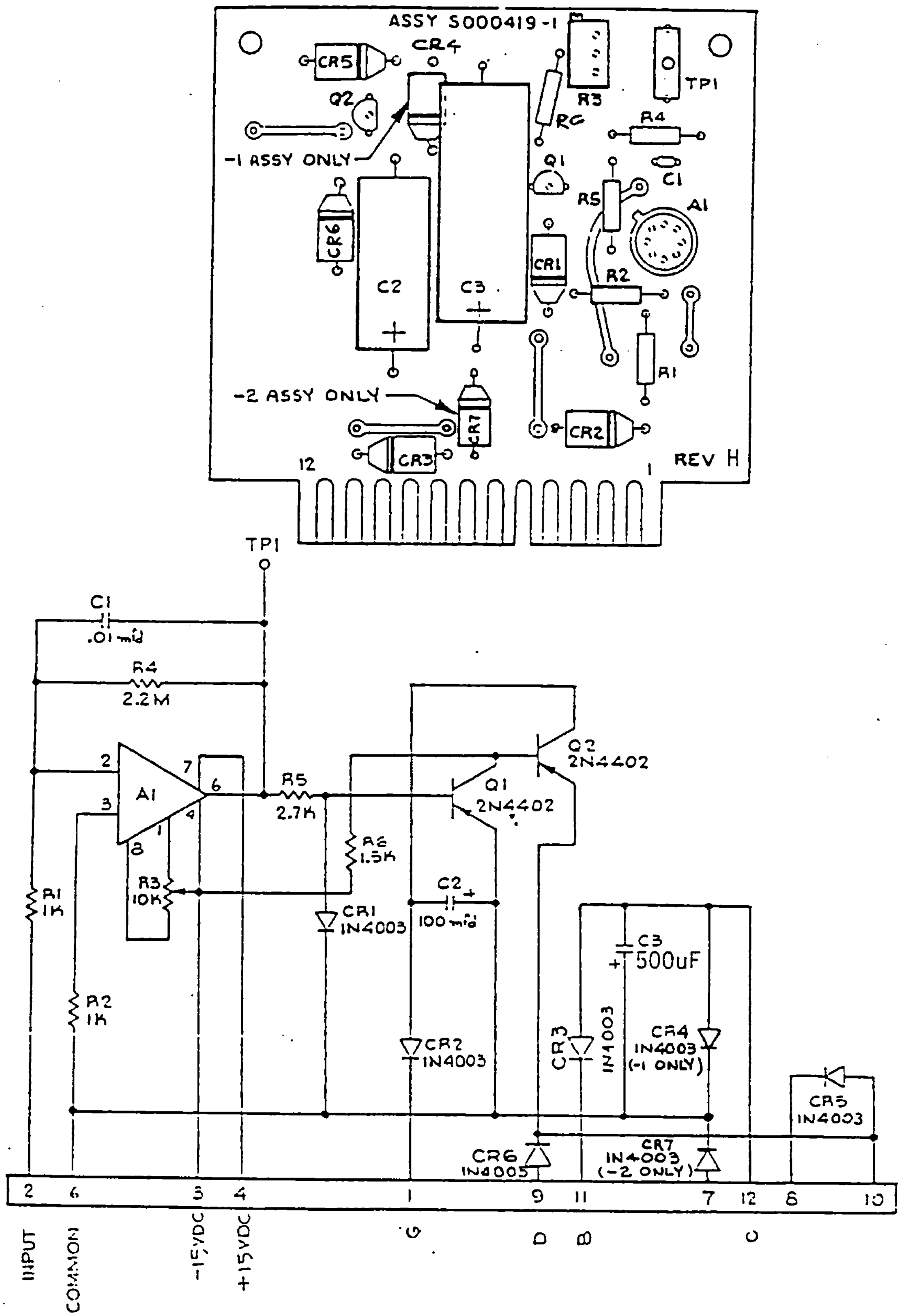
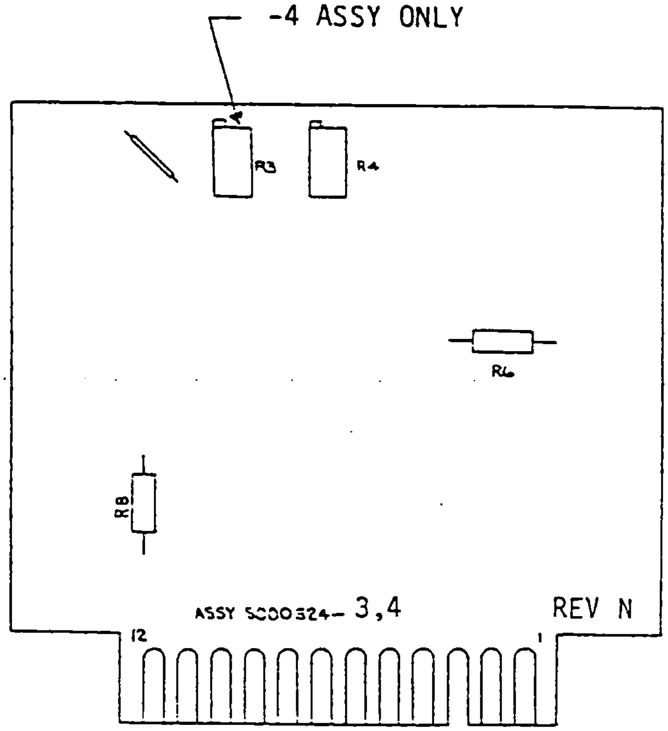
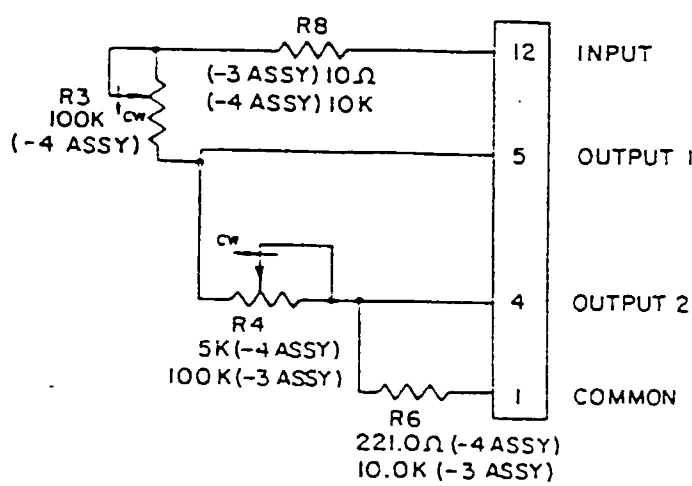


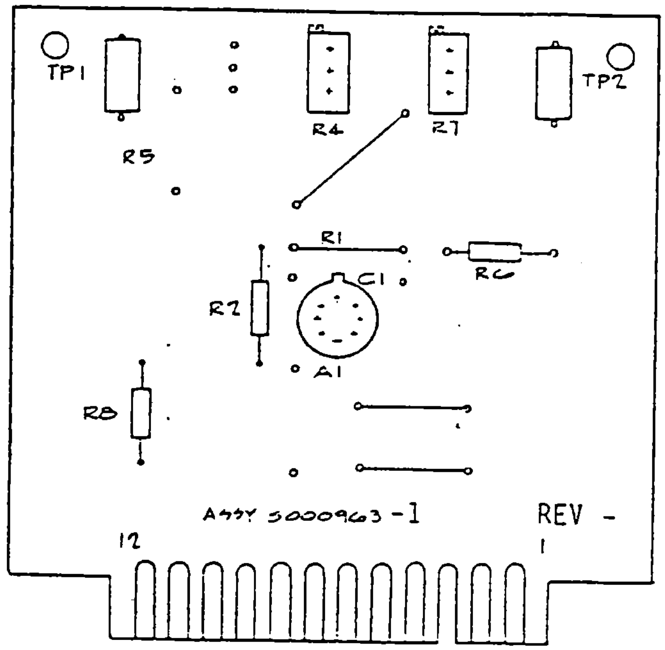
FIGURE 8.5 Flame-Out Module





-3 AND-4 SCHEMATIC

Figure 8.6 Output Amplifier, S000324-4 (J34)



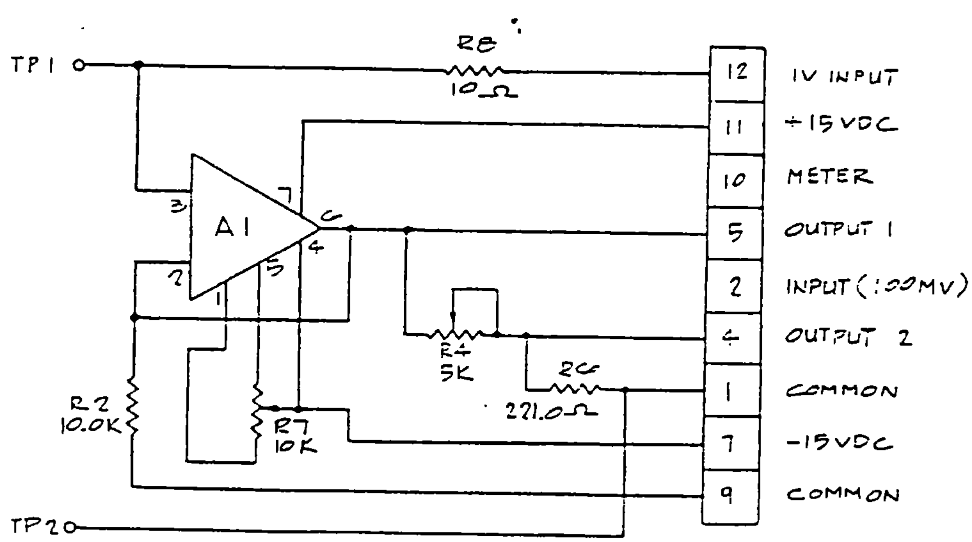
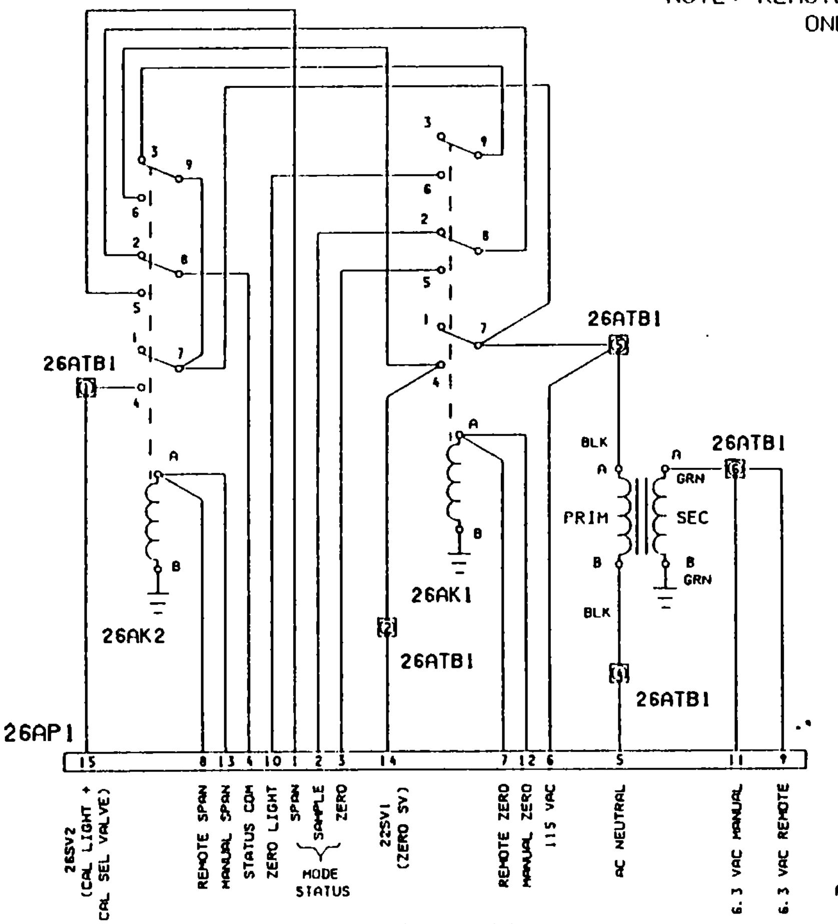
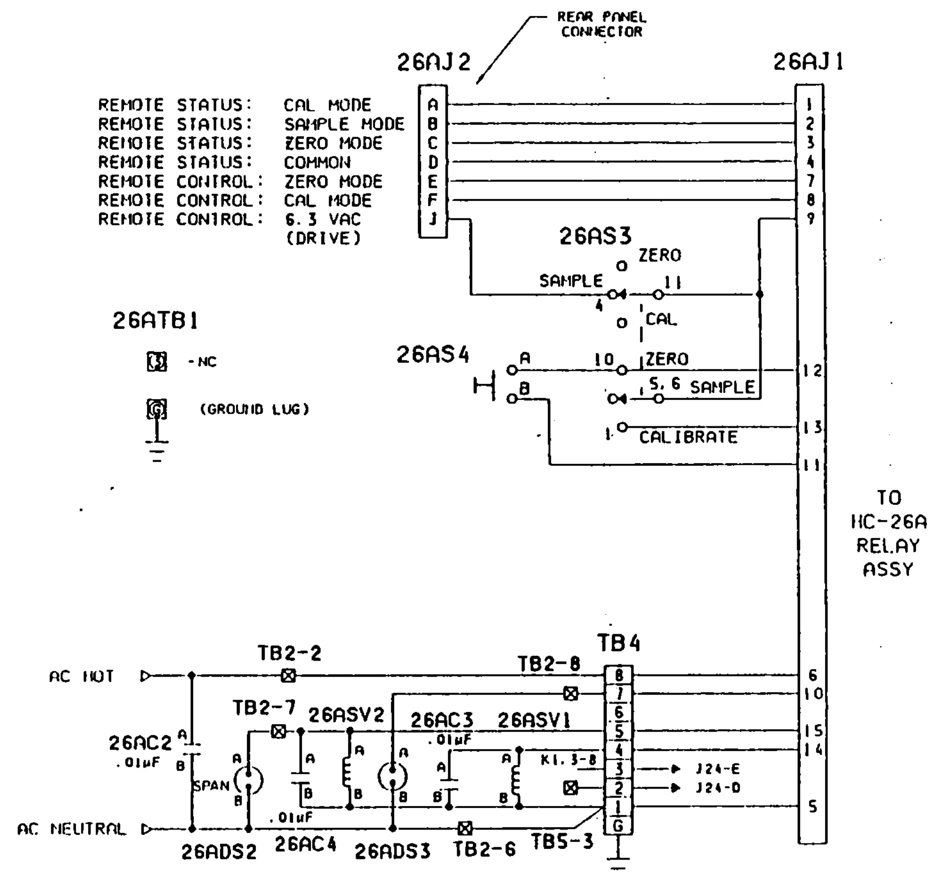


Figure 8.7 Output Amplifier Option HC-15 (J34)

NOTE: REMOTE CONTROL IS AVAILABLE
ONLY IN SAMPLE MODE.





VALVE STATE TABLE: 0= OFF; 1= ON; X= DON'T CARE

26ASV1	26ASV2	RESULT
0	X	SAMPLE
1	0	ZERO AIR
1	1	SPAN GAS

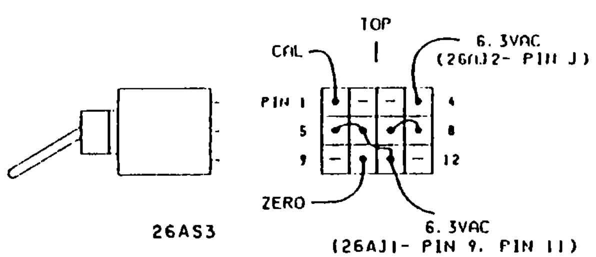


Figure 8.8

COLUMBIA SCIENTIFIC INDUSTRIES, AUSTIN TEXAS

OPTION HC-26A
ELECTRICAL SCHEMATIC,
REMOTE/MANUAL, ZERO/SPAN
& STATUS

SHEET 1 of 1 | SIZE C | 972-2000 | REV -

DATE 12-29-88

RELEASE APPROVAL

9. PARTS LIST

Part No.	Description	Qty.	Circuit Symbol
S000497-2	Rotameter Assembly	1	
S000349-1	Exhaust Valve/Line Assembly	1	
S900787	Solenoid Valve, 3-way (Options HC-11B and HC-26A)	2	SV1,2
S900120	Solenoid Valve, Hydrogen Shut-Off	1	SV3
S900425	Hydrogen Pressure Regulator	1	
S000743-1	Restrictor Oven Assembly	1	
S000746-1	Burner Block Assembly	1	
R451585-4	Block		
R357710-1	Burner Tip		
R357708-1	Ignitor Glow Plug w/O-ring		
S900163	Block Heater		
S900311	Flame-Out Sensor w/Plate		
R259120-1	Front Plate	1	
250-0100	O-ring, Front Plate	1	
S000857-1	Meter	1	M4
S903132	Ignition Switch	1	S2
S900130	Air Flow Switch (Options HC-11B, HC-26A and HC-11BF)	1	
S902914	Power/Circuit Breaker Switch	1	S1
S900131	Mode Switch (Options HC-11B, HC-26A, HC-11BF)	1	S4
S900137	Indicator Lights (Options HC-11B, HC-26A and HC-11BF)	2	DS1,2
511-0015	Mode Switch (Option HC-26A)	1	26AS3
S900996	Timer, 10 minute, w/Cams and Switches	1	M3

Part No.	Description	Qty.	Circuit Symbol
S902474	Fan 5"	1	M5
S903261	Filter for 5" Fan	1	
S000668-1	Low Voltage Power Supply Board	1	J25
S000213-1	Temperature Control Board	1	J27
S000213-2	Temperature Control Board	1	J26
S000419-1	Flame-Out Indicator Board	1	J29
S000849-1	Amplifier Assembly	1	
450-0072	Relay	2	K1 & K3
C3987-0019	Calibrator Interface Connector	1	P24
S001802-1	Ion Probe Assembly	1	
S000117-1	Battery Box Assembly	1	
S903817	Relay (Option HC-26A)	2	
S900228	Battery	2	
S900749	Transformer, 6.3 volt	1	T1
S902594	Pump, Vacuum 115 V 60 Hz	1	M6
S000324-4	Output Amplifier	1	J34
S000963-1	Output Amplifier (Option HC-15)	1	(J34)
S902595	Pump, Vacuum 115 V 50 Hz (230 Vac version of HC500-2C)	1	M6
S900388	Timer, 24 hour, 60 Hz (Option HC-11B)	1	M1
S900995	Timer, 2 hour, 60 Hz (Option HC-11B)	1	M2
S900487	Timer, 24 hour, 50 Hz (Option HC-11BF)	1	M1
972-8001	Battery Cable 13"	1	P2,6

Part No.	Description	Qty.	Circuit Symbol
972-8002	Battery Cable 21"	1	P3,5
S001804-1	Thermocouple Assembly	2	
999-5009-1	H2 Orifice/Filter (at SV3 out)	1	

10. OPTIONS

CSI has a variety of available options at additional cost which the suer can select to incorporate into the basic analyzer to meet his particular requirements.

10.1 Option HC-11B, Automatic Zero/Span/Sample Control

Analyzers with this optional feature have the same calibrate functions as in paragraph 10.3 (below), but without external remote control capabilities. Instead, they have a timer with a dial on the front panel which automatically programs the calibrate cycle once every 24 hours. The air flow is thus switched from "SAMPLE" to "ZERO" to "CALIBRATE" to "ZERO" and back to "SAMPLE". The "ZERO", "CALIBRATE" and "ZERO" steps are approximately 15 minutes each.

The automatic Span, Zero, and Sample switching option consists of 3 main components:

(1) 24 hour timer

(2) 2 hour solenoid sequence control, and

(3) Solenoid valves.

Refer to Figure 8.1. The twenty-four hour timer, mounted on the front panel, furnished a pulse once every twenty-four hours, (the time of occurrence can be set by the user as desired) to start the sequence control. The timer can be turned manually to set the time of day or to initiate the sequence.

The sequence control consists of 3 sets of cams. One set is the latching group which, after sequence has been initiated, apply power to the cam drive for a period of 2 hours after which time the latching contacts open and the cams cease to be driven. The other two sets of cams control the zero and span control solenoids. These two cams are adjustable to allow application of any time combination of zero and span air to the detector, up to one hour. The factory adjusted sequence is: zero-15 min, span-15 min, zero-15 min and then return to the normal ambient sampling mode.

The zero and span inputs may be manually controlled by a front panel toggle switch at any time outside the automatic sequence span.

The 2 hour control can be reset only after removing the chassis cover and manually moving the cams.

Sample flow rate is adjusted while observing rotameter flow of "zero" air. In this manner the rotameter is protected from contaminants and the flow path for the sample air is maintained as short as possible thereby keeping "on line" response time to a maximum.

10.2 Option HC-11BF, Automatic Zero/Span/Sample Control

Same as Option HC-11B but with 50 Hz timer.

10.3 Option HC-18, Rack Mount Option

Includes front draw handles and slide mounts.

10.4 Option HC-18A, Rack Handles with Ears

Same as HC-18 less slide mounts.

10.5 Option HC-26A, Remote Manual Zero/Span with Status

Analyzers equipped with this option have a three position "MODE" switch on the front panel which controls two solenoid valves that in turn control the air flow path. With the switch in the "CALIBRATE" position, both valves are energized and air flows through the "SPAN GAS" port into the burner block. With the switch in the "ZERO" position, only one valve is energized and the air flows through the "ZERO AIR" port and into the burner block. When the switch is in the "SAMPLE" position, neither valve is energized and the air flow through the "SAMPLE INLET" port into the burner block. Remote actuation through external contact closures can be attained when the "MODE" switch is in the "SAMPLE" position.

Status is indicated on the front panel by indicator lamps and in the "SAMPLE" position at a rear panel connector as contact closures. Figure 4.3 shows the pneumatic network for this option. Wiring diagram for this option is shown in Figure 8.10.

10.6 Option HC-15, Recorder Output 0-10 V

This option allows the normal 0-1 volt output to be expanded up to 10 volts. The output booster (S000963-1) replaces the amplifier at J34. Figure 8.7 shows the PCB layout and wiring diagram.

11. WARRANTY

The Warranty Statement appears on the following two pages.

WARRANTY

1. Except as otherwise indicated, all instruments and stack systems manufactured and sold by Columbia Scientific Industries Corporation (CSI) are guaranteed for a period of one year from date of shipment from the factory against defects in materials and workmanship of those parts manufactured by CSI, and then, only when operated, serviced and maintained in accordance with the instruction manual. Those parts not manufactured by CSI are guaranteed only to the extent that they are covered by a warranty of original manufacturer. Permeation tubes are warranted for six (6) months. Spare parts and accessories, except expendables, are warranted for ninety (90) days. Expendables such as batteries, sample holders, fuses and indicating lamps are not covered by this warranty.

2. The warranty is voided by the following:

a) Injection into CSI stack systems or CSI ambient air monitoring or calibrating equipment, of gas mixtures containing reactive suspended matter or molecules yielding and depositing liquids, tars, solids and other non-gaseous residues.

b) Injection of caustic solutions into the hydrogen lines of CSI hydrocarbon monitors by a malfunctioning hydrogen generator.

c) Damage to CSI Accelerating Rate Calorimeters by samples that detonate, deflagrate or otherwise escape the confines of the sample holder.

d) Damage to stack sampling probes caused by severe corrosion.

e) Damage caused by incorrect installation, by misuse, or by mishandling.

3. Warranty service requests must be received by CSI within the warranty period. Upon notification by the purchaser, CSI will correct defects coming within the scope of this warranty by repairing or replacing the defective unit either at the CSI factory or at the customer's site, at CSI's option. Return shipment of items to CSI must be authorized by a CSI representative and is at customer's expense.

4. Instruments and systems which have been repaired or replaced during their warranty period are themselves guaranteed for only the remaining unexpired portion of their original warranty period. Parts and accessories, including stack probes, umbilicals and permeation tubes, will receive their full warranty period from the date of replacement even if the instrument or system warranty period should expire.

5. Repairs, replacements, adjustments and service performed out-of-warranty shall be charged to the customer at the then current prices for parts, labor, transportation and subsistence.

6. This warranty attaches to the instrument itself and is not limited to the original purchaser.

7. In no event will CSI have any obligation or liability for damages, including but not limited to, consequential damage arising out of, or in connection with, the use or performance of equipment or accessories. No other warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose will apply to equipment or accessories.

8. This warranty constitutes the full understanding of the manufacturer and buyer, and no terms, conditions, understanding or agreement professing to modify or vary the terms hereof shall be binding unless hereafter made in writing and signed by an authorized official of CSI.

All price revisions and design modification privileges reserved.

PUREGAS®

P-07409

CO_2 EXTRACTOR

MODELS 100A301 & 100A303

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

PUREGAS®

General Cable Company

A Unit of The Penn Central Corporation

P.O Box 666, 5600 West 88th Avenue, Westminster, Colorado 80030
(303) 427-3700/Telex 45908

TABLE OF CONTENTS

P100A301 AND P-100A303 CO_2 EXTRACTORS

DRAWINGS

I GENERAL

This instruction manual covers the description, installation, operation and maintenance of the P-100A301 and P-100A303 CO_2 extractors. The purpose of the unit is to provide clean dry air with minimal CO_2 for air bearings and for purging the optics of IR and FTIR analyzers.

II DESCRIPTION

The units described in this manual are designated as CO_2 extractor Model P-100A301 and CO_2 extractor Model P-100A303. These two models are basically identical, except for their chamber size and capacities. Model P-100A301 has the larger chambers and capacity. These extractors consist of a dryer and CO_2 adsorber piped in series with inlet and outlet filters attached. The relative locations and functions of the various major components can be best understood by referring to the following drawings:

Flow Diagrams	Figures 1 & 1A	Page 7
Wiring Diagram	Figure 2	Page 8
CO_2 Extractor	Figure 3	Page 11
Dryer and Adsorber (Exploded View)	Figure 4	Page 13

III MAJOR COMPONENTS

1. INLET AIR FILTER - ITEM 15, FIGURE 3. The functiion of the inlet air filter is to collect liquid condensate and particles, larger than 25 microns, contained in the compressed inlet air. The air filter bowl has a manual drain petcock. It is necessary to periodically check the filter and drain the liquid.

   Special Note: This filter is not an "oil removal" filter. While it will intercept some oil in liquid form, it will not remove oil mist or "aerosols" that may be present in the system. Therefore, in any system in which the air source is an oil-lubricated compressor, it is recommended that a "coalescing" type filter be used. Refer to flow diagram, Figure 1A for installation.

III 2. MOISTURE REMOVAL DRYER - ITEM 1, 2, 3 or 4, FIGURE 3. The function of the air dryer is to remove the moisture from the compressed inlet air.

3. CO_2 ADSORBER - ITEM 5, 6, 7 or 8, FIGURE 3. The function of the adsorber is to remove CO_2 from the dry compressed air leaving the dryer and entering the adsorber. The adsorber differs from the dryer. Its chambers are packed with a different adsorbent material and its cycle timer permits repressurizing of the purging chamber prior to dumping the adsorbing chamber's pressure to atmosphere.

Repressurization results in a substantial reduction in the outlet pressure fluctuation during switching, which occurs in dryers not equipped with this feature. Further reduction in the outlet pressure variation can be obtained by installing a suitable two to five gallon air storage tank downstream of the outlet air filter and upstream of a pressure regulator.

The air dryer and adsorber have purge exhaust mufflers installed on the solenoid valves to quiet the exhaust air. Do not plug or restrict the purge discharge. Additional muffling of the purge air may be obtained by enclosing the unit in a well-ventilated, sound-adsorbing box.

4. OUTLET AIR FILTER - ITEM 16, FIGURE 3. The function of the outlet air filter is to trap particles larger than 5 microns, primarily occasional particles of adsorbent material, which may escape from the adsorbent beds.

5. OUTLET FLOW ORIFICE - ITEM 28, FIGURE 3. The function of the orifice is to limit the outflow of air in accordance with operating pressures and conditions as specified on the purchase order. The number P-300-691 is the number of the blank before its final orifice size is established. The numbers range from P-300-691-4 (.005" diameter) to P-300-691-103 (.0995" diameter).

IV SPECIFICATIONS

1. CAPACITY, DEW POINT AND CO_2 REMOVAL.

	MODEL P-100A301	MODEL P-100A303
Inlet Pressure	90 PSIG	90 PSIG
Inlet Temperature	70° F.	70° F.
Inlet Flow		
Outlet Flow *	3.5 SCFM	1.5 SCFM
Atmospheric Dew Point	-100° F.	-100° F.
CO_2 Removal **	90%	90%

* Contact the factory for rated capacity at other operating pressures.

** 90% of the CO_2 from ordinary atmospheric air.

2. Maximum Inlet Pressure: 100 PSIG

3. Maximum Inlet Temperature: 100° F.

4. Air Connections: 1/4" FPT

5. Electrical Requirements:

Model No.	Power		
P-100A301-1/P-100A303-1	120V	50/60Hz	115W
P-100A301-2/P-100A303-2	240V	50/60Hz	115W

V INSTALLATION INSTRUCTIONS

1. Puregas heatless dryers have been thoroughly inspected and tested at the factory and are in proper working condition. Inspect the CO_2 extractor for evidence of any exterior or interior shipping damage and immediately report damage to the carrier.

2. Read description of equipment and specifications before installing CO_2 extractor.

3. OPERATING PRESSURES. The CO_2 extractors are designed to operate at a maximum pressure of 100 PSIG. The sizing of the purge orifices is critical to the correct operation of the air dryer and CO_2 adsorber. Any change in operating pressure, inlet temperature, or outlet flow will require an orifice change to maintain the proper degree of water and CO_2 removal. Orifice glands (Item 4, Figure 4), are identified by numbers stamped on the top of the hex. Both orifices in the dryer or adsorber must be the same size (same number). Orifice numbers are also stamped on the name plate as the last two numbers of the dryer and CO_2 adsorber model number. (Example: P-05411A1<u>34</u>.) Orifice sizes must not be changed unless operating conditions change.

V

3. (continued) Your instrument is sized for a specific flow and operating condition. The outlet flow of the CO_2 extractor can be regulated with a throttle valve and a visual indication of measurement made with a flow meter. After installation, the outlet flow and operating pressure should be checked to be sure they do not exceed the rated capacity of the instrument.

   If a lower outlet pressure is required, always install the pressure regulator <u>downstream</u>, as close to the usage point as possible.

4. **OPERATING TEMPERATURES** The dryer and adsorber can operate at a maximum ambient temperature of 100° F. and a maximum inlet air temperature of 100° F. However, at temperatures above 70° F. the capacity will have to be reduced.

   Do not operate the unit at temperatures which could result in damage due to freezing.

5. **PIPING AND AIR CONNECTIONS.** The CO_2 extractor is designed to be mounted on a bench or shelf with the desiccant chambers up.

   The inlet and outlet connections are 1/4" female NPT. When connections are made directly into the unit, a pipe compound should be used to prevent galling of the threads. 3/8" copper tubing with 1/4" pipe connections should be installed at the input and output for maximum flow. Larger lines are recommended to avoid pressure drop where long piping runs are encountered.

   After connecting the piping or tubing to the unit, use a soap solution to check the connections for air leaks.

   A manual drain, 25-micron inlet filter is supplied with the CO_2 extractor to remove particulate matter and liquid water. Reference flow diagram, Figure 1. If oil in liquid or mist form is present in the air stream, an oil coalescing filter should be used as shown in Figure 1A.

   The extractor should not be operated in corrosive atmospheres.

6. **ELECTRICAL CONNECTIONS.** Before wiring, check the nameplate for electrical requirements. Standard electrical characteristics are 120V, 50-60Hz, 115 W. 240V., 50-60Hz units are also available.

   No overload protection is provided in the CO_2 extractor. The attached 8 foot wire power cord should be plugged into a properly protected outlet.

V 7. SOLID STATE TIMERS. The solid state cycle timers are equipped with a one-hour-minimum memory circuit which will restart the timers at the same point in the timing cycle as when the power was lost or interrupted.

During start up and when timer memory has been lost, it will be necessary to stagger the timing cycles so that the dryer and CO_2 adsorber will not switch simultaneously. This can be accomplished by removing the power from the dryer timer for a period of 15 seconds.

Timers P-06521-F1 or F2 are the standard timers used on the air dryer. The timers permit simultaneous switching of the solenoid valves every 30 seconds.

Timers P-06500-F1 or F2 permit the CO_2 adsorber to repressurize the purging chamber before switching chambers. The repressurizing period is 3.75 seconds and the purging period is 26.25 seconds.

Repressurizing helps to minimize dryer outlet pressure fluctuation as the flow switches from one desiccant chamber to the other. Further reduction in outlet pressure swings can be obtained by installing a 2 to 5-gallon air storage tank between the outlet filter and the outlet pressure regulator. Refer to Figure 1A.

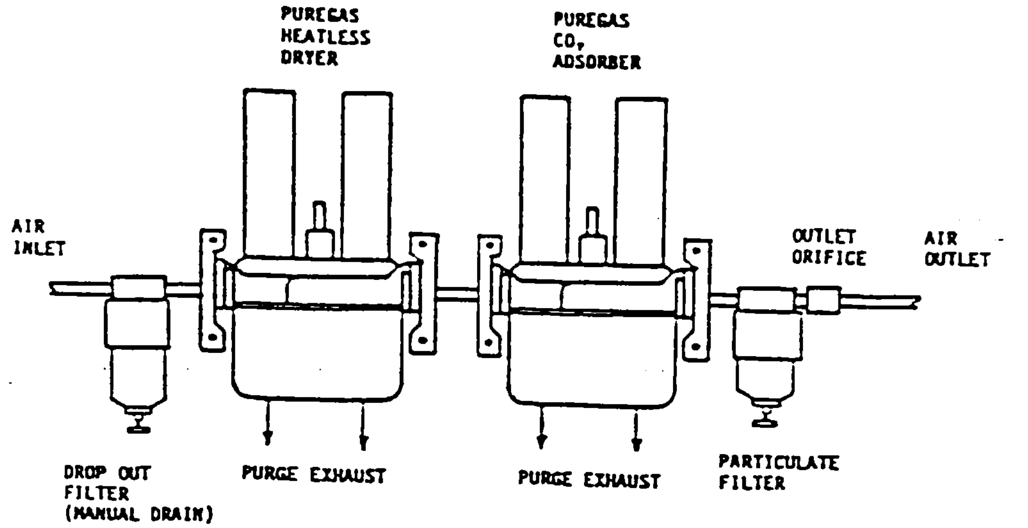
VI OPERATING INSTRUCTIONS

In normal operation, the dryer and CO_2 adsorber will switch every 30 seconds or, when their cycle times are staggered, (Reference Section V, Paragraph 7), approximately every 15 seconds. Each chamber alternately purges with an audible exhaust. This sound is quieted by the use of mufflers installed on the exhaust port of each solenoid valve. Do not plug or restrict the purge exhausts. If operating conditions change, different purge orifices may be required. If orifices are replaced, they should be replaced in matched pairs. The heat of adsorption and the heat from the solenoid coils cause the unit to become warm - this is normal and does not indicate a malfunction of the unit. The temperature rise is more pronounced in a dryer operating at a low flow rate.

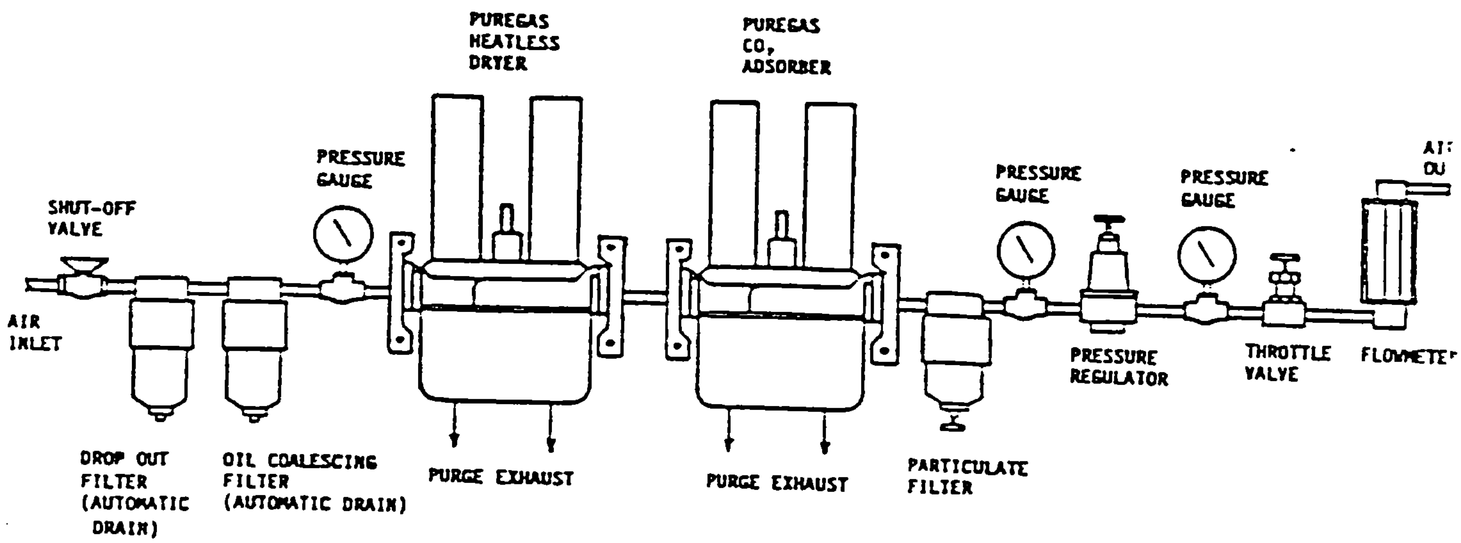
VII MAINTENANCE INSTRUCTIONS

No field adjustments are necessary after a Puregas CO_2 extractor has been installed in accordance with these instructions. No lubrication is required on the instrument.

It is recommended, however, that at six-month intervals the unit be thoroughly inspected. Inspection should include audible inspection for proper solenoid valve operation and purge, and visual inspection for excessive dirt or oil fouling



FLOW DIAGRAM CO_2 EXTRACTOR
FIG. 1



RECOMMENDED INSTALLATION DIAGRAM
FIG. 1A

VII (continued) and for desiccant attrition. This involves removal of the air manifold covers and the desiccant chambers. Annual inspections should be more thorough, and should also include removal of the solenoid valves and the purge orifice glands to inspect for excessive wear or deterioration of valve parts or the check valve balls as well as for possible plugging of the purge orifices.

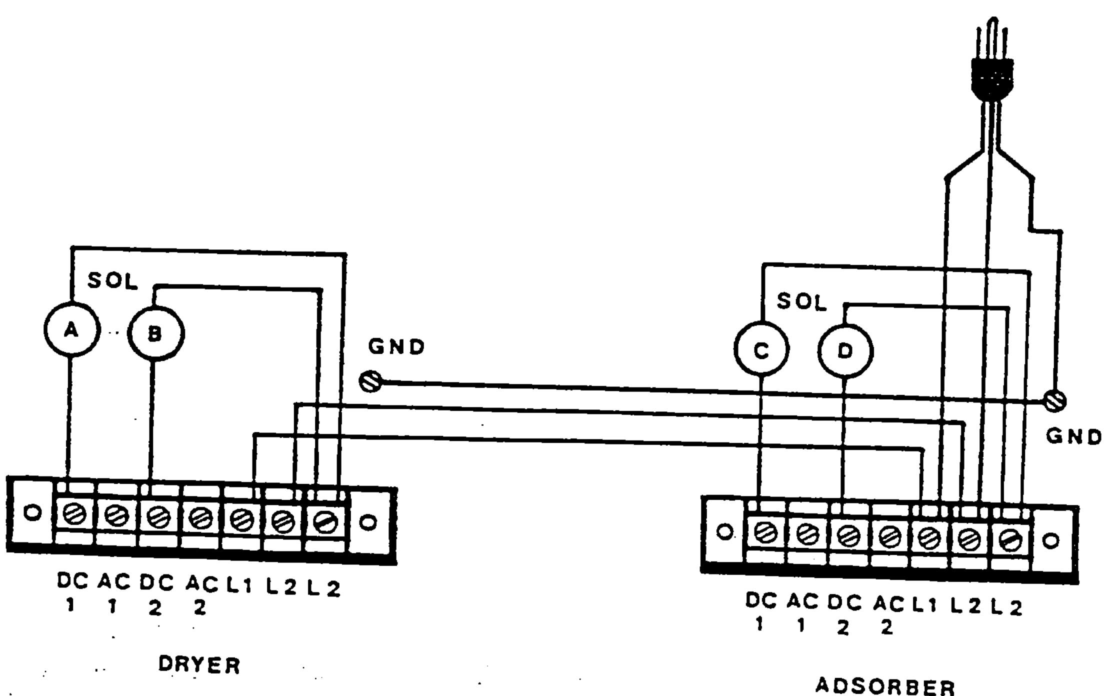
As the orifices are critical parts in determining the performance of a dryer and adsorber, do not increase the orifice size by drilling a larger hole. Instead, orifices of the proper size should be obtained from the factory.

Purge orifice glands are screwed into the manifold beneath the desiccant chambers. To change orifices, unscrew the chambers and remove the orifices with a standard 7/8" socket wrench.

The cycle timer can be replaced in the field.

Improper packing of the desiccant chambers can cause channeling of the gas stream and improper purification. For this reason, NO ATTEMPT SHOULD BE MADE TO REPACK DESICCANT CHAMBERS IN THE FIELD. Replacement chambers should be obtained from your local authorized distributor.

In the event of breakdown, the following troubleshooting guide should enable you to determine the problem. Contact your local authorized distributor for replacement parts, dryers or adsorbers.



WIRING DIAGRAM
FIG. 2

VIII TROUBLESHOOTING GUIDE

1. UNIT DELIVERS WET AIR

A. Improper operating conditions.

Adjust operating conditions.

B. Solenoid core spring broken.

Remove solenoid valve, inspect core assembly. Spring should be seated on core and not broken. Replace if necessary.

C. Purge orifice plugged.

Remove, inspect, and clean orifice. DO NOT FORCE WIRES THROUGH CRITICALLY-DRILLED HOLES. Use air gun to clean.

D. Solenoid coil burned out.

Remove cover, place iron or steel material (screwdriver or nail) on exposed end of solenoid base to feel the magnetic effect indicating proper operation. NOTE: Each dryer coil should be energized for 30 seconds and each adsorber coil for 33.75 seconds. Check Section 1, Paragraph E immediately below, before replacing coil.

E. Improper operation of cycle timer.

1. Check the power supply. If the correct voltage is not present between L1 and both of the L2 terminals., check the wiring and protective devices supplying power to the dryer.

2. Dryers with DC solenoid valves should alternately have DC voltage between L2 and DC1 and between L2 and DC2. Replace the timer if voltage is present at either DC terminal continuously or not at all.

   Timer Input 120 VAC/Timer Output 53 VDC
   Timer Input 240 VAC/Timer Output 106 VDC

3. Refer to Solid State Timers Section V, Paragraph 7, Page 6 for timing cycle information.

1. F. Desiccant contamination or attrition.

1. Check inlet and outlet filters and outlet air line for indication of oil.

2. Remove the desiccant chambers from the air manifold. If the perforated disc at open end of the chambers can be depressed more than 1/4" from the retaining ring, replace chamber, or have it repacked.

2. <u>EXCESSIVE DROP IN OUTLET PRESSURE.</u>

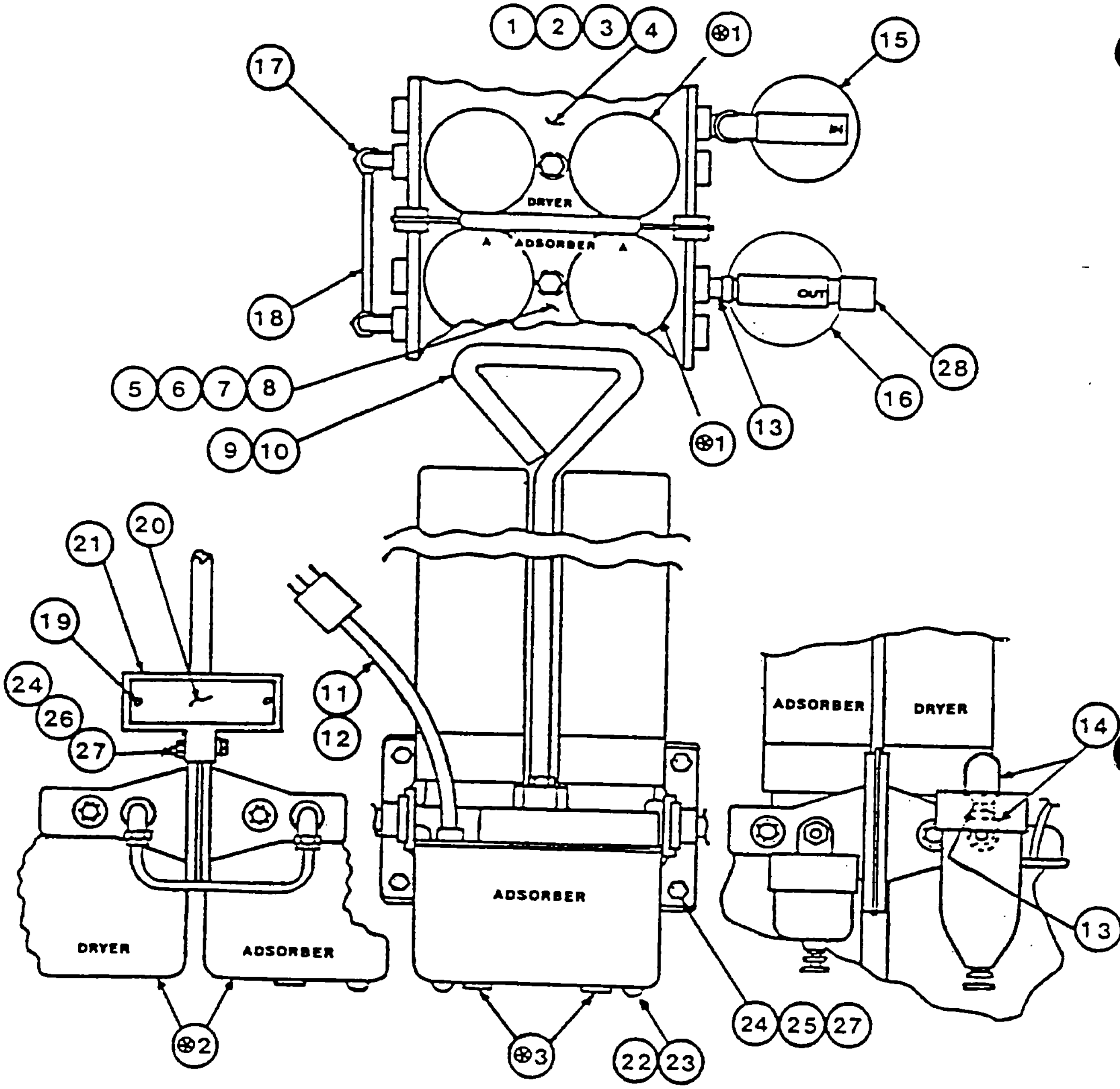
A. Improper operating conditions.	See Section I, Paragraph A.
B. Solenoid coil burned out.	See Section I, Paragraph D.
C. Improper operation of cycle timer.	See Section I, Paragraph E.
D. Check valve balls seated improperly.	Remove check balls and springs and inspect for excessive wear or damage. Replace if necessary.
E. Plugged air passages.	Check inlet and outlet air passages and piping for blockage
F. Desiccant contamination or attrition.	See Section I, Paragraph F.

3. <u>SOLENOID VALVE CHATTER</u>

A. Solenoid valve defective.

1. Solenoid valve connected to AC terminal on Solid State Timer.

2. Voltage too low.



CO_2 EXTRACTOR

FIG 3

REFER TO PG. 14

⊛	ITEM NO.
1	1
2	26
3	43

PARTS LIST - CO_2 EXTRACTOR

REFERENCE FIGURE 3.

QUANTITY				PART NO.	DESCRIPTION	ITEM NO.
1	1	1	1	*P-300-691-(--)	ORIFICE-DISCHARGE	28
4	4	4	4	H-NK01-04C-R5	NUT-KEPS 1/4-20 CZ	27
1	1	1	1	H-SH83-04C-12	SCREW HH 1/4-20 X 1 1/4 CZ	26
3	3	3	3	H-SH83-04C-10	SCREW HH 1/4-20 X 1 CZ	25
4	4	4	4	H-WF01-04B-R0	WASHER-FLAT 1/4 CZ REG. B	24
4	4	4	4	H-SP56-0DC-02	SCREW-PH 4-40 X 1/4 CZ F	23
4	4	4	4	P-400-451	BUMPER-RUBBER	22
1	1	1	1	P-300-683	HOLDER NAMEPLATE	21
1	1	1	1	P-300-696	NAME PLATE-CO_2 EXTRACTOR	20
2	2	2	2	P-400-322-1	SCREW-DRIVE #4 3/16	19
1	1	1	1	P-300-690	TUBE-INTERCONNECT	18
2	2	2	2	P-400-437-108	ELL-SWAGE-1/4 MPT X 3/8 SWG-BRS	17
1	1	1	1	P-400-452-20	FILTER-5 MICRON-1/4 MPT	16
1	1	1	1	P-400-452-3	FILTER-25 MICRON-1/4 MPT	15
2	2	2	2	P-1291	ELL-STREET-1/4 NPT-BRS	14
2	2	2	2	P-5000-5-12B	NIPPLE-1/4 MPT X 1 3/16-HEX-BRS	13
1	---	1	---	P-200-501	POWER CORD 240 VAC	12
	1	---	1	P-200-411	POWER CORD 120 VAC	11
		1	1	P-300-682-2	PLATE-MTG W/HANDLE/100-301	10
1	1	---	---	P-300-682-1	PLATE-MTG W/HANDLE/100-303	9
		1	---	P-05414A2	CO_2 ADSORBER 240 VAC	8
			1	P-05414A1	CO_2 ADSORBER 120 VAC	7
1	---	---	---	P-05412A2	CO_2 ADSORBER 240 VAC	6
	1	---	---	P-05412A1	CO_2 ADSORBER 120 VAC	5
		1	---	P-05413A2	AIR DRYER 240 VAC	4
			1	P-05413A1	AIR DRYER 120 VAC	3
1	---	---	---	P-05411A2	AIR DRYER 240 VAC	2
	1	---	---	P-05411A1	AIR DRYER 120 VAC	1
X	---	---	---	P-100A303-2	CO_2 EXTRACTOR - 12" 240 VAC	
	X	---	---	P-100A303-1	CO_2 EXTRACTOR - 12" 120 VAC	
		X	---	P-100A301-2	CO_2 EXTRACTOR - 20" 240 VAC	
			X	P-100A301-1	CO_2 EXTRACTOR - 20" 120 VAC	

* Refer to Page 3, Section III, Paragraph 5 for orifice size information.

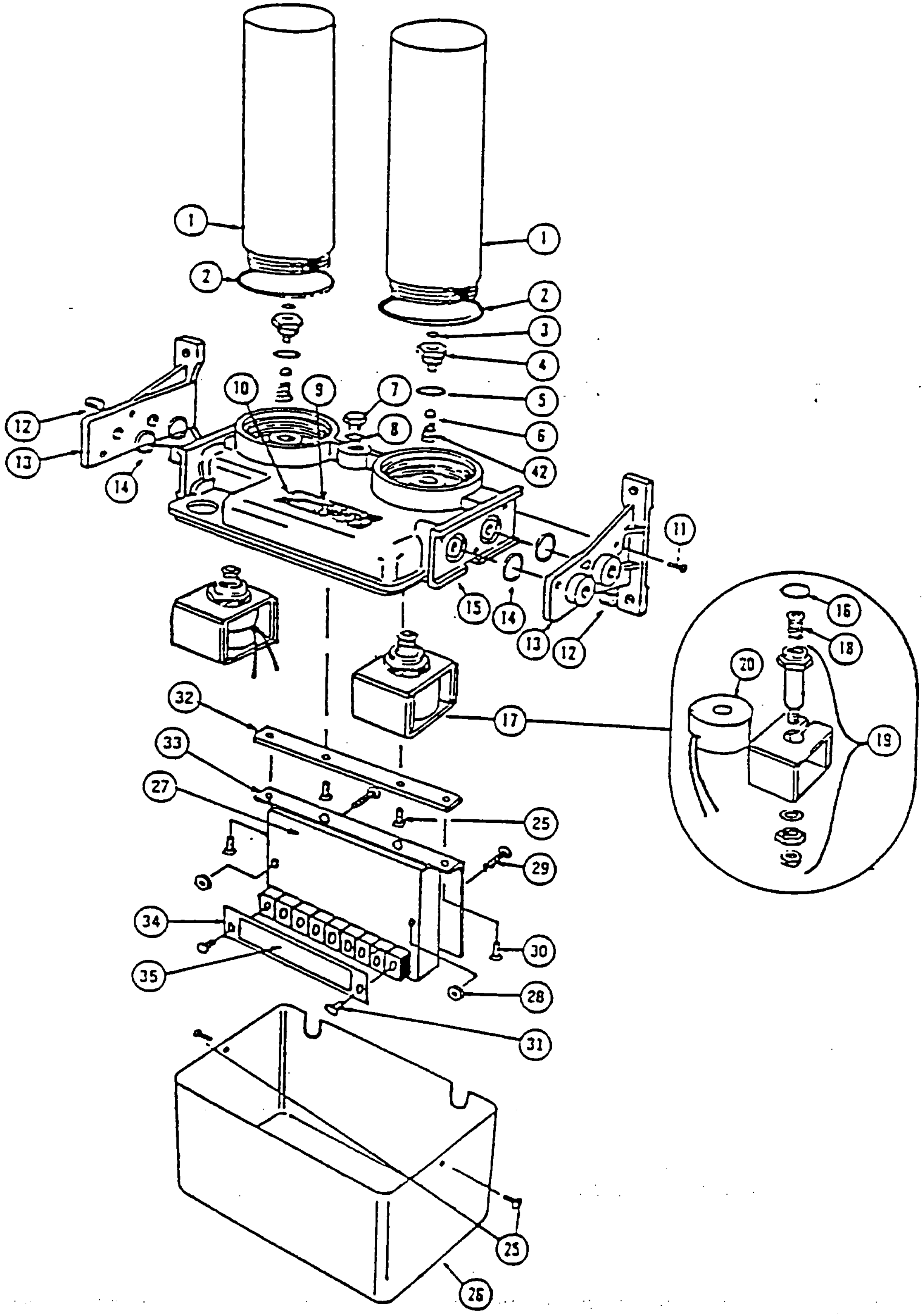

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FIG 4

WARRANTY

These air dryers carry a one year warranty against defective workmanship and material. This period starts at the date of shipment. The Puregas heatless dryers are designed in a manner which permits field repair by the user and replacement parts will be shipped enabling the user to make the necessary field repairs and return the defective parts.

However, the warranty also includes the offering of an immediate replacement with an equivalent air dryer for any unit *for which field repairs are not authorized by Puregas.* Only in unusual cases will it be necessary to ship a replacement unit. On receipt of the replacement air dryer the user will return the defective unit in the same shipping container.

No claims for labor in replacing defective parts or for consequential damages will be allowed. Replacement parts (or if applicable, replacement air dryers) will be invoiced in the regular way with invoices subject to adjustment after the parts (or dryers) claimed defective are examined in our factory. In addition, no material or parts will be accepted at our factory for in-warranty repairs or credit without previous authorization from the Puregas.

Responsibility for damages incurred in transit will be borne by the user and the user in turn should file any damage claim against the carrier.

This warranty shall not apply to any air dryer which shall have been repaired or altered in any way be anyone other than the Puregas, or its authorized repair agent, so as to affect, in our judgment, its proper functioning or reliability, neither will it apply to any air dryer which has been subjected to misuse, negligence or accident.

PUREGAS

PUREGAS®
General Cable Company

A Unit of The Penn Central Corporation

P.O. Box 666, 5600 West 88th Avenue, Westminster, Colorado 80030
(303) 427-3700 / Telex 45908

Code:	A	B	C
Used on:	Dryer & Adsorber	Dryer	Adsorber

ITEM NO.	PART NUMBER	USED ON DRYER	QTY. PER DRYER OR ADSORBER	PART DESCRIPTION
1	P-200-403-12	B	2	Assy-Des Ch-Dryer 12",incl. Item 2
	P-200-403-A12	C	2	Assy-Des Ch.- CO_2 12",incl. Item 2
	P-200-403-20	B	2	Assy-Des Ch-Dryer 20",incl. Item 2
	P-200-403-A20	C	2	Assy-Des Ch.- CO_2 20",incl. Item 2
2	P-400-312-924	A	2	O-Ring - 1.720 I.D. x 0.118 W.
3	P-400-313-110	A	2	O-Ring - 0.362 I.D. x 0.103 W.
4	*P-200-404-(--)	A	2	Purge Orifice Assy. (incl.#3 & #5)
5	P-400-312-908	A	2	O-Ring - 0.644 I.D. x 0.087 W.
6	P-400-375	A	2	Ball, Check Valve
7	P-400-307-4	A	1	Plug, Hex
8	P-400-312-904	A	1	O-Ring - 0.351 I.D. x 0.072 W.
9	P-300-737	A	1	Nameplate
10	P-400-322-1	A	2	Drive Screw #4 x 3/6" Type U rnd. hd., st. st.
11	P-400-361-2	A	6	Screw, #10 - 24 x 5/8", pan.hd.
12	P-400-320-3	A	2	Pipe Plug, 1/4" - 18 socket hd.
13	P-300-497P	A	2	Mounting Bracket
14	P-400-313-116	A	4	O-Ring - 0.731 I.D. x 0.103 W.
15	P-300-495P	A	1	Air Manifold
16	P-400-313-018	A	2	O-Ring - 0.739 I.D. x 0.70 W.
17	P-400-308-DC1	A	2	Solenoid Valve - 53 VDC (for 120 V., 50/60 Hz units)
	P-400-308-DC2	A	2	Solenoid Valve - 106 VDC (for 240 V., 50/60 Hz units)
18	P-400-308-12	A	2	Core Assembly
19	P-400-308-13	A	2	Base Assembly
20	P-400-308-DC11	A	2	Coil, 53 VDC
	P-400-308-DC21	A	2	Coil, 106 VDC
25	P-400-361-1	A	4	Screw #6 - 32x8/8" pan. hd.
26	P-300-685P	A	1	Air Manifold Cover
27	P-06521-F1	B	1	Timer - SS 1 min, cycle 120 VAC
	P-06521-F2	B	1	Timer - SS 1 min, cycle 240 VAC
	P-06500-F1	C	1	Timer - SS 1 min. cycle 120 VAC Repressurizing
	P-06500-F2	C	1	Timer - SS 1 min. cycle 240 VAC Repressurizing
28	H-NK01-0HC-R5	A	2	Nut-Keps 8-32
29	H-SB83-0HC-10	A	2	Screw 8-32 x 1" BH
30	H-SB83-0FC-04	A	2	Screw 6-32 x 1/4" BH
31	H-SB83-0FC-02	A	2	Screw 6-32 x 1/2" BH
32	P-06496	A	1	Plate-Adapter-SS Timer Brkt.
33	P-06497	A	1	Bracket - Mtg. - SS Timer
34	P-06499	A	1	Cover - Terminal
35	P-06498	A	1	Decal - Terminal Cover
42	P-300-507	A	2	Spring - Check Ball
43	P-400-498	A	2	Muffler (not shown)

When ordering parts, always state the dryer and adsorber Model and Serial Nos.
* Orifice number must be specified.

MIGHTY MODULE

INSTRUCTIONS FOR
MM4010, MM4050,
MM4300 & MM4310
DC TO DC TRANSMITTERS

FUNCTION

The MM4010, MM4050, MM4300 and MM4310 DC to DC Transmitters provide DC output voltages or currents proportional to a DC input signal. They are useful in converting voltages to currents or currents to voltages, in providing signal isolation and in scaling signal levels from one amplitude to another.

DESCRIPTION

A stable amplifier is used to monitor a DC input voltage. For current inputs a shunt resistor is added inside the module to create a voltage level at the amplifier input. A final amplifier produces the desired DC voltage or current output.

MM4300 and MM4310 provide input/output isolation by modulating the pulse width of a VCO with the amplified input. The pulses are optically coupled to a separately-powered demodulator which, in turn, feeds the final amplifier. MM4010 and MM4050 are direct-coupled, input to output.

A wide range input option adds an 8 position DIP switch which provides input voltage and current range selection by connecting any of 6 gain-setting and 2 current-shunt resistors.

MODEL NUMBERS

Transmitters are available with or without input isolation and with standard or narrow spans. The narrow span models use a superior, low drift input amplifier. Model numbers are as follows:

MM4010	Standard spans, nonisolated
MM4050	Narrow spans (below 50mV), nonisolated
MM4300	Standard spans, input-output isolated
MM4310	Narrow spans (below 50mV), input-output isolated

OPTIONS

WR Wide range input. Allows a choice of input voltage and current range selections by use of an 8 position DIP switch.

U All circuit boards polyurethane coated for protection against moisture.

WILKERSON INSTRUMENT CO., INC.
3615 CENTURY BLVD. • LAKELAND, FL 33811 • USA
1 (813) 646-3909 • TELEX: 5106011060 WILK INST CO
FAX: 813-644-5318

Linearity	MM4010, MM4050	±0.01% of Span
	MM4300, MM4310	±0.05% of Span
Output Ripple	MM4300, MM4310	less than 0.1% of Span peak-to-peak
Temperature Stability		±0.025% of span per deg C
Common Mode Rejection		120db, DC to 60Hz
Response Time	MM4300, MM4310	75 milliseconds
Isolation:	Power	1500 Vrms
	Input/Output (MM4300, MM4310)	1000 Vrms
Temperature, Operating		0 deg C to 60 deg C
		32 deg F to 140 deg F
Power	Standard	115V ±10%, 50 or 60Hz
	Optional	230V, 50 or 60Hz AC
		12 or 24V DC; 2.5W max

MOUNTING

The transmitters are designed to plug into a standard 8-pin relay socket. Part number MP008 is a molded plastic socket suitable for mounting on a flat surface or in a piece of PVC track.

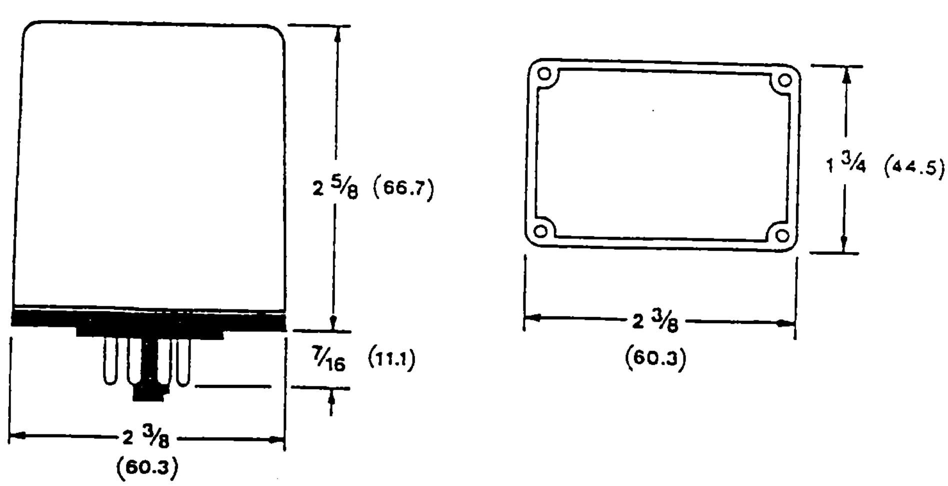
WARRANTY

All Wilkerson Instrument Company products carry a 5 year limited warranty against defective material or workmanship. The product will be repaired or replaced, at the company's option, if it fails during this time due to defective material or workmanship. Misapplication or abuse by the user is not covered by this warranty.

In addition, the company will repair any of its products for a period of 5 years after the warranty period for an amount no greater than 10% of the original purchase price.

The owner is responsible for freight costs.

MOUNTING DIMENSIONS INCHES (MM)



POWER 115 or 230 VAC, 12 or 24 VDC.

CONTROLS

The DC to DC transmitters contain two calibration controls, zero and span (gain). The WR option adds an 8 position DIP switch for range selection.

CALIBRATION

The transmitters are precisely calibrated at the factory and do not normally require user calibration. If there is a need to recalibrate, proceed as follows:

If your transmitter includes the WR option, remove its cover and set the 8 DIP switches according to the table below.

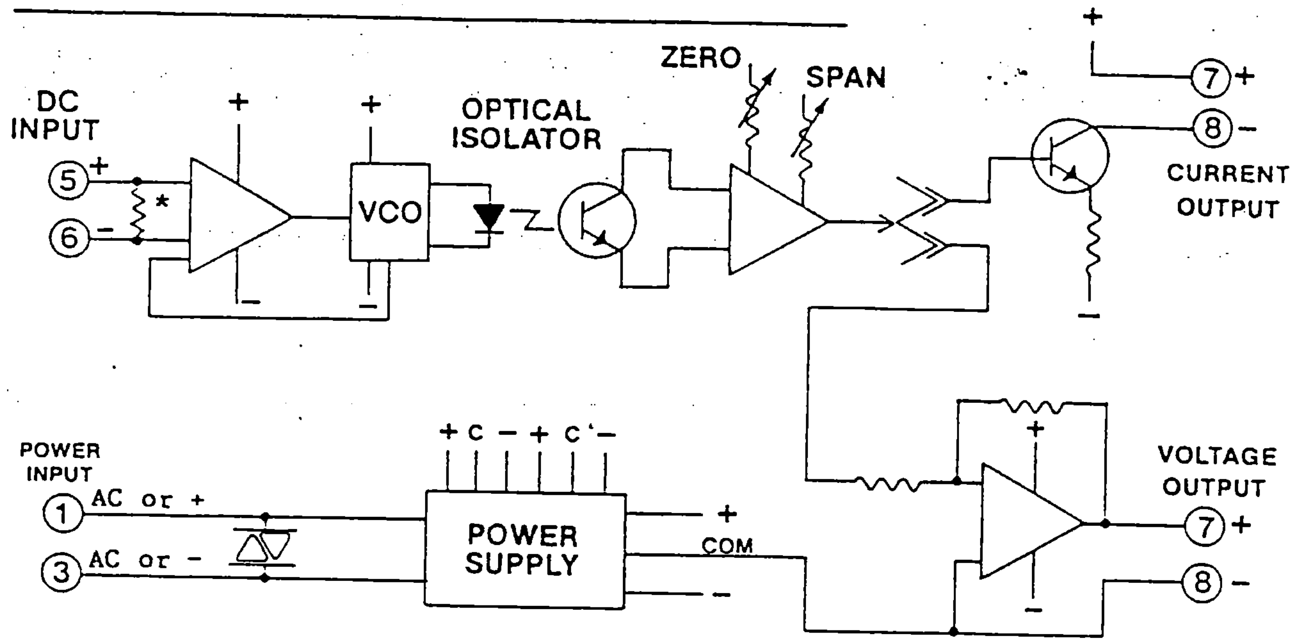
ZERO and SPAN adjustments are available on top of the transmitter module. Connect a calibrated signal source to the module input. Monitor the output of the module with an accurate digital meter. Set the input signal to its zero or low value and adjust the ZERO control for the proper output. Increase the input signal to its full scale value and adjust the SPAN control for the proper output. Repeat the procedure once or twice, the controls may interact slightly.

WIDE RANGING INPUT (WR OPTION)			
INPUT	CLOSE SW	INPUT	CLOSE SW
50mV	none	1mA	7
100mV	6	2mA	6,7
200mV	5	4mA	5,7
500mV	4	5mA	7,8
1V	3	10mA	4,7
2V	2	20mA	3,7
5V	1	4/20mA	5,8
10V	1,2,3,4,5,6	25mA	3,5,7
1/5V	2,3,4,5,6	50mA	4,7,8
		10/50mA	4,8

SPECIFICATIONS

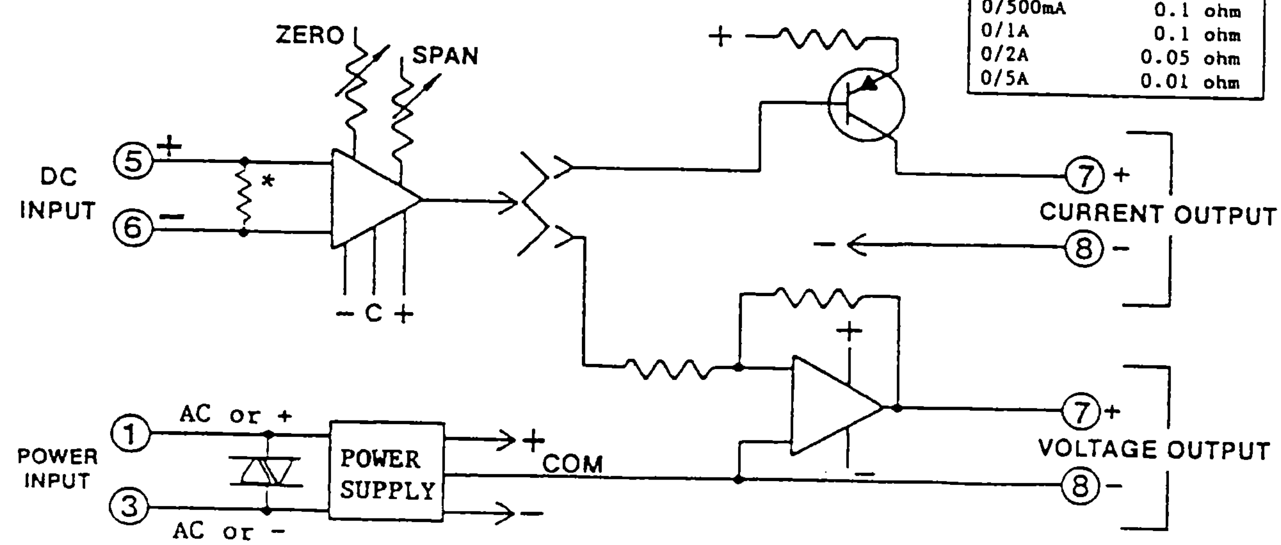
Input Impedance	Voltage	200K
	Current	see table on block diagram
Input Limits	MM4010, MM4300	50mV Span min; 200V max
	current:	5 A max, internal shunt
	MM4050, MM4310	10mV Span min; 20V max
Output Limits	Voltage	-10 to +15V, 10mA
	Current	50mA, 24V compliance

MM4300/MM4310
BLOCK DIAGRAM AND PIN CONNECTIONS



* CURRENT INPUT	INPUT SHUNT VALUE
0/1mA	100 ohms
0/10mA	10 ohms
0/20mA	5 ohms
4/20mA	61.9 ohms
0/50mA	2 ohms
0/100mA	1 ohm
0/200mA	0.5 ohm
0/500mA	0.1 ohm
0/1A	0.1 ohm
0/2A	0.05 ohm
0/5A	0.01 ohm

MM4010/MM4050
BLOCK DIAGRAM AND PIN CONNECTIONS



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IMPULSE SUPPRESSOR INSTALLATION

PLEASE READ **DANGER** SHEET BEFORE INSTALLING

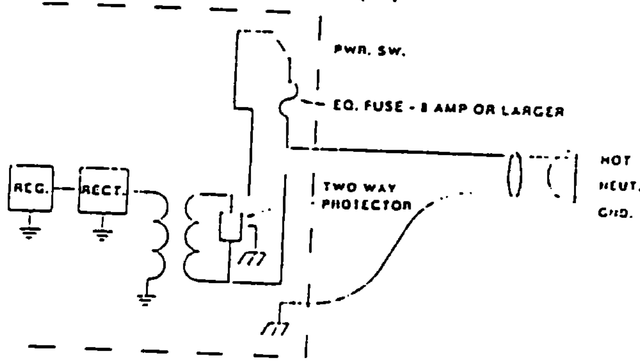
Your "Two Way" IS-PSP-120 (Power Supply Protector) will protect from surges from the power line as well as surge voltages attempting to go to the power line. Your IS-PSP-120 is fast (: nanoseconds) and is capable of very high current (35,000 Amps) using IEEE waveform of 8μS ris and 20μS decay to a 50% point. It should have a long life time (which is dependent on the severit of surges that it shunts).

THIS DEVICE IS ONLY FOR 120 VAC (RMS) OR LOWER POWER LINES.

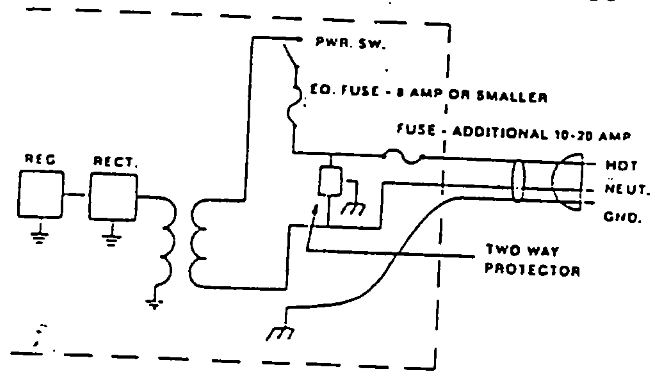
DANGER - DISCONNECT POWER CORD FROM POWER OUTLET BEFORE PROCEEDING WITH INSTALLATION.

To install, it is important that the fuse be electrically located between the power cord and the protector. This is for when the device finally reaches the end of its life, the fuse will continue to be blown, (it dies in a shorted mode). If your equipment has a fuse smaller than 8 Amps, you may wish to add an additional fuse of 10 to 20 Amps. This will prevent surges from frequently blowing the equipment fuse and yet gives safe localized "end of life" protection. Solder in place using the center black wire for chassis ground and the two white wires for each side of the transformer primary as shown in diagram.

For 8 Amp and up Equipment



For less than 8 Amp Equipment add additional fuse



For further information on grounds, ground systems, power line and telephone interconnect protection, order PolyPhaser's book "The 'Grounds' for Lightning & EMP Protection" at a cost of $19.95.

LIMITED WARRANTY

PolyPhaser Corporation warrants this product to meet or exceed the published specifications of the time of manufacturing and to be free of manufacturing defects for a two year period after proven date of purchase. PolyPhaser Corporation makes no claims, nor extends any warranty to include an "IMPLIED WARRANTY OF MERCHANTABILITY OR IMPLIED WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE". PolyPhaser Corporation assumes no responsibility for personal injury, property damage, and any other losses. This warranty is limited to the repair, replacement or refund of purchased price of this product only and it will be PolyPhaser Corporation's decision as to whether this unit is defective and as to which of the above mentioned actions will be taken. PolyPhaser Corporation extends no obligation to up-date or modify any of its existing products, as newly developed products are marketed.

"To Keep **You** communicating
U.S. Patent #'s 4,359,764, 4,409,637 & 4,554 608

PolyPhaser CORPORATION

We Changed Blitz to Bliss"
and other U.S. & Foreign Patents Pending

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Phone: (800) 325-7170
(702) 782-2511
RCA TELEX: 272718 POLYPHASER

OPERATING INSTRUCTIONS & PARTS MANUAL

SHADED-POLE BLOWERS

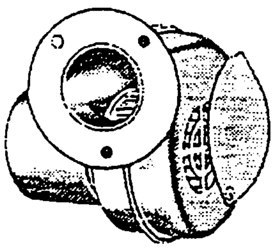
MODELS 2C782, 2C914A, 4C440, 4C441A & 4C443A

FORM 5S2549
0404C

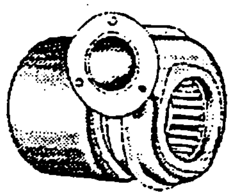
DAYTON ELECTRIC MANUFACTURING CO. CHICAGO 60648

1186/415/1

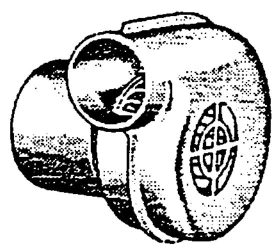
READ INSTRUCTIONS CAREFULLY BEFORE ATTEMPTING TO INSTALL, OPERATE OR SERVICE DAYTON SHADED-POLE BLOWERS!
RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.



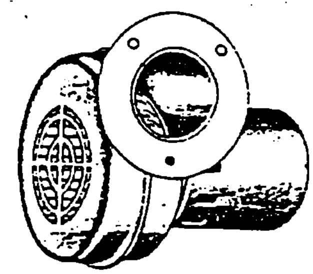
MODELS 4C440 AND 2C914A



MODEL 2C782



MODEL 4C441A



MODEL 4C443A

Figure 1

Description

The Dayton shaded pole blower, finished in grey enamel, is a single speed unit designed specifically for heating, cooling, exhausting, ventilating and drying. It is field interchangeable with most direct drive blowers and can be mounted in any discharge position. Blower is driven by a shaded-pole motor.

Models 2C914A, 4C440, 4C441A and 4C443A feature automatic-reset thermal protection which automatically shuts off the motor should excessive temperatures develop. Model 2C782 has impedance protection. Maximum ambient temperature is 104°F (40°C).

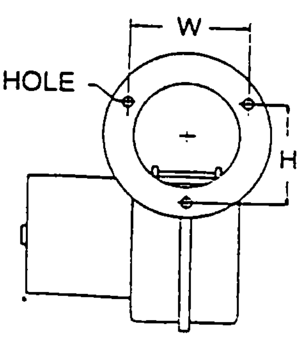


Figure 2

Dimensions

MODEL	"H"	"W"	"D"
2C782	1 13/32	1 5/8	13/64
2C914A	2 13/16	2 3/8	9/32
4C440	2 13/16	2 3/8	9/32
4C441A	—	—	—
4C443A	2 13/16	2 3/8	9/32

6119-4160

General Safety Information

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).
2. Blower must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system, by using a separate ground wire connected to the bare metal of the blower frame, or other suitable means.
3. Always disconnect power source before working on or near a motor or its connected load. If the power disconnect point is out-of-sight, lock it in the open position and tag to prevent unexpected application of power.
4. All moving parts should be guarded.
5. Be careful when touching the exterior of an operating motor — it may be hot enough to be painful or cause injury. With modern motors this condition is normal if operated at rated load and voltage — modern motors are built to operate at higher temperatures.
6. Protect the power cable from coming in contact with sharp objects.
7. Do not kink power cable and never allow the cables to come in contact with oil, grease, hot surfaces, or chemicals.
8. Make certain that the power source conforms to the requirements of your equipment.
9. Wiping or cleaning rags and other flammable waste materials must be placed in a tightly closed metal container and disposed of later in the proper fashion.
10. When cleaning electrical or electronic equipment, always use an approved cleaning agent such as dry cleaning solvent.
11. Do not use these blowers in explosive atmospheres.

Specifications

MODEL	WHEEL SIZE DIA.	WHEEL SIZE W	MOTOR HP	MOTOR SPD	MOTOR PWR. REQD.	OUTLET OPENING DIA.	OVERALL DIMENSIONS H	OVERALL DIMENSIONS W	OVERALL DIMENSIONS D
2C782 •	2	1	1/250	1	115V 50/60 HZ	1¼	3 13/16	4 3/16	3 29/32
2C914A Δ	3	1⅞	1/125	1	230V 50/60 HZ	2⅛	5 13/16	5 7/32	6 5/16
4C440 Δ	3	1⅞	1/125	1	115V 50/60 HZ	2⅛	5 13/16	5 7/32	6 5/16
4C441A Δ	3	1⅞	1/125	1	115V 50/60 HZ	2⅛	5 13/16	5 7/32	6 5/16
4C443A Δ	3 13/16	1⅞	1/70	1	115V 50/60 HZ	2⅛	5 13/16	6 7/16	6 5/16

ΔAutomatic-Reset Thermal Protection. NOTE: All dimensions in inches. • Impedance Protected.

Performance

MODEL	CFM AIR DELIVERY AT SPEED AND STATIC PRESSURE (SP) SHOWN: FREE AIR	0.1" SP	0.2" SP	0.3" SP	0.4" SP	0.5" SP	CUT-OFF SP	FREE AIR: SPEED *	WATTS *	AMPS *
2C782	15	13	4				0.22"	3160	16	0.21
2C914A Δ	60	57	54	49	39	23	0.60	3030	36	0.21
4C440 Δ	60	57	54	49	39	23	0.60	3030	36	0.42
4C441A Δ	60	57	54	49	39	23	0.60	3030	36	0.42
4C443A Δ	100	98	95	90	85	80	0.80	2870	61	0.74

ΔAutomatic-Reset Thermal Protection. *At Free Air. NOTE: All data based on 60Hz operation. When operated on 50Hz, a decrease of approximately 20% will occur in flow rate performance.

Installation

1. Mount the unit in the position most desirable to your needs.
2. Connect the two leads to the appropriate power source. Refer to blower name plate.

   NOTE: These blowers are not recommended for use with any type of speed control device.

CAUTION: A ground wire must run from the blower motor housing to a suitable electrical ground such as a properly grounded metallic raceway or ground wire system.

Maintenance

LUBRICATION

The motor bearings should be relubricated every 6 months with 10 or 20 drops of SAE 10W or 20W non-detergent oil (ML-type) or with electric motor oil.

GENERAL

Should further servicing of the unit be necessary, refer to the "exploded" view illustration as an aid in disassembly and assembly procedures.

WARNING: ALWAYS DISCONNECT POWER SUPPLY BEFORE SERVICING THE BLOWER OR WORKING WITH THE UNIT FOR ANY REASON. THIS IS ESPECIALLY IMPORTANT WITH UNITS EQUIPPED WITH AUTOMATIC-RESET THERMAL PROTECTION. UNIT MAY ACTIVATE WITHOUT WARNING!

Troubleshooting Chart

SYMPTOM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
Excessive Noise	1. Blower wheel contacting housing 2. Foreign material inside housing 3. Leak in duct work 4. Loose duct work	1. Realign or replace. 2. Clean. 3. Repair. 4. Secure properly.
Insufficient air flow	1. Leaks in duct work 2. Dampers and/or registers closed 3. Obstruction in system 4. Clogged Filters	1. Repair. 2. Open. 3. Remove. 4. Clean or replace.
Unit fails to operate	1. Blown fuse or open circuit breaker 2. Defective motor 3. Automatic-reset thermal protector "tripped" 4. Motor improperly wired	1. Replace fuse or reset circuit breaker. 2. Replace. 3. Check for high (or low voltage input or ambient temperatures in excess of 40°C (104°F). 4. Re-wire.

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. Blowers, Models 2C782, 2C914A, 4C440, 4C441A & 4C443A, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from state to state.

LIMITATION OF LIABILITY. To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to, and shall not exceed, the purchase price paid.

WARRANTY DISCLAIMER. Dayton has made a diligent effort to illustrate and describe the products in this literature accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the products are merchantable, or fit for a particular purpose, or that the products will necessarily conform to the illustrations or descriptions.

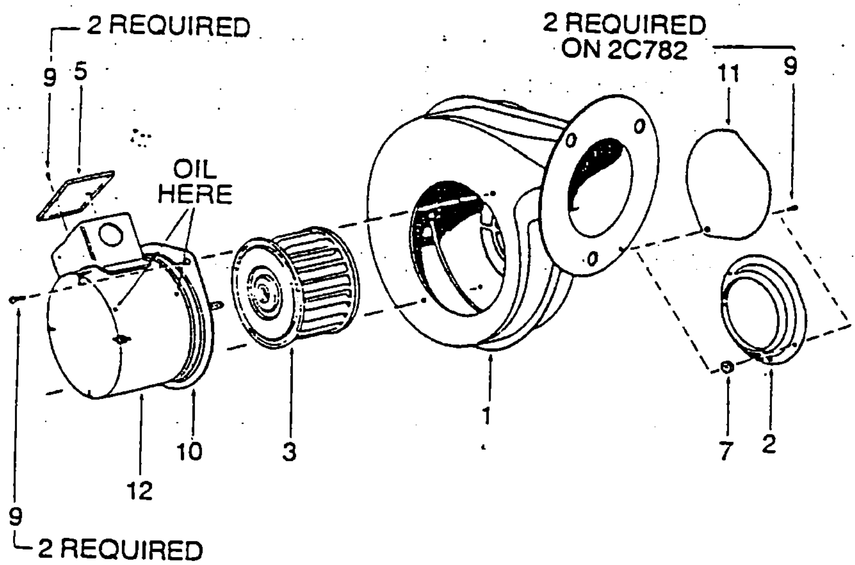
Except as provided below, no warranty or affirmation of fact, expressed or implied, other than as stated in "LIMITED WARRANTY" above is made or authorized by Dayton.

PRODUCT SUITABILITY. Many states and localities have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, please review the product application, and national and local codes and regulations, and be sure that the product, installation, and use will comply with them.

Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Dayton Electric Mfg. Co., 5959 W. Howard St., Chicago, IL 60648



ORDER REPLACEMENT PARTS THROUGH DEALER FROM WHOM PRODUCT WAS PURCHASED

Please provide following information:
- Model Number
- Serial Number (if any)
- Part Description and Number as shown in parts list.

If dealer cannot supply, order from:
Dayton Electric Mfg. Co.
Parts Department
5959 W. Howard St.
Chicago, Illinois 60648

Figure 3 — Replacement Parts Illustration, Models 2C782, 2C914A, 4C440 & 4C441A

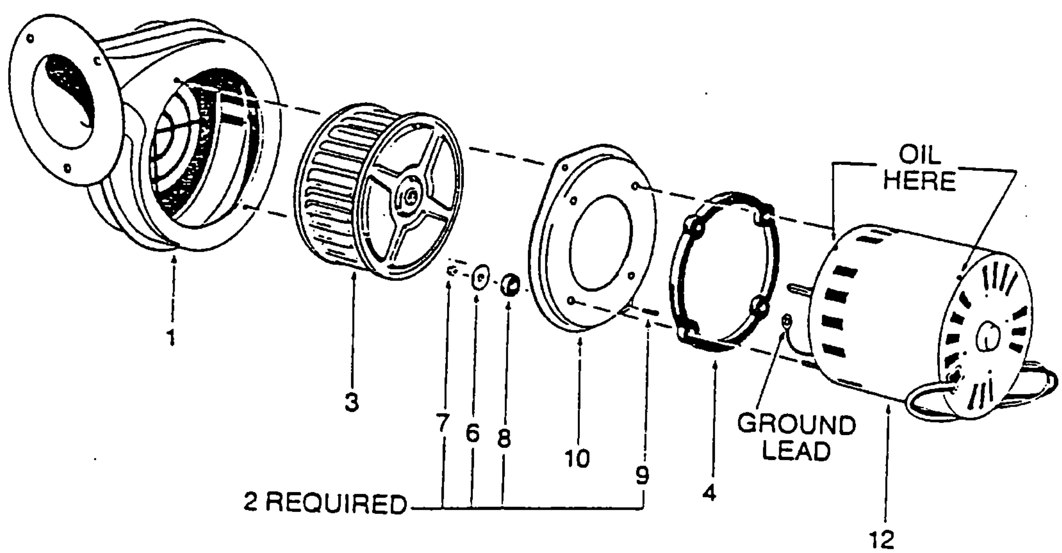


Figure 4 — Replacement Parts Illustration, Model 4C443A
NOTE: Conduit box and cover not shown for Model 4C443A.

Replacement Parts List

REF. NO.	DESCRIPTION	PART NO. FOR MODELS:				
		2C782	2C914A	4C440	4C441A	4C443A
1	Housing	8853-4296	8853-4291	8853-4291	8853-4289	8853-4283
2	Inlet ring	8793-4055	—	—	—	—
3	Blower wheel	0907-0023	0905-0059	0905-0059	0905-0059	0910-0002
4	Gasket	—	—	—	—	0912-0167
5	Conduit box cover	—	8591-6628	8591-6628	8591-6628	8591-6628
6	Washer #8	—	—	—	—	*
7	Nut #8-32	*	—	—	—	*
8	Grommet	—	—	—	—	0912-0168
9	Screw #8-1/4	*	*	*	*	*
10	Mounting cup	8768-4026	—	—	—	8768-4027
11	Damper	—	8631-4006	8631-4006	—	—
12	Motor	7121-1998	7121-3482	7121-3466	7121-4930	7121-4931

*Standard hardware item, available locally.

METHANE REACTOR TROUBLE SHOOTING

I. Methane reactor is cold to touch.

(a) Fuse is blown

(1) Before replacing fuse, check resistance between black wire and chassis and white wire and chassis. Resistance should be infinite. Replace fuse. Unit should be operational.

(2) If resistance is zero, there is a short in the wiring inside the methane reactor. Allow the reactor to cool and inspect all wiring and components for evidence of shorting. Repair wiring or replace defective components.

(3) If no shorts visible, lift entire wiring harness from methane reactor block and lay it on non-conducting surface. Measure resistance between black and red leads. It should read zero, indicating continuity through temperature controller switch. If not, replace temperature controller switch.

(b) Fuse is not blown but power is constant to unit and unit is cold.

(1) Measure resistance between red lead and white lead. If unit has 10-LPM or less capacity and operates 120V, the resistance should be about 48-ohms. If operating 230V, resistance should be about 185-ohms. In either case, if resistance is infinite, replace heater.

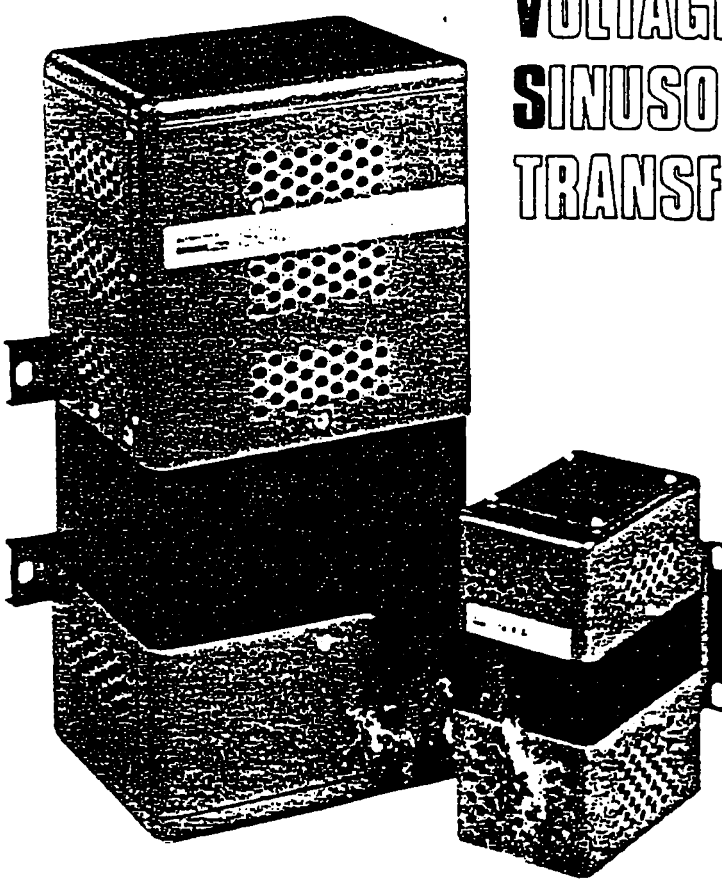
(2) If capacity is 20 or 30-LPM, resistance should be about 22-ohms if both heaters are okay and operating 120V. Resistance should be about 95-ohms if for 230V. If reading is about 48-ohms, 120V, means one heater gone. If reading is about 185-ohms, 230V, means one heater gone. All readings taken between red and white leads.

(3) If readings in (b)(2) above are infinite, both heaters gone.

II. Unit is at temperature other than 290°C, replace temperature switch with switch from AADCO. It is imperative that temperature setting be correct. Settings other than prescribed will cause formation NO_X and improper hydrocarbon removal.

III. It is imperative that proper filtering of air prior to methane reactor be done. Removal of particulates, halogens and sulfur compounds is mandatory for longevity and flow specifications to be met.

CONSTANT VOLTAGE SINUSOIDAL TRANSFORMERS



A UNIT OF GENERAL SIGNAL GS

SOLA

INTRODUCTION

This operating and service manual has been prepared to ensure that your SOLA Constant Voltage Transformer can be operated and serviced with minimal effort and involvement. This manual covers SOLA Constant Voltage Sinusoidal (CVS) Transformers.

INSTALLATION - Mechanical

Position

All stock sizes with end housings are intended to be mounted with the silkscreened THIS SIDE UP legend facing upwards. This will place the ventilated capacitor compartment downward, thus providing cooler operation of the capacitor(s). However, all units will give satisfactory performance if mounted in a horizontal position. In either case, the unit should be mounted in an area where it is unlikely that anyone will come into contact with the core surface of the unit. Figure 1 shows a phantom view of a typical unit.

Mounting Considerations

If a unit is to be wall mounted, the mounting hardware should be sized as in Table 1 below. All mounting holes provided must be used.

Table 1. Mounting Screw/Bolt Sizing

RATED VA OF REGULATOR	MIN. DIAMETER OF STEEL MOUNTING BOLTS
30 to 120	#10 Machine Screws
250	1/4" Bolts
500 to 1000	5/16" Bolts
1500 to 10000	3/8" Bolts
15000	1/2" Bolts

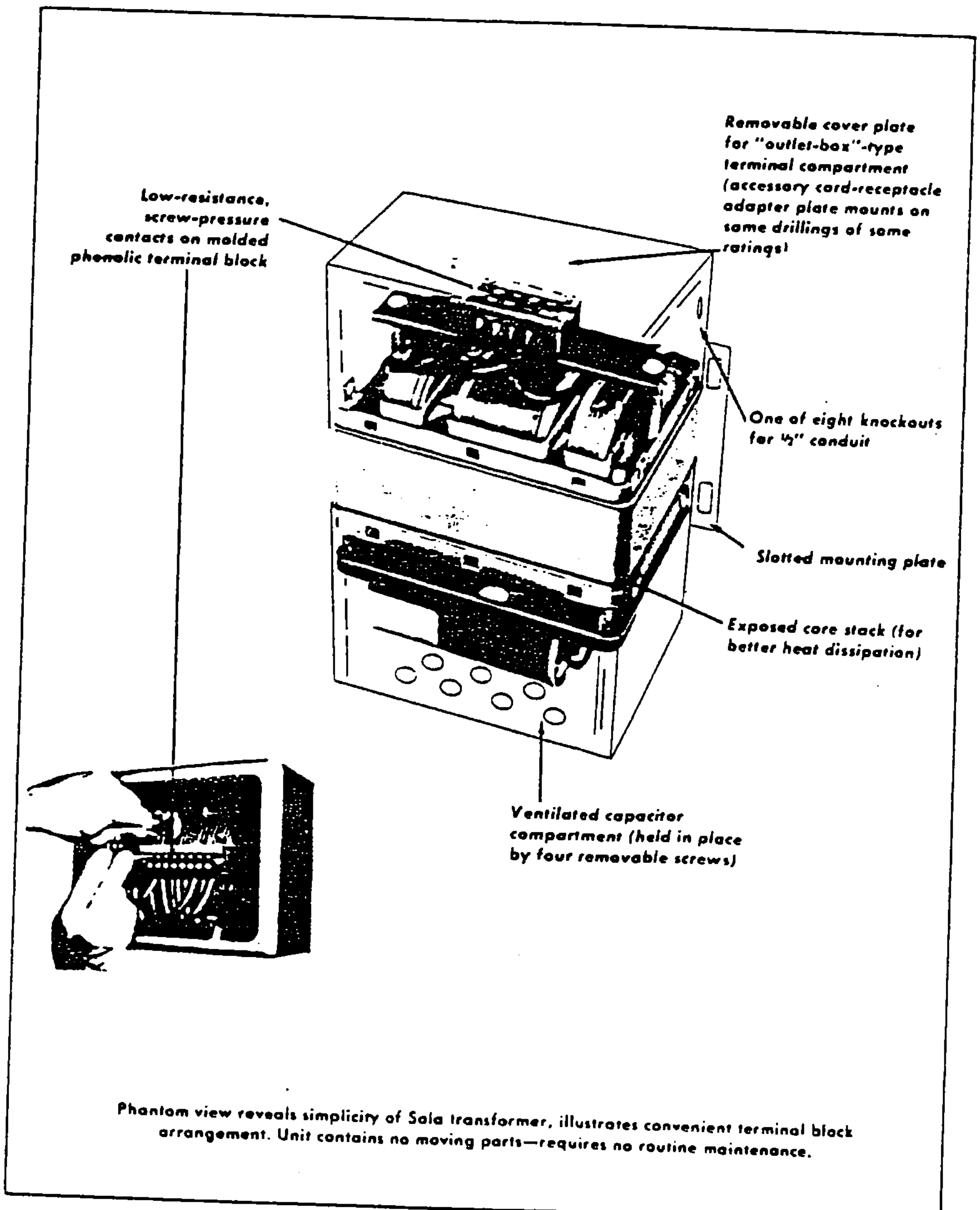


Figure 1. Phantom View

All ratings depend on natural draft air circulation for cooling. They should not be mounted in confined or enclosed spaces unless special provisions have been made for ventilation. Sola's Technical Service department is available for assistance in doubtful situations (see note on Operating Temperature, page 13). Table 2 and Figure 2 show model numbers with their weights and physical dimensions.

Table 2. CVS Weights and Physical Dimensions

Catalog Number	VA	Outline	A	B	C	D	E	F	G	H	Shipping Weight (lbs)
					(in inches)						
60Hz Single Phase:											
23-13-030-2	30	A	6.12	5.19	3.31	4.00	3.50	3.00	1.75	.22 X .59	7
23-13-060-2	60	A	6.94	5.19	3.31	4.00	3.50	3.00	1.75	.22 X .59	9
23-23-060-2	60	A	6.94	5.19	3.31	4.00	3.50	3.00	1.75	.22 X .59	9
23-22-112-2	120	A	8.12	5.19	3.31	4.00	3.50	3.00	2.44	.22 X .59	13
23-22-125	250	A	9.62	7.44	4.50	5.38	4.75	4.12	2.19	.31 X .69	28
23-23-125-8	250	A	9.88	7.44	4.50	5.38	4.75	4.12	2.19	.31 X .69	28
23-23-125	250	A	9.62	7.44	4.50	5.38	4.75	4.12	2.19	.31 X .69	29
23-22-150	500	A	11.69	6.44	7.78	9.00	8.12	5.62	3.06	.38 X .81	36
23-26-150	500	A	11.69	6.44	7.78	9.00	8.12	5.62	3.06	.38 X .81	36
23-23-150-8	500	A	12.69	6.44	7.78	8.00	8.12	5.62	3.06	.38 X .81	37
23-25-175	750	A	15.38	6.44	7.78	9.00	8.12	5.62	3.06	.38 X .81	52
23-23-175-8	750	A	13.69	6.44	7.78	9.00	8.12	5.62	3.06	.38 X .81	52
23-25-210	1000	A	16.38	6.44	7.78	9.00	8.12	5.62	3.06	.38 X .81	60
23-26-210	1000	A	16.38	6.44	7.78	9.00	8.12	5.62	3.06	.38 X .81	60
23-23-210-8	1000	A	16.75	6.44	7.78	9.00	8.12	5.62	5.25	.38 X .81	63
23-25-215	1500	B	18.44	9.03	10.56	12.75	11.75	3.00	5.19	.44 X .69	94
23-23-215-8	1500	B	16.44	9.03	10.56	12.75	11.75	3.00	5.19	.44 X .69	95
23-25-220	2000	B	19.31	9.03	10.56	12.75	11.75	3.88	5.19	.44 X .69	111
23-23-220-8	2000	B	17.31	9.03	10.56	12.75	11.75	5.25	5.19	.44 X .69	109
23-26-220	2000	B	19.31	9.03	10.56	12.75	11.75	3.88	5.19	.44 X .69	111

Table 2. CVS Weights and Physical Dimensions - (Continued)

Catalog Number	VA	Outline	A	B	C (in inches)	D	E	F	G	H	Shipping Weight (lbs.)
23-25-230-3	3000	B	20.69	9.03	10.56	12.75	11.75	5.25	5.19	.44 X .69	142
23-26-230	3000	B	20.69	9.03	10.56	12.75	11.75	5.25	5.19	.44 X .69	142
23-23-230-8	3000	B	18.69	9.03	10.56	12.75	11.75	5.25	5.19	.44 X .69	142
23-25-250-6	5000	B	30.69	9.03	10.56	12.75	11.75	8.25	8.88	.44 X .69	225
23-26-250-6	5000	B	30.69	9.03	10.56	12.75	11.75	8.25	8.88	.44 X .69	225
23-23-250-8	5000	B	28.19	9.03	10.56	12.75	11.75	8.25	8.88	.44 X .69	225
23-28-275-6	7500	C	29.06	9.03	22.81	25.81	24.81	6.62	8.88	.44 X .69	222
23-28-310-6	10000	C	30.69	9.03	22.81	25.81	24.81	8.25	8.88	.44 X .69	365
23-28-315-6	15000	*	30.69	9.38	35.56	38.25	37.22	8.25	8.88	.56 X .69	715
50Hz Single Phase:											
24-551-2	60	A	7.75	5.19	3.31	4.10	3.50	3.00	2.44	.22 X .59	11
24-552-2	120	A	8.62	7.44	4.50	5.38	4.75	4.12	2.19	.31 X .69	21
24-553-2	250	A	10.31	7.44	4.50	5.38	4.75	4.12	2.19	.31 X .69	37
24-554-9	500	A	12.31	6.44	7.78	9.00	8.12	5.62	3.06	.38 X .81	56
24-554-10	500	A	12.31	6.44	7.78	9.00	8.12	5.62	3.06	.38 X .81	56
24-555-9	1000	B	17.12	6.44	7.78	9.00	8.13	5.62	4.06	.38 X .81	65
24-555-10	1000	B	17.12	6.44	7.78	9.00	8.13	5.62	4.06	.38 X .81	65
24-556-9	2000	B	19.94	9.03	10.56	12.75	11.75	4.50	5.19	.44 X .69	126
24-557-9	3000	B	25.41	9.03	10.56	12.75	11.75	6.66	5.19	.44 X .69	187
24-572-9	5000	C	21.12	9.03	22.81	25.81	24.81	5.69	5.19	.44 X .69	310

* Triplex assembly: Same as Figure 2 (c) except for one more transformer.

Note: 50 and 60Hz CVS transformers are of different designs, and cannot be adjusted or rebuilt for other frequencies.

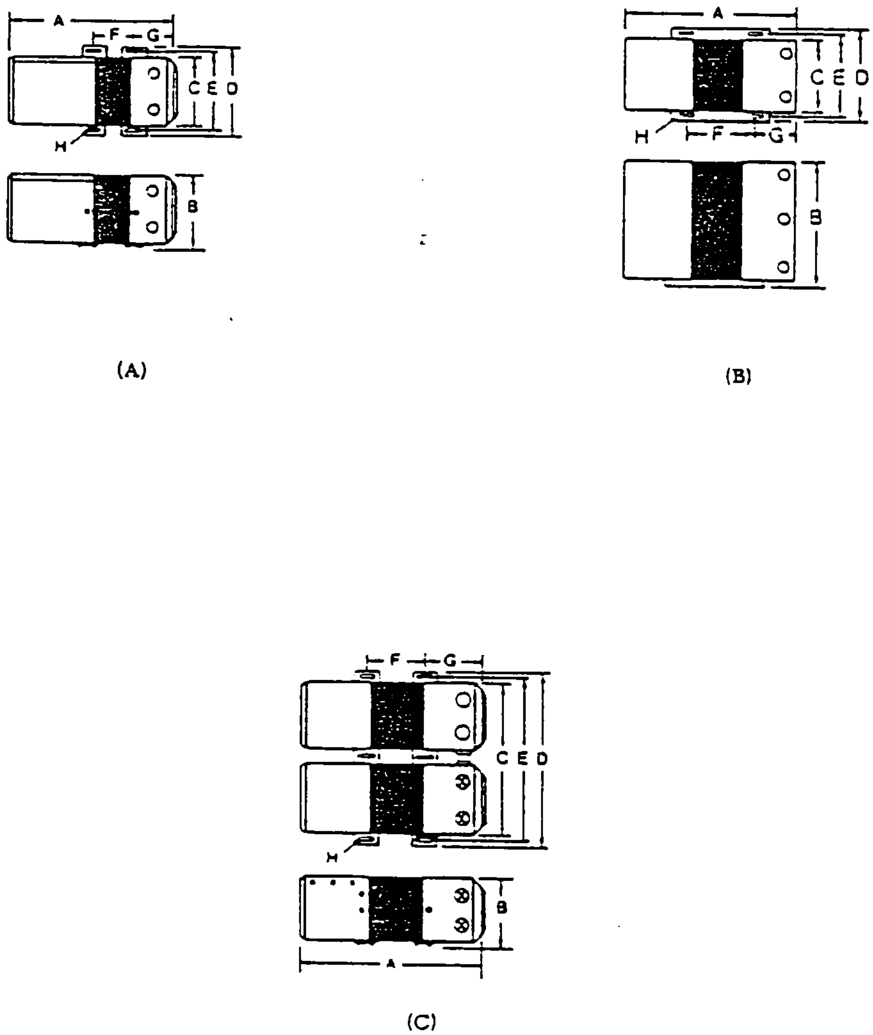
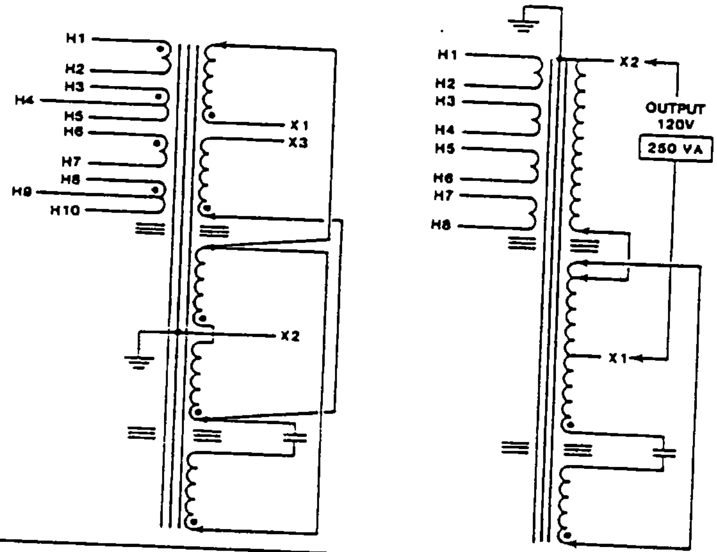


Figure 2. Mounting Holes and Dimensions

INSTALLATION - Electrical

On 60VA or smaller units, screw-type lugs in the outlet box are marked "input" and "output", and no connection diagram is necessary. Units rated 120 to 15000 VA are provided with multiple inputs for any one, two, three, or four different line voltages, and some have provision for three-wire output. With all units, a connection diagram is attached to the inside lid of the box cover, or inserted in the outlet box. Figure 3 shows typical connections for -8 models, and Figure 4 shows multiple input connections for all other models. Figure 5 shows the output connections for all models.



INPUT CONNECTIONS - All except 250 VA

Volts	Input	Jumper
95-130	H1-H2	(H1 + H3 + H6 + H8) (H2 + H5 + H7 + H10)
175-235	H1-H4	(H2 + H3) (H7 + H8) (H1 + H6) (H4 + H9)
190-260	H1-H5	(H2 + H3) (H7 + H8) (H1 + H6) (H5 + H10)
380-520	H1-H10	(H2 + H3) (H5 + H6) (H7 + H8)

INPUT CONNECTIONS - 250 VA Only

Volts	Input	Jumper
95-130	H1 - H2	(H1 + H3 + H5 + H7) (H2 + H4 + H6 + H8)
190-260	H1 - H4	(H2 + H3) (H6 + H7) (H1 + H5) (H4 + H8)
380-520	H1 - H8	(H2 + H3) (H4 + H5) (H6 + H7)

Figure 3. Electrical Connection for -8 Models

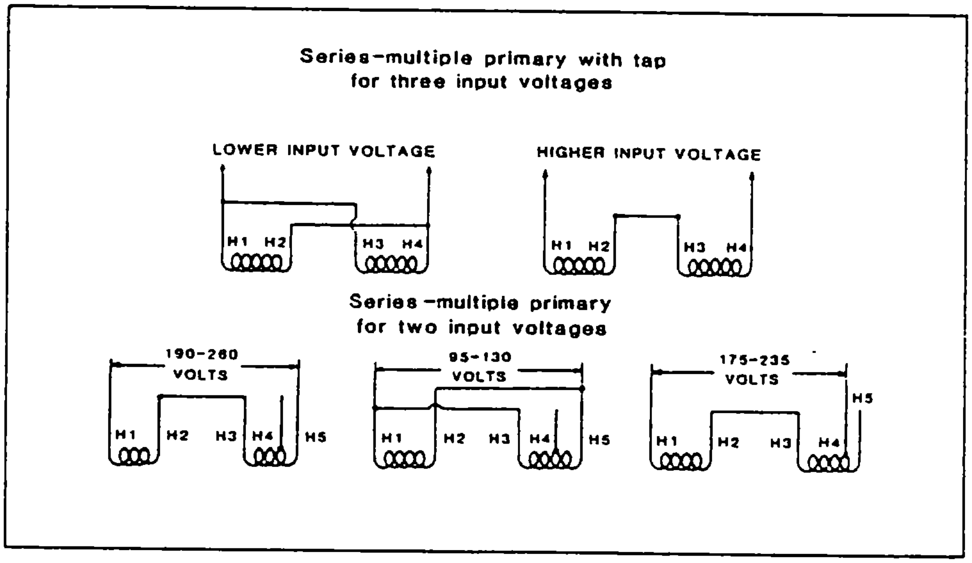


Figure 4. Multiple Input Connections for All Models Not Ending In -8

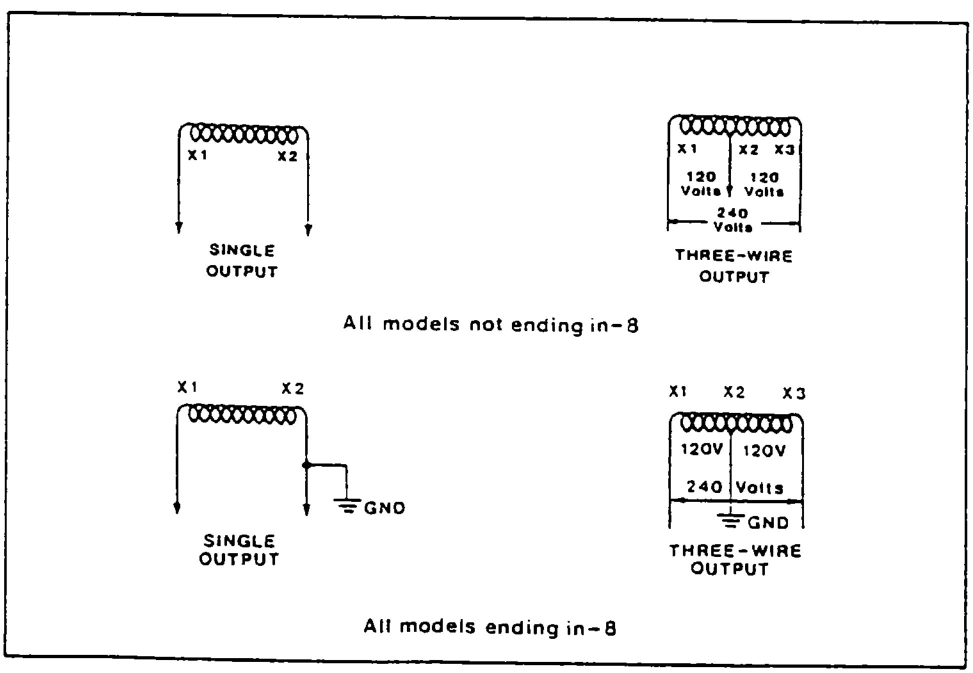


Figure 5. Output Connections

Wire Sizing and Circuit Protection

Table 3 shows suggested circuit protection and wire sizing for the various models of CVS transformers.

Table 3. Circuit Protection/Wire Gauge Sizes

CVS VA Rating	INPUT Rated Volts	INPUT Required Circuit Protection (A)	INPUT Minimum Gauge 90°C Wire	OUTPUT Rated Volts	OUTPUT Minimum Gauge 90°C Wire
30	95-130	1	14	120	14
60	95-130	2	14	120	14
120	95-130	3	14	120	14
	175-235	3	14	120	14
	190-260	3	14	120	14
	380-520	1	14	120	14
250	95-130	6	14	120	14
	175-235	3	14	120	14
	190-260	3	14	120	14
	380-520	1	14	120	14
500	95-130	10	14	120	14
	175-235	6	14	208	14
	190-260	6	14	240	14
	380-520	3	14		
750	95-130	15	14	120	14
	175-235	10	14	208	14
	190-260	6	14	240	14
	380-520	3	14		
1000	95-130	15	14	120	14
	175-235	10	14	208	14
	190-260	10	14	240	14
	380-520	6	14		
1500	95-130	25	10	120	12
	175-235	15	14	208	14
	190-260	15	14	240	14
	380-520	10	14		
2000	95-130	30	10	120	10
	175-235	20	12	208	14
	190-260	15	14	240	14
	380-520	10	14		

Table 3. Circuit Protection/Wire Gauge Sizes - (Continued)

CVS	INPUT			OUTPUT	
VA Rating	Rated Volts	Required Circuit Protection (A)	Minimum Gauge 90°C Wire	Rated Volts	Minimum Gauge 90°C Wire
3000	95-130	45	8	120	8
	175-235	25	10	208	12
	190-260	25	10	240	12
	300-520	15	14		
5000	95-130	80	4	120	8*
	175-235	40	8	208	10
	190-260	40	8	240	10
	380-520	20	12		
7500	175-235	60	6	120	4
	190-260	60	6	208	8
	380-520	30	10	240	8
10000	175-235	80	3	120	3
	190-260	80	4	208	6
	380-520	40	8	240	8
15000	175-235	125	1	120	0
	190-260	110	2	208	4
	380-520	60	4	240	4

*Leads in the wiring compartment must be sleeved with 105°C sleeving.

Three-Wire Regulating Action

On those units provided with three-wire output, the standard regulating action of ±1% or better may be obtained from the 240 volt terminals alone, either 120 volt leg alone, combination 240 and 120 volt loads, or unbalanced 120 volt loads.

Other Considerations

For certain smaller ratings, an accessory adapter plate-carrying an input cord and output receptacle, or jacks, is available at a small additional cost. Simple directions for installation are furnished with the adapter kit.

It is desirable to have a switch in the input circuitry for turning off power to the unit when it is not in use. While all CVS transformers are designed for continuous duty, they draw appreciable current regardless of output loading.

The outputs of all Sola standard CVS transformers are isolated from the input lines. Voltage generated by internal leakage currents will occur with respect to ground. This can have undesirable affects in many pieces of electronic equipment. Therefore, it is suggested that the installer tie the input power system neutral to the X2 output terminal. This will not affect regulation or the ability to reject power line noise or transients.

SPECIAL INSTALLATIONS

Use on Three-Phase Power Supply

Any three stock units having a tap for 190-260 input connections may be connected in delta to a 240-volt, three-phase power supply; those units equipped with primary tap for 175-235 volts may also be connected in delta to a 208-volt supply. (Terminals to be used are identified on the connection diagram located on the inside face of the outlet box cover.)

All stock production, harmonic-free units now have uniform terminal polarity. This eliminates necessity for "phasing out" either input or output connections.

Output must serve three, independent, single-phase loads of the same total volt-ampere rating. Connections should be made in one of two ways shown in Figure 6.

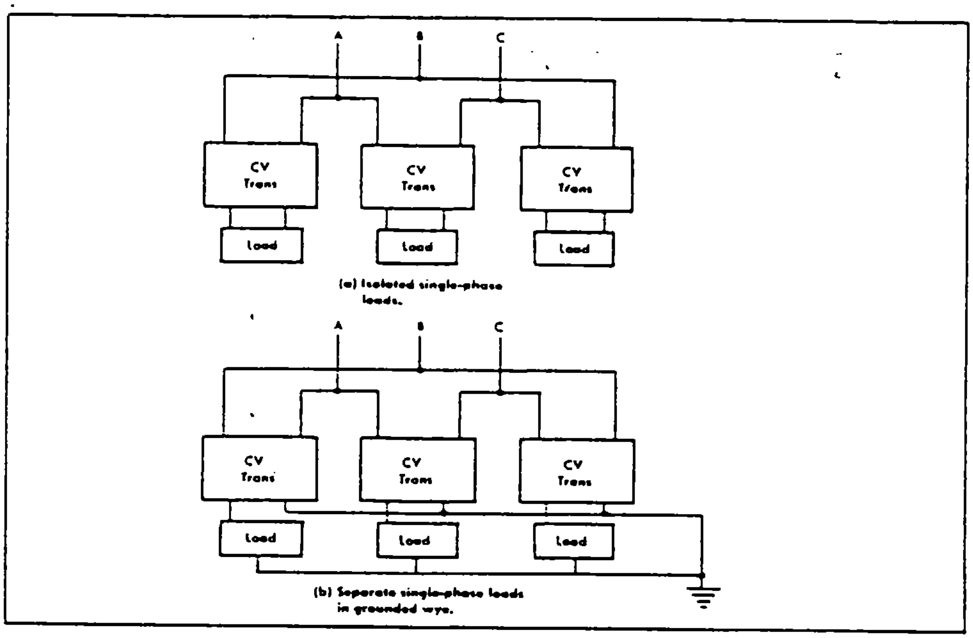


Figure 6. Three-Phase Connections

Use With Switchmode Power Supplies

If a CVS transformer is used as a source for a switchmode power supply, a slight amount of ringing may be noticed on the sine wave output of the CVS at half cycle intervals for a short duration. This ringing occurs at the point when the switchmode power supply current demand drops to zero. The ringing need not be a cause for concern since it is of relatively low magnitude and frequency. The CVS has been tested with a variety of switchmode power supplies and it has been determined that the ringing never affects the DC outputs, nor has it been found to degrade the components of any switchmode power supply.

Multiple Operation

Two CVS transformers of the same rating may be connected with their inputs and outputs in parallel. The regulating action will usually be excellent although the standard ±1% cannot be guaranteed. Series connection of either input or output is not recommended.

Use With Rectifier Loads

The ratio of crest to rms values is approximately 1.3 at rated load, and slightly lower at fractional loads. This factor must be considered when all or a portion of the voltage is rectified. The rectified voltage will now be 10 - 15% lower than if connected directly to a sine wave source.

Operation With Motor Loads

Because of the current limiting effect described later, special attention should be given to motor applications. In general, the CVS must have a load rating nearly equal to the maximum power drawn during the starting cycle. This may run from two to eight times the normal running rating of the motor. In doubtful cases it is advisable to measure the actual starting current.

Cascade Operation

For applications requiring close regulation, two CVS transformers may be operated in "cascade". The output of the combination will show little or no detectable change arising from supply line variations of up to ±15%. However, the combined units will still be frequency sensitive (as discussed under Effect of Frequency, page 15). Since even good power systems may often vary in frequency by 0.1% or more, the output of a Sola cascade combination may vary by up to 0.25% from this cause alone. In actual practice, then, a cascade combination is highly recommended for special applications requiring regulation in the general region of ±0.25%. If the tandem setup is to be operated at near full rating, then the Type CVS "driver" unit should be one standard size larger than the driven unit, in order to overcome the losses in the latter.

PHYSICAL CHARACTERISTICS OF OPERATION

Operating Temperature

Standard units are designed to operate in ambient temperatures of minus 20°C to plus 50°C. In operation, a temperature rise will occur whether or not the transformer is serving load. Normally, this rise may fall anywhere in the range of 45°C to 110°C, depending on the type and rating. In any case, the maximum operating temperature at an ambient of 50°C is always within safe operating limits for the class of insulating material used. (Special units can be designed for lower heat rise or wider ambient temperature range.)

External Magnetic Fields

In almost all applications, this effect may be disregarded. On critical applications, care should be exercized in the orientation of the core with respect to critical circuits, in order to minimize the effect of the field.

In certain rare cases in which the transformer is connected to, or mounted near, high gain audio frequency circuits, special attention may need to be given to adequate physical spacing and/or orientation of the CVS transformer so as to avoid interaction with the audio circuits. Sola's Technical Service Department may be able to offer suggestions for such problems.

ELECTRICAL CHARACTERISTICS OF OPERATION

Checking With Voltmeters

All checks on output voltages should be made with a true RMS voltmeter such as a Fluke model 8020 A. Rectifier-type voltmeters will not give accurate readings due to the small amount of harmonics present in CVS output.

Load Regulation

Changes in output voltage resulting from changes in resistive loads are usually small - running one percent or less in the larger units. Table 4 shows average values for output voltages.

Table 4. Output Voltage Changes - 20% Load to Full Load (100% Power Factor - Nominal Input Voltage)

Transformer VA	Percent Change - Output Voltage
11-30	approximately 4%
31-120	approximately 3%
121-150	approximately 2%
151-over	approximately 1%

Phase Shift

The phase difference which exists between input voltage and output voltage in the range of about 120° to 140° at full load. This phase difference varies with the magnitude of the load and, to a lesser extent, with changes in line voltage.

Output Wave Shape

The CVS transformers all include harmonic-neutralizing circuitry. These units typically have less than 3% total harmonic distortion at full load and less than 4.5% at no load.

Response Time

An important advantage of the Sola principle of static magnetic regulation is its exceedingly fast response time compared with other types of AC regulators. Transient changes in supply voltage are usually corrected by a Sola CVS with 1 1/2 cycles or less, the output voltage will not fluctuate more than a few percent during this interval.

Isolation

Since the input and output are separated not only electrically, but physically, by a magnetic shunt, the Sola CVS has a stronger isolating effect than a conventional transformer. This may often eliminate the need for static shields.

FACTORS AFFECTING OPERATION

Input Charcteristics

As the Sola CVS transformer includes a resonant circuit that is fully energized whether or not a load is present, the input current at no load or light loads may run 50% or more of the full-load primary current. As a result, the temperature of the unit may rise to near full-load levels, even at light or nonexistent loads. Input power factor will average 90-100% at full load, but may drop to approximately 75% at half load and 25% at no load. In any case, it is always leading.

Effect of Load Power Factor

The median value of output voltage will vary from the nameplate rating of the load is a power factor other than that for which the unit was designed. Load regulation will also be relatively greater as the inductive load power factor is decreased (see Figure 7). However, the resulting median values of the output voltage will be regulated against supply line changes at any reasonable load or power factor.

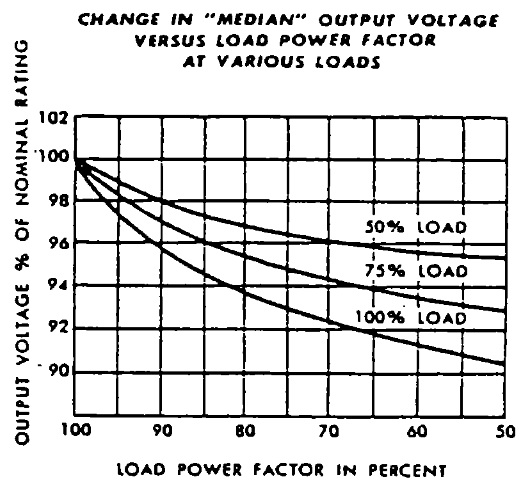


Figure 7. Median Output Voltage Vs. Load Power Factor

Effect of Frequency

Changes in the frequency of the supply voltage will be directly reflected in the output voltage. A change of approximately 1.8% in the output voltage will occur for every 1% change in input frequency in the same direction as the frequency change.

Effect of Temperature

The output voltage will show a small change as the unit warms up to stable operating temperatures at a constant ambient temperature. This change may be about one or two percent, depending on the unit's VA rating. At a stable operating temperature, the output voltage will change slightly with varying ambient temperature. This shift is approximately one percent for each 40°C of temperature change.

Current Limitation

When the load is increased beyond the transformer's rated value, a point is reached where the output voltage suddenly collapses and will not regain its normal value until the load is at least partially released. Under a direct short circuit, the load current is limited to approximately 150-200% of the rated full load value, the input wattage to less than 10% of normal. A CVS will protect both itself and its load against damage from excessive fault currents. Fusing of load circuits is not necessary.

Manufacturing Tolerance

The nominal output voltage of each stock Constant Voltage Transformer is adjusted at the factory to within plus 2%, minus 0% of rated (nameplate) value with rated, nominal voltage at rated frequency applied to the input, and with full rated load at 100% power factor applied to the output. This adjustment is made with the unit at substantially the same temperature as room ambient temperature (25°C).

SERVICING

Routine Maintenance

As the Sola CV Transformer is a simple rugged device without moving parts or manual adjustments, no servicing or maintenance is needed in the ordinary sense. The percentage of possible poor performance or failure is exceedingly low. In any case of apparent poor performance, the user is urged to check the following points immediately:

Checklist on Factors Affecting Performance

A. Nominal Voltage Too High

1. The load may be considerably less than full rating. (See "Load Regulation", page 13.)
2. The load may have a leading power factor.

B. Nominal Voltage Too Low

1. Load power factor may be lagging. (See Load Regulation, page 13.)
2. Unit may be slightly overloaded. (See Current Limitation, page 15.)

C. Does Not Regulate Closely

1. Unit may be slightly overloaded. (See Current Limitation, page 15.)
2. Actual line voltage swings may be outside the rated coverage of unit, particularly on the low side.
3. On varying loads, a certain amount of load regulation may be mixed with the line voltage regulating action. (See Load Regulation, page 13.)

D. Output Voltage Very Low (20-60V)

1. Unsuspected or unplanned overloads of substantial size may occur intermittently (motor-starting currents, solenoid inrush currents, etc.). (See Current Limitation, page 15.)
2. One or more capacitor units in the CVS transformer may be defective. (See Field Replacement of Capacitors, page 18.)

E. No Output Voltage At All

1. Check power source breakers or fuses.
2. Check continuity between input terminals, and also between output terminals.

F. Transformer Operating Temperature

1. These transformers are designed to operate at high flux density, and hence, relatively high temperatures (see Operating Temperature, page 13). After connection to line for a half hour or so, the exposed core structure may be too hot to touch with bare hand, but this is normal and need give no concern. However, if there is any indication of oil or compound leakage, unit should be returned to factory. (See below.)

NOTE

In case the transformer is operating but does not appear to have the correct output, it is very helpful to apply the following test:

1. Disconnect the working load.
2. Connect a dummy load of lamps, heaters, or other resistive load substantially equal to the full load rating of transformer, directly across its output terminals.
3. Measure the output voltage of the CVS using a true RMS type voltmeter directly across its output terminals.

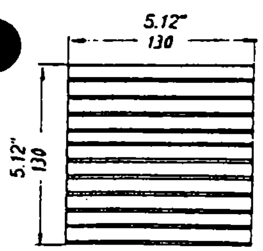
This test will usually establish whether the apparent poor performance is due to a fault in the CVS transformer or to some peculiarity of the working load. Sola's Technical Service department will then be in far better position to give helpful service advice or suggest factory test or service as indicated.

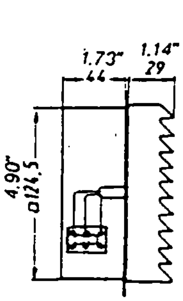
Factory Test and Inspection

If the field test suggested earlier indicated that the CVS transformer itself may be faulty, a full report of the difficulty should be communicated to the place of purchase, with a request for permission for return. The Authorized Sola Distributor may then suggest further helpful field tests, or authorize return for inspection at once. A Return Authorization Number will be issued. **This number must appear on the outside of the shipping container** otherwise the shipment will not be accepted.

260-0023 FAN SK3168
260-0024 FILTER SK3163

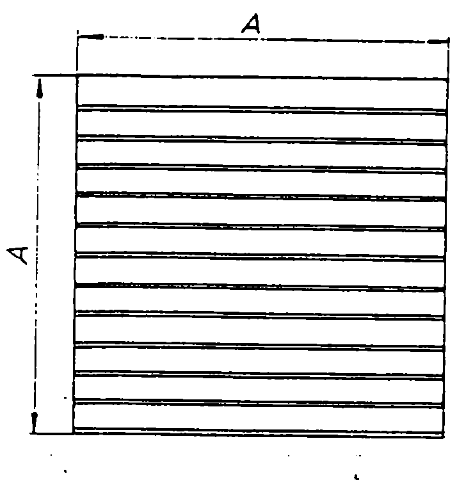
Technical Information at a Glance

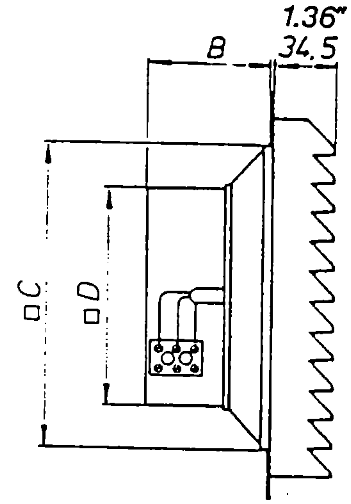




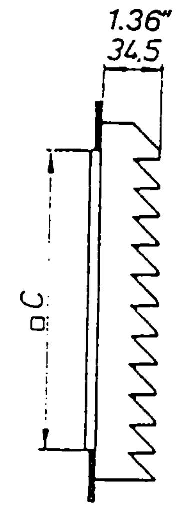
Filter Fan
SK 3150
SK 3165

Outlet
Filter
SK 3160

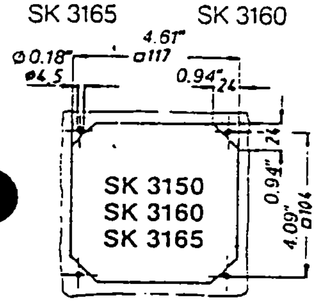




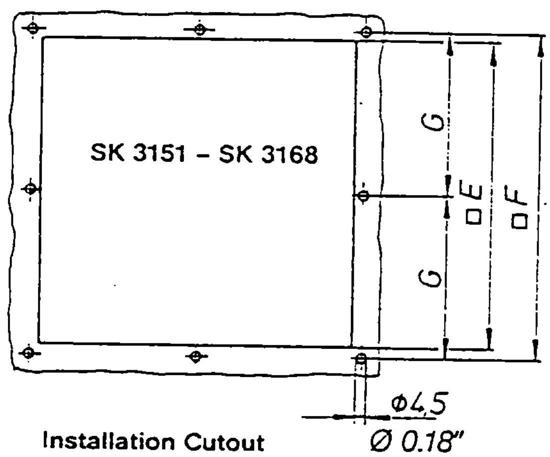
Filter Fan
SK 3151/52/53
SK 3166/67/68



Outlet Filter
SK 3161/62/63



Installation Cutout



Installation Cutout

Filter Fans	3151/66	3152/67	3153/68
Outlet Filter	3161	3162	3163
A mm/in	204 /8.03"	255 /10.04"	323/12.72"
B mm/in	66 /2.60"	103.5/ 4.07"	140/ 5.51"
C mm/in	175 /6.89"	222 / 8.74"	290/11.42"
D mm/in	124.5/4.90"	160 / 6.30"	206/ 8.11"
E mm/in	176 /6.93"	223 / 8.78"	291/11.46"
F mm/in	185 /7.28"	234 / 9.21"	302/11.89"
G mm/in	–	117 / 4.61"	151/ 5.94"

Model No.	SK 3150	SK 3165	SK 3151	SK 3166	SK 3152	SK 3167	SK 3153	SK 3168
Axial fan with self-starting split pole motor							Axial fan with capacitor motor	
Operating voltage	220/230 V 50/60 Hz	110/115 V 50/60 Hz	220/230 V 50/60 Hz	110/115 V 50/60 Hz	220/230 V 50/60 Hz	110/115 V 50/60 Hz	220 V 50 Hz	115 V 60 Hz
Capacitance value							2 µF	8 µF
Current rating	0.11 A	0.24 A	0.11 A	0.24 A	0.225 A	0.6 A	0.27 A	0.6 A
Power	18 W	20 W	18 W	20 W	35 W	42 W	58 W	75 W
Noise level	48.5/49 dB (A)		47.5/48 dB (A)		49/49.5 dB (A)		64/69 dB (A)	
RPM	2650/3100 min-1		2650/3100 min-1		2850/3350 min-1		2650/3000 min-1	
Temperature range	−10 to +55 °C [+14 to +131 °F]		−10 to +55 °C [+14 to +131 °F]		−10 to +55 °C [+14 to +131 °F]		−10 to +55 °C [+14 to +131 °F]	
Air throughput: unimpeded airflow	48 m³/h [28.3 ft³/min]		103 (70) m³/h [60.62 (41.20) ft³/min]*		220 (130) m³/h [129.5 (76.52) ft³/min]*		500 (340) m³/h [294.3 (200.1) ft³/min]*	
With outlet filters	1 SK 3160, 35 m³/h [20.60 ft³/min] 2 SK 3160, 42 m³/h [24.72 ft³/min] 1 SK 3161, 42 m³/h [24.72 ft³/min]		1 SK 3161, 61 (48) m³/h [35.90 (28.25) ft³/min]* 2 SK 3160, 59 (47) m³/h [34.73 (27.66) ft³/min]* 2 SK 3161, 85 (62) m³/h [50.03 (36.49) ft³/min]* 1 SK 3162, 78 (58) m³/h [45.91 (34.14) ft³/min]*		1 SK 3162, 150 (105) m³/h [88.29 (61.80) ft³/min]* 2 SK 3161, 160 (110) m³/h [94.17 (64.74) ft³/min]* 2 SK 3162, 190 (120) m³/h [111.8 (70.63) ft³/min]* 1 SK 3163, 180 (118) m³/h [105.9 (64.45) ft³/min]*		1 SK 3163, 360 (285) m³/h [211.9 (167.7) ft³/min]* 2 SK 3162, 380 (285) m³/h [223.7 (167.7) ft³/min]* 2 SK 3163, 440 (320) m³/h [259.0 (188.3) ft³/min]*	
Special voltages available in	24 V DC 24 V AC 50/60 Hz 48 V AC 50/60 Hz		24 V DC 24 V AC 50/60 Hz 48 V AC 50/60 Hz		24 V AC 50/60 Hz		110 V AC 50 Hz 230 V AC 60 Hz	

* = Values in brackets ( ) apply when using fine filter

Field Replacement of Capacitors

Capacitors used in all CVS transformers are the highest commercial grade available. Each one is given a rigid acceptance test upon receipt. Nevertheless, as with all capacitors, there is a certain small percentage of failure. Sola's guarantee includes free replacement at the factory of any capacitor unit which fails within one year from date of purchase. Older units can be replaced at moderate charge.

Where competent technical help is available, it may be possible to test and identify defective capacitors in the field, and to make field replacement with new units shipped from the factory. In all such cases, factory advice and cooperation should be requested in advance. Sola cannot be responsible for repairs performed outside factory Authorized Service Centers.

N

APPENDIX N

RESUMES

Resumes of Key Personnel

Z. Lowell Taylor, Ph.D., P.E.
Chief Operating Officer

Experience

1988-Date

Chief Operating Officer for Williams Environmental Services, Inc. As such, he has been directly responsible for thermal treatment activities of the company. These activities include actual hands-on efforts in design and operation of the thermal treatment units used at two Superfund sites the company has been involved in. He has directly supervised remediation of and operation of two new units used to remediate petroleum-contaminated soils at Columbia, South Carolina, and Fort McClellan, Alabama, in addition to numerous other sites. He has managed the design and construction of a third unit which began operation at another Superfund site, the Letterkenny Munitions Depot in August 1991. Dr. Taylor was on site at the Prentiss, Mississippi, project to perform project and equipment evaluations; he proposed design modifications to be performed before the unit was employed on the Bog Creek Farm site. He was on site at the Bog Creek project approximately 50 percent of the time and directly involved with management of the project. He has been involved with several key field engineering modifications which were instrumental in successful completion of projects. Williams' operating centers include Remediation Services, Thermal Treatment, Groundwater Services, Laboratories, Engineering Services, and Industrial Hygiene Services. He manages approximately 125 employees located in four offices and three laboratories throughout Alabama and Georgia.

JIM WALTER RESOURCES, INC.
Birmingham, Alabama

1980-1987

Vice President. Responsible for operations, environmental affairs, engineering, and research and development for $150 million chemical, coke and fiber manufacturing operation. These facilities included five manufacturing plants, extensive utilities and power plant and waste treat-ment facilities. Major environmental projects included:

- Development and construction of wastewater facilities to treat 1 MGPD of complex coke and chemical waste.
- Design and permitting of waste incinerator for chemical waste.
- Development of RCRA-mandated investigation for five complex landfills and lagoons.
- Development of plans for handling coke facility hazardous waste.
- Development and implementation of environmental and technical feasibility program for incineration of coke oven fuels with cogeneration of steam and power for three 100,000 lb/hr boiler systems.

In this position Dr. Taylor was directly responsible for some 800 employees. The technical groups which conducted the R&D and environmental affairs were comprised of approximately 40 engineers and 30 chemists and industrial hygiene professionals.

FRIT INDUSTRIES, INC.
Ozark, Alabama

1976-1980

Vice President. Responsible for operations, environmental affairs, and engineering for the largest manufacturer of micronutrients in the United States. Operations included five chemical plants located in the Southeast and Midwest. Major environmental projects included:

- Design permitting and construction of facilities to utilize byproduct flue dusts from the metals industry in the manufacture of micronutrient products.
- Lagoon, soil and groundwater studies and corrective action plans for manufacturing site contaminated with heavy metals and nitrates.
- Closure of large chemical fertilizer facility located in the Midwest. The cleanup of nitrates, lead and cadmium was required.

HARMON ENGINEERING ASSOCIATES, INC.
Auburn, Alabama

1975-1976

Senior Vice President. Responsible for the management of all projects including proposal preparation, job costing, project scheduling, and report preparation. Supervised staff of 42 with approximately 17 professionals. Project load included environmental studies, testing and design. Major projects included:

- Development of environmental plan for large foundry operation to include air quality, runoff and wastewater evaluations. Design of total environmental systems was completed.
- Conducted large river basin study of Flint, Chattahoochee, and Apalachicola system. Identified all major industrial and municipal sources of wastewater pollution. Modeled system to show stream and system impacts.
- Developed wastewater treatment systems and designs for 16 industrial facilities ranging from small plating shops to major steel producers.

AUBURN UNIVERSITY
Auburn, Alabama

1970-1975

Professor and Head, Department of Engineering. Responsible for research and academic affairs of an accredited engineering program; consulting practice included the development of wastewater disposal alternatives for DuPont's facility at Holt, Alabama. Treatability studies for ethylene glycol and pesticide containing wastes, and evaluation of fluoride waste control system for aluminum smelting.

U.S. PIPE AND FOUNDRY COMPANY
Birmingham, Alabama

1969-1970

Director of Research. Directed technical effort for the Chemical Division. Responsible for development, technical services, quality control and environmental matters.

AUBURN UNIVERSITY
Auburn, Alabama

1966-1969

Assistant Professor, Department of Chemical Engineering.

U.S. MARINE CORPS
Camp LeJeune, North Carolina

1959-1962

1st Lieutenant.

Education

1959, B.S., Chemical Engineering
1963, M.S., Chemical Engineering
1966, Ph.D., Chemical Engineering

Mark A. Fleri
Project Development Manager

Experience

1988-Date
Project Development Manager. Reports to Vice President, with responsibility for design, installation, startup, and troubleshooting of mobile hazardous waste incinerator. Develops large-scale remediation projects. Activities include conceptual design, estimating, proposal preparation and presentation. Has managed more than forty projects, including incineration, waste stabilization, NPDES/SID permits, PCB remediation, and volume reduction.

1988-1989
Project Manager. Managed Emergency Response Division, with full responsibility for on-scene coordination, establishment of communication with and between federal and state agencies, supervision of site personnel, and monitoring disposal activities.

1987-1988
Project Engineer/Laboratory Manager. Responsible for daily operations of hazardous waste laboratory. Duties included operation of gas chromatograph/mass spectrophotometer unit, gas chromatograph, and other laboratory instruments. Managed and supervised equipment and supply procurement, laboratory analysis, and quality control program. Other duties included variety of wet chemistry methods in *Standard Methods for Water and Wastewater, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846), and *American Society for Testing and Materials* (ASTM) standards.

1986-1987
Part-Time Lab Technician. Responsible for operation of variety of laboratory instruments, including GC/MS system, GC, Atomic Absorption unit, Total Organic Carbon analyzer, pH/ISE meter, and spectrophotometer. Daily activities included preparation of standards, duplicates and spikes; preparation of reports; and guidance of other laboratory personnel.

Project Experience

Technician. PCB sampling of a vacant lot with abandoned capacitors for an international construction firm. Duties included site layout, sampling scheme, analysis of samples, chain-of-custody, quality assurance, quality control, and transportation of samples. Approximately two hundred samples were collected and analyzed by EPA Method 608 (40 CFR 136, Appendix A). The analytical results were used to design a remediation plan for this client.

Technician. Developed method to sample flare gas for a major chemical plant. The methodology involved the use of three impingers filled with varying amounts of methanol. The methanol was used to trap isopropanol, neopentyl glycol, ethylene glycol and epichlorohydrin. The analysis was performed by GC/MS.

Health and Safety Officer. Duties included site safety audits and personnel safety guidance for a U.S. Military Base. The job involved the demolition of a metal plating shop which included such hazards and cyanide, asbestos and heavy metals.

Project Manager. Job duties included the inventorying of 700 lab chemicals, the lab packing of more than 400 chemicals, the identification of 40 unknown chemicals by HazCat procedures, and the detonation of more than 100 pounds of reactive chemicals at a U.S. Military Installation.

Project Manager. A study was performed for a large tire manufacturer to give detailed information on the dissolved oxygen content and sludge depth of an industrial wastewater settling basin.

Project Manager. Job entailed the tracing of the phosphitizing and stripping processes to determine the causes of the high phosphate and pH excursions for a large athletic equipment manufacturer.

Project Manager. A study was conducted for a large wood processing facility to determine the causes of the phenolic excursions at the wastewater treatment facility. The study showed a process change would correct the phenol problem.

Project Manager. The job entailed the development of mercury decontamination procedures and development of a sampling/analytical protocol; the job also involved the application of these procedures and protocol. Asbestos abatement was also involved in the mercury decontamination.

Incinerator Design. Designed an incinerator to meet TSCA/RCRA standards. The design also included an economic feasibility study.

Job Superintendent. Supervised the in-ground cleaning of a deactivated 15,000-gallon oil tank for a large tire manufacturer.

Technician. Sampled and analyzed several hundred inactive transformers for PCBs at a U.S. Military Installation. Sampling was performed in accordance with ASTM Method D923-86 and the PCB analysis was performed in accordance with 40 CFR 136, Appendix A (Method 608).

Technician. Purged and sampled groundwater monitoring wells for permit compliance for miscellaneous groundwater division work.

Project Manager. A study was conducted for a large clothing service to determine the causes of its pH excursion. The wash process was traced and documented to determine the varying pH values during different wash cycles.

Project Engineer. A chemical spill involving the release of several thousand gallons of nonylphenol polyethylene glycol ether occurred at a major chemical manufacturing plant. The job involved the collection of raw material; the cleaning of the containment system; the collection of 100,000 gallons of contaminated groundwater; and the later release of the water into a municipal sewer system, and the supervising of the support laboratory.

M. Allen Tucker, Jr., P.E.
Manager, Thermal Treatment

Summary of Qualifications

Responsible for design and/or management of engineering projects in the areas of Incineration, Hazardous Waste, Asbestos, Plumbing and HVAC. Many of these projects involved aspects of other disciplines, such as Civil, Structural, Architectural and Electrical. Scope of these projects included collection of field data, design, and engineering inspection of work.

Representative Project Experience

Project Manager for the redesign of a $4 million transportable incineration system used to decontaminate solvent-contaminated soils at a Superfund site. The 32 million Btu/hour system incorporated the country's first application of an oxy-fuel burner system in a transportable incinerator. The unit processed soil at 20 tons per hour and met the 99.99% DRE and stringent 0.015 gr/dscf particulate emission limits.

Project Manager for the design and construction of a 15 ton/hour mobile thermal processing unit used to decontaminate soils at various locations.

Project Manager for the design and construction of a 25 ton/hour mobile thermal processing unit for hazardous and non-hazardous waste processing.

Project Manager for a 400-ton industrial chilled water HVAC system for the paper finishing area of a paper mill. Design included temperature and humidity control for the paper finishing process and architectural alterations to adapt the area for air conditioning.

Project Manager on numerous projects of a three-year open-end contract at Fort Benning, Georgia. Projects included replacement of HVAC systems in buildings, replacement of a commissary refrigeration system, energy conservation measures at Martin Army Hospital, construction of recreational cottages, etc.

Project Manager for additions/renovations of a public high school and elementary school (HVAC and plumbing only).

Project Manager for a cooling water system study for the basic oxygen furnaces at a steel mill. Made recommendations to extend the service life of water cooled panels subjected to direct furnace off-gas.

Project Engineer for the HVAC, plumbing, cost estimating, and fire protection design for a new hazardous waste storage facility for the U.S. Navy. Building included specialized warehouse spaces, office and laboratory spaces.

Project Engineer for the HVAC, plumbing, cost estimating and fire project design for a $1.1 million maintenance facility for the Army Corps of Engineers.

Project Engineer for the mechanical design of an industrial wastewater treatment system for a copper tubing manufacturer involving a new treatment building, pumps, piping, cooling tower, etc.

Education

1982, B.S., Agricultural Engineering
1983, B.S., Mechanical Engineering

Certifications

Registered Professional Engineer, Alabama No. 17611

Industry-Related Training

Supervision of Asbestos Abatement Projects, August 1985, Georgia Institute of Technology

Air Conditioning—Physical Processes and Load Calculations, September 1985, University of Wisconsin

Industrial Ventilation Conference, 1988, University of Alabama

Hazardous Waste Incineration, February 1989, Lamar University

Mark J. Johnson, P.G.
Manager, Groundwater Services

Experience

Mr. Johnson designs, implements and supervises sampling programs for sites which may have been adversely affected by hazardous wastes. He helps conduct groundwater investigations via computer modeling in order to determine hydrogeologic parameters and potential contaminant migration. He has also helped design groundwater remediation programs which are the most cost efficient and effective for specific sites. Specific projects include:

- **Project Geologist** for a preliminary site investigation of 27 potential CERCLA sites at Marshall Space Flight Center (MSFC). Duties included setting up and sampling 27 potential CERCLA sites at MSFC, technical writing, coordinating and overseeing drilling operations.
- **Project Geologist** for an emergency response of 1,1,1-trichloroethane (TCA) spill. Acted as on-site coordinator of drilling and monitoring well installation, setup and operation of pump and treat system (PAT); responsible for technical report writing. Sampled wells and analyzed data using computer-generated graphics.
- **Project Manager** for an assessment of several Chevron USA stations to determine potential hydrocarbon contamination of the soil and groundwater. Duties included job estimates, coordinating drilling operations, overseeing site operations, initial screening of samples with Hnu meter, technical report writing, and data analysis.
- **Project Geologist.** Performed well sampling, supervised drilling and installation of monitoring and test wells. Assisted in the computer analysis of pump test data. Helped design and build pilot scale carbon adsorption system for treatability of groundwater contaminated with phenolic compounds. Determined carbon contact times, isotherms and breakthrough points during operation of pilot scale adsorption system.
- **Project Manager.** Responsible for the estimates, site assessements, data analysis and technical writing for several Maxwell Air Force Base, Montgomery, Alabama sites which may have potential hydrocarbon contamination. These sites ranged from underground storage tanks to aviation refueling areas, and included soil and water sampling. Has also sampled soil and transformers for PCB contamination.
- **Geologist** responsible for Phase I and Phase II assessments to determine horizontal and vertical extent of woodtreating contaminants for a RCRA timber company. Duties included supervision and installation of piezometer and monitoring wells, point-of-compliance wells, well sampling, technical writing, and data analysis. Responsible for designing and implementing sampling and assessment plan. Wrote post-closure permit for RCRA waste impoundments.
- **Geologist.** Assisted in gridding and sampling PCB-contaminated soils for the Marine Corps Logistics Base, Albany, Georgia.
- **Project Geologist.** Responsible for setting up and implementing monitoring plan for lower aquifer for the Pleasure Island Sewer Service, Orange Beach, Alabama, in order to increase pumping rate of treated water to spray fields. Wrote technical paper to permit Pleasure Island Sewer Service to eliminate insignificant analytical parameters which were previously required by wastewater permit.

Education

1982, B.S., Geology
1988, M.S., Geology

Industry-Related Training

1988, 40-Hour Hazardous Materials Handling and Response

1988, Asbestos Worker Training Program, National Asbestos Council

Professional Affiliations

Alabama Academy of Science
Geological Society of America

Nathan D. Heinrich, P.G.

Groundwater Division Manager

Summary of Qualifications —

General job duties include supervision of eight employees and ongoing work at over 60 sites, with annual gross revenues of $11,000,000. Projects include preparation and implementation of work plans for preliminary groundwater assessments, corrective action plans, and site assessments; preparation of post-closure permit applications; interpretation of hydrologic and geologic data; groundwater modeling; and preparation of reports for submittal to state and federal agencies.

Related Project Experience —

- **Project Geologist.** Jointly conducted site investigations of 27 potential CERCLA sites on site in north Alabama. Investigations included over 1,150 locations sampled for potential hazardous waste, including solvents, fuels, heavy metals, PCBs, and cyanide. Supervised and conducted geophysics surveys (conductivity and magnetics) on three sites. Contract required coordination with NASA engineering and security.

  Project Manager. Conducted environmental assessments of closed and open gasoline stations. Responsibilities included subcontracting drilling services and cost estimates. Supervised borings along tank excavation to determine hydrocarbon contamination and installed monitoring wells when contamination extended to groundwater.
- **Project Geologist.** Responsible for the preliminary groundwater assessment. Prepared RFP for installation of wells. Assisted with installation of four wells with two nested piezometers each at a wood treatment facility.
- **Project Manager.** Responsible for preliminary groundwater assessment at former hot-dip galvanizing operation. Supervised soil borings and installation of monitoring wells. Prepared preliminary assessment report for submittal to Alabama Department of Environmental Management (ADEM). Prepared revised assessment plan to define soil and groundwater contamination plumes.
- **Project Manager.** Conducted groundwater assessment outlining contaminant plume at gasoline service station. Implemented free product recovery system which recovered approximately 900 gallons of product. Prepared, submitted, and implmented a corrective action plan and state indirect discharge permit for recovery of dissolved hydrocarbon product.
- **Project Geologist.** Conducted on-site work, including monitoring well installation, at site with volatile organic contaminants. Prepared detailed hydrogeologic study which identified inhomogeneities in the aquifer which affected groundwater flow. Ran computer models to identify locations of recovery wells.
- **Project Manager.** Coordinated and conducted environmental audits for various property transfer sites including: a former cotton mill in Alabama; a commercial/residential area in Florida; a former box plant; a car dealership; a former DOT site; and a former bottling plant in St. Croix, U.S. Virgin Islands. Audits focused on both soil/groundwater contamination and asbestos problems.
- **Project Geologist.** Prepared and submitted post-closure plan for wastewater treatment facility with PCB and cyanide contamination.
- **Project Geologist.** Prepared revision of post-closure permit for wood treating facility with creosote and pentachlorophenol contamination. Also prepared annual groundwater monitoring review for the facility.
- **Project Geologist.** Groundwater assessment for a confidential client. Conducted soil borings to define the extent of contamination in the upper aquifer. Contracted drillers and purchased supplies for installation of three compliance wells in two aquifers and five pump test wells.
- **Project Geologist.** Groundwater corrective action program for a confidential client. Responsible for writing CAP for submittal to ADEM. CAP included groundwater monitoring plan.
- **Project Manager.** PCB sampling at Gunter Air Force Base. Prepared estimates and coordinated sampling of transformers and soil. Responsible for client contact and reporting of analytical results.
- **Materials Coordinator.** Emergency groundwater remediation for a large manufacturing corporation. Responsible for obtaining equipment and materials for remediation system. Contacted local and national vendors for supplies.
- **Project Geologist.** Modification of lagoons and wastewater treatment system for a tubing manufacturer. Supervised installation of three pump wells for use in chromium reduction treatment plant. Conducted well development prior to completion of the treatment system. Prepared groundwater monitoring/effectiveness testing plans for treatment plant.
- **Project Geologist.** Post-closure permit application for NASA. Prepared closure/post-closure permit application for closure in-place of cyanide-contaminated lagoons. Compiled existing data and prepared groundwater monitoring plans.
- **Project Director.** Supervised project managers on over 30 projects conducted under open-end sampling and analysis blank Purchase Agreement for Maxwell Air Force Base, Alabama.
- **Project Director.** Supervised project managers and engineers during preparation of corrective action plans for four UST sites. Plans specified air strippers or diffused air tanks.

Education —

- B.S., Geology, 1981
- M.S., Geology, 1987

Industry-Related Training —

- AHERA Accreditation for Inspectors and Management Planners
- EPA Seminar, "Groundwater Monitoring at Hazardous Waste Sites"
- HES, "Hazardous Materials Handling and Response"
- AEG Short Course, "Geology and Site Characteristics of Hazardous Waste Sites"
- NWWA Short Course "Theory and Application of Vadose Zone Monitoring Techniques"

Professional Affiliations

- Geological Society of America
- NWWA

RÉSUME

Name:	DENNIS R. MOBLEY, P.E.
Title:	PROJECT ENGINEER
Assignment:	CIVIL ENGINEERING
Name of Firm:	BENCHMARK ENGINEERING INC.
Education:	B.S. / 1975 / CIVIL ENGINEERING UNIVERSITY OF ALABAMA M.S. / 1993 / ENGINEERING
Years Experience:	WITH THIS FIRM (1) WITH OTHER FIRMS ( )
Active Registration:	REGISTERED PROFESSIONAL ENGINEER; ALABAMA

Mr. Mobley has a broad base of civil engineering experience and expertise. Prior to joining Benchmark, he worked for a major Southern utility holding company and a major international construction firm. His project assignments have included: Hydro Engineer on dam-related projects; various structural and design-related duties on a variety of projects; and environmental engineering.

Specific Project Experience Includes—

Project Engineer—Manufactured Gas Plant Investigation, Americus, Georgia. Scope of work for this project included review of the previously completed environmental site assessment for adequacy and completeness. These data were then used to develop a work plan and sampling and analysis management plan (SAMP) for a more detailed site investigation to determine more precisely the contaminants present at the site, level of contamination, and horizontal and vertical extent of the contamination. The information was also used evaluate possible remedial alternatives.

Project Engineer—SoGreen Site Remediation, Tifton, Georgia. This PRP-funded cleanup action involves the stabilization of approximately 56,000 cubic yards of electric arc furnace (EAF) dust which is contaminated with lead, nickel, chromium, cadmium, and arsenic. The selected remedial alternative included stabilization of the hazardous waste with Portland cement, subsequent delisting of the material, and disposal in a RCRA Subtitle "D" landfill. Mr. Mobley's efforts on the project included authoring of the Sampling Analysis and Quality Assurance Plan which detailed all of the QA/QC protocols for material stabilization. He also prepared the Mobilization/Demobilization, Utility Installation , and Sampling Handling and Documentation portions of the Remedial plan.

Project Engineer—UST Program Management and Implementation, North Alabama UST site. The scope of work for this project included the completion of Secondary Investigation activities. Mr. Mobley's duties included securing right-of-way for required monitoring wells, surveying of existing wells, supervision of monitor well installation, completion of boring logs, and collection of soil and groundwater samples. Collected samples were properly preserved in the field and prepared for shipment to the laboratory under strict chain of custody. Mr. Mobley reviewed data and prepared a complete report to the Alabama Department of Environmental Management (ADEM).

Structural Engineer—Advanced Solid Rocket Motor Project, Yellow Creek, Mississippi. Mr. Mobley completed the design of concrete rocket support mats for the main rocket test building. The MATS three-dimensional computer-aided drafting program was used to complete the design. Additional duties on this project included design of the main crane girder and crane column for the Auxiliary Building. He reevaluated the existing steel structure for its ability to support additional weight without the benefit of having the original calculations.

Structural Engineer—Gulf States Steel, Demopolis, Alabama. Mr. Mobley was responsible for completion of the structural calculations for construction of a three-story ClO_2 building and a two-story chiller building on this project. Design efforts included concrete and steel design using the STAAD 3 three-dimensional computer-aided drafting program Mr. Mobley also supervised drafting of the construction drawings for the project.

Structural Engineer—Shell Oil, New Orleans, Louisiana. Mr. Mobley was responsible for completing design of pipe supports for a major renovation project. The renovation incorporated fiberglass pipe with special requirements. Site conditions precluded standardization of design. Shutdown forces, low soil strength, and tank settling were all factors which increased the difficulty of the design.

Hydro Engineer—Rocky Mountain Pumped Storage, Rome, Georgia. Mr. Mobley conceptualized and designed an innovative auxiliary spillway system for the lower reservoir at this facility. The client's initial conceptual design called for two spillways, one 250-foot-long concrete ogee and one 350-foot concrete ogee with a total cost of $6,000,000-$8,000,000. Mr. Mobley's alternative design reduced the overall project cost by approximately $2,000,000.

Project Manager—Alabama Power Hydroelectric Dam's Stability Analysis, State of Alabama. Mr. Mobley was responsible for scope, budget, manpower training, and drafting supervision for reanalysis of nine Alabama Power Dams. The purpose of the project was to incorporate new flood level requirements and replace lost stability analysis for normal and earthquake conditions. Twelve engineers and eight draftspersons were trained to complete the analysis. During the project, all existing drawings were converted to CAD. The project schedule provided for the completion of a separate report for each site with deadlines for reports spaced at one month intervals. All phases of the project were completed on time and within budget.

Senior Hydro Engineer—Hope Hydroelectric Project, Hope, Arkansas. Mr. Mobley completed the layout design and wrote the technical specifications for intake structure tailrace and one-mile-long tailrace canal as part of a Phase I feasibility study. His efforts included calculation of water flow velocity and water volume required to ensure correct hydraulic operation at the turbine. The work product was accepted for Phase II without comment by the U.S. Army Corps of Engineer.

Senior Hydro Engineer—Mitchell Dam Redevelopment. Project involved the addition of three units to an existing dam and hydroelectric generation facility. The additions required additional spillway capacity and modifications to the powerhouse and upstream and downstream retaining walls. Coffer cells were designed for the stage construction project. Mr. Mobley completed the hydraulic design of the D/S tailtrace.

Hydro Engineer—Crist Steam Plant. Mr. Mobley was responsible for design and preparation of the technical specifications for the installation of 2500 feet of 24 inch diameter drainage pipe at a staged dual location (fly and bottom ash) landfill site. Design required separation ditches segregate contaminated water from natural runoff. Inflow and outflow hydrographs for the site were calculated to aid in the design. The design was reviewed by Florida Department of Environmental Regulation (FDER) to ensure environmental compliance.

Hydro Engineer—R.L. Harris Hydroelectric Project. Mr. Mobley was responsible for plant layout and design of the concrete spillway, nonoverflow walls, intake structure, powerhouse, and downstream retaining walls. The project included considerations for the stability of each structure for construction, under normal operating conditions, earthquake conditions, and maximum flood conditions. The total length of the dam was 650 feet with a 150-foot height. Designed 70-foot-diameter upstream and 35-foot-diameter downstream coffer cells required for the two-stage construction at the site. Mr. Mobley supervised the drafting of all stability analyses and conceptual design drawings.

Hydro Engineer—Walter Bouldin Dam Redesign. Mr. Mobley was responsible for design of the intake structure required for an enlarged dam. Overall size of the structure was 260 by 200 feet. The trash rack were redesigned and flownets for sloping multimedia soils were required. Condition analysis included requirements for construction, normal operating, earthquake, and maximum flood.

O

APPENDIX O

RESPONSES TO USEPA REGION X

WILLIAMS ENVIRONMENTAL SERVICES, INC.

October 15, 1993

Ms. Lynda Priddy
Hazardous Waste Coordinator
U.S. Environmental Protection Agency Region X
1200 Sixth Avenue
Seattle, Washington 98101

Subject: Transmittal of Responses to USEPA Region X
July 20, 1993, Comment Letter on the
Draft Soil Treatment Work Plan
for the Woods Industries Site, Yakima, Washington

Dear Ms. Priddy:

In response to U.S. Environmental Protection Agency (USEPA) Region X's July 20, 1993, comments on the Draft Soil Treatment Work Plan, dated June18, 1993, Burlington Northern Railroad (BNRR), through Williams Environmental (Williams) and Burlington Environmental Inc. (BurlingtonEnvironmental), has prepared this letter and is in the process of revising the Draft Soil Treatment Work Plan.

On August 27, 1993 Cathy Massimino and Bob Kievit of EPA Region X visited the THAN site. A meeting was held on the same day between Mark Fieri, Brett Burgess, Z.L. Taylor (Williams Environmental Services), Bruce Sheppard (Burlington Northern Railroad) and Bob Kievit, Cathy Massimino and John Gilbert (EPA). The following comments and responses are the result of this meeting and later conversation with all parties.

RESPONSES TO USEPA REGION X COMMENTS

Comment No. 1

The work plan needs to include an ambient air monitoring program. Sample locations should include on-site, fence line, and downwind offsite areas predicted to contain maximum concentration of contaminants from the stack. The sampling program should include both time-integrated and real-time monitoring. The sampling program should specify equipment to be used, sampling and analytical procedures, the name(s) of the laboratory(s) conducting the analytical work, action levels,and QA/QC procedures. The plan should be comprehensive to start out and allow for scaling back upon demonstration of acceptable results.

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Response No. 1

A comprehensive air monitoring program prepared by Williams will be included as an appendix to the "Final" Soil Performance Test Work Plan and in the Health and Safety Plan. A "scaled back" monitoring program will be prepared upon demonstration of acceptable results. This "scaled back" version is expected to be implemented after the performance test with the EPA's approval. This will monitor a select number of indicator chemicals based upon previous monitoring results.

The air monitoring program will use sample locations derived from air modeling predicted to contain the maximum concentrations of contaminants resulting from the stack and fugitive dust generated from material handling and will monitor site-related contaminants of concern on a time-integrated and Real-Time basis. Action levels, sampling and analytical procedures, equipment specifications, and QA/QC procedures will also be described.

Identification of the laboratory conducting the analytical procedures will be submitted to the EPA as soon as the appropriate laboratory is selected.

Comment No. 2

A risk assessment needs to be performed based on predicted air emissions and the air modeling currently being conducted. This risk assessment should be updated with the results from the performance test and be included in the performance test report.

Response No. 2

A site specific Air Quality Impact Report is being performed based on predicted air emissions during normal operation and interim operation. This Air Quality Impact Report addresses the compounds listed on page 28 of the draft plan and the risk assessment will be updated if necessary with results from the performance test. Dioxins and furans are not a part of the Air Quality Impact Report, however, as requested by the EPA, dioxins and furans will be tested for in the off gases during the performance test. HCl, Cl and potential organic breakdown or reformation compounds will be addressed in the Air Quality Impact Report.

Comment No. 3

Please note that based on the current schedule the system should expect to operate in conditions beginning in dry 100°F heat and possibly ending in snowy conditions or subzero temperatures.

Response No. 3

Williams anticipates few problems as a result of weather conditions. Williams thermal unit is currently operating at the THAN site with temperatures exceeding 110°F. During cold weather, Williams will take necessary measures to assure that the thermal desorption unit is properly outfitted and winterized.

Comment No. 4

The work plan should discuss any anticipated impact on the surrounding community with respect to noise and odor.

Response No. 4

Regarding odor, Burlington Environmental and Williams do not expect odors above that which existed during soil excavation.

It has been determined through noise level dosimetry that the loudest recorded noise levels were the material handling equipment at the THAN site. The nearest residents located to the THAN property are located approximately one-quarter mile from the site and no complaints have been received about the thermal desorption unit operating twenty-four hours per day. The Woods site is located in an industrial area with the nearest residential area located approximately one-quarter of a mile away from the site.

Comment No. 5

The consent order between EPA and BN is an important document that should be included as an appendix to the final work plan.

Response No. 5

The consent order will be included as an appendix.

Comment No. 6

Section 2.1 The draft plan states that demobilization will proceed after the stockpiled soils have been treated and lab confirmation received that the treated soils meet the cleanup criteria. Please note that the existing stockpiles are situated over areas of contaminated soils that need to be excavated and treated after the piles are removed. Confirmational soil samples will need to be taken in the excavated areas to assure that all soils above cleanup levels are removed. In addition, soil samples will need to be taken in the areas used for treatment, stockpiling of soils, and along soil

hauling routes to assure that clean areas weren't contaminated during the treatment process. The schedule should allow for these activities.

Response No. 6

The soil treatment schedule will allow sufficient time for the necessary soil removal and sampling to occur prior to demobilization. Burlington Environmental will collect the necessary samples in accordance with protocol described in the soil removal work plan. Samples will be collected beneath existing stockpiles and areas where contaminated soils were transported over, stockpiled, or treated.

Comment No. 7

Section 2.2 The responsibilities of BEI should be discussed. The relationship between BEI and Williams needs to be clarified and discussed. The relationship between BEI and the Thermal Treatment Consultant needs to be clarified. This section needs to describe the role and authority of the EPA OSC. Will Williams personnel be responsible for transferring treated soils and oversized cobbles, for excavating contaminated soils from underneath the existing north and south stockpiles, for final site grading. This section should indicate who is responsible for sampling of treated soils, of contaminated soils underneath the existing stockpiles both during and after excavation, of final site sampling just prior to demobilization, and ambient air monitoring. How many shifts will be used? The plan should discuss transition procedures used in changing shifts.

The plan needs to state the name(s) of the laboratory(s) conducting analytical work prior to and during the performance test and during regular operations. The plan should also include detailed information on detection level, lab procedures, and lab QA/QC procedures. Who will subcontract with the labs?

Response No. 7

In reference to Section 2.2, responsibilities will be clarified and incorporated into the "final draft". Responsibilities of Burlington Environmental and Williams will be similar to that of Burlington Environmental and Olympus for soil removal activities. Burlington Environmental will provide oversight and Williams will be the Contractor. Burlington Environmental will have an on-site coordinator. Burlington Environmental will be responsible for weekly reports, reporting to the EPA and the Final Report. Burlington Environmental will also be responsible for emergency reporting. The Thermal Treatment Consultant, independent consultant, will be used for technical guidance and support during the performance test activities and will be subcontracted under Williams. Williams will be responsible for all material handling associated with soil treatment which includes excavating beneath existing stockpiles, backfilling and final site grading. Sampling of treated soils will be the responsibility of Williams and ambient air monitoring will be the responsibility of Burlington Environmental.

Sampling excavations beneath stockpiles and haul roads prior to demobilization will be the responsibility of Burlington Environmental.

Regarding work, Williams will most likely use three shifts. In some instances, shifts are dependent upon weather conditions. Williams will delineate shift transition procedures in the "final draft". Williams will supply its own qualified operators. However, Williams does use local labor from time to time.

Regarding laboratory selection and analytical procedures, Williams will provide this information as soon as it is available.

Comment No .8

Section 3.2 - In general more details are needed regarding soil handling and disposition of cobbles and debris mixed in with soils - i.e. metalbands, pipes, etc. This section says that material over approximately 3 to 4 inches will be considered oversized. What are the factors needed to determine whether it is 3 or 4 inches or something in between. EPA requests that the larger material be treated if the system can physically handle it - i.e. we prefer that 4 inches be the cut off as opposed to 3 inches.

When will oversized cobbles be crushed and analyzed? What procedures will be used to collect, crush and analyzed the cobble samples? How many samples will be taken? Add lead, arsenic, and mercury to the list of analytes for the crushed cobbles. The analytical results from the crushed cobbles should be compared to the treatment goals not the cleanup levels. Assuming that the results will be below the treatment goals, the section should describe how the cobbles will be handled from the screen to final disposition. Will soils from the existing stockpiles be taken directly to the treatment unit or will a secondary stockpile be placed closer to the treatment unit?

Response No. 8

Burlington Environmental is preparing a plan which describes the objectives and methods for characterizing oversized material. Thermal desorption requires a significant amount of material handling. A cutoff size will be established through experience in handling the on-site soils to determine which material will be screened out. Through experience at other sites Williams believes the cutoff size will be 3 inches or less. Through observations made during soil removal activities conducted at the site, BNRR and the USEPA are aware that the soil excavated and placed in the temporary soil storage piles contain approximately 35 to 45 percent "oversized material." This oversized material will not be treated by the thermal desorption process because it cannot be handled via the material handling equipment involved with the thermal desorption process.

As discussed in the Draft Feasibility Study, it is believed that contaminants adhere preferentially to finer particles (silts, clays and humic materials) and contamination of larger materials is related to the adhesion of finer particles to the exterior of larger ones. Observations made during soil removal activities at the site revealed that the exterior of the larger materials are relatively free of finer materials adhering to their surface.

To evaluate the disposition of the oversized material, BNRR proposes collecting and compositing material into a batch which will be screened to form samples of 2.0"+ and 3.0"+ material representing potential "cutoff sizes." These samples of potentially oversized material will be crushed and analyzed for several indicator chemicals.

The results of these analyses will be compared to the treatment goals established for the soils exiting the thermal desorption process which will be used as backfill on site. BNRR understands that oversized material which is below the treatment goals will be suitable to be used as backfill without additional treatment. Additional details will be included in the "final draft" of the work plan.

Debris will be handled similarly as in building demolition and soil removal. Contaminated debris will be disposed of at Chemical Waste Management's Arlington, Oregon, facility. Clean debris will be disposed of at a local sanitary landfill.

Williams anticipates hauling soils directly from the stockpiles to the treatment unit. Necessary precautions will be taken in the event that a "secondary stockpile" is needed.

In the event a secondary stockpile is required (because of increased production rates) control measures such as containment and additional covering of the piles will be added. Engineering controls will be used to prevent fugitive dust emissions where applicable, such as haul roads from stockpiles.

Comment No. 9

Section 3.3 - More details are needed regarding the transfer of baghouse dust to the treated soil pile, the dust control procedures used in the transfer, whether the discharge of baghouse dust is continuous or batch,

and the kind of mixing that occurs between treated soils and baghouse dust. Is the baghouse dust conveyor covered? Discuss dust control during the treated soil stacking. Where will the stacks be located? How long will they be stored?

Discuss backfilling procedures.

Discuss final site grading.

Are there any conditions under which hot gases from the dryer come in contact with the burner?

Response No. 9

The baghouse dust emissions are well controlled prior to mixing with the treated soils. These control measures include negative pressure on the cross over conveyor, transfer auger conveyor and discharge auger conveyor. The baghouse dust is mixed with the treated soils and is moisturized prior to being transferred to the stacking conveyor to prevent fugitive dust. Additional information will be provided in the "final draft". Both Bob Kievit and Cathy Massimino have seen the baghouse transfer auger and control system.

Backfilling procedures and final site grading will be incorporated in the "final draft". Treated soil will be used as backfill on-site. It is expected that final site conditions will be level in most areas and possibly slightly sloped in others. Details will be supplied in the soil treatment work plan.

Williams' unit has been designed to ensure that the burner does not come into contact with hot gases from the rotary dryer.

Comment No. 10

Section 3.4 - This section should discuss locations in the treatment train where hot gases from the dryer can bypass any portions of the air emissions treatment train and the conditions required for such a release. This discussion should include past performance history. How is the acidity of the gases from the dryer monitored?

How is the dissolved solids in the recirculating quench water monitored?

The activated carbon should be periodically sampled to assess the possibility to organic break through. The work plan proposes to re-heat the gas steam to about 150°F to prevent condensation in the carbon beds. According to the Calgon information in the Appendix, 150°F is the

maximum temperature for these systems. Also, it is generally accepted that the carbon efficiency decreases with increasing gas temperatures. Thus, there is a concern the carbon treatment will not be satisfactory for both the pesticides and total hydrocarbons. Lower gas temperatures to the carbon system would relieve this concern. Also see later comment on THC monitoring.

Response No. 10

The VO is designed such that air may only enter from the outside eliminating concerns of hot gases bypassing the air emissions treatment train. For example, the VO is triggered when the baghouse exceeds 510°F and quench gas temperature exceeds 200°F, thus allowing cool air to enter the thermal desorption unit and cool the baghouse and the remainder of the thermal treatment unit. This is done to protect equipment.

Presently the pH of the quench water is monitored manually during the normal operations of the unit. When the water becomes acidic (pH < 4) caustic soda (sodium hydroxide) is added to bring the pH up to approximately 8.

Solids are visually monitored in the quench and air mix chambers. Approximately 1 to 4 gpm of quench water is removed, settled, filtered and processed through activated carbon and then re-used within the thermal desorption unit.

Comment No. 11

Section 3.5 - What is the action level and detection level for effluent sampling from the liquid phase carbon adsorption unit?

The water in the filled collection tanks should be analyzed for metals as well as pesticides. What are the action levels for this water? This section indicates that this water may be used to cool and moisturize treated soils. Is any of this water anticipated to be used for dust control outside the treatment unit or for discharge to the local sewage treatment works? Can a rough mass balance be done on water generated versus water needs? Compare the estimated mass of organics to be collected in the scrubber to the design capacity of the carbon beds. This comparison should assume a worst case scenario of all organics in the air stream being removed in the scrubber system.

Response No. 11

Based upon past history, excess water is not expected from the process. Treated soils will be sampled after the addition of the treated quench water.

Williams does not expect nor intend to analyze metals if the water is to be used for dust suppression or reused as quench water in the thermal desorption unit. If Williams is to discharge treated water to the sanitary sewer system then Williams will analyze for the appropriate constituents and meet the discharge limits prior to discharge to the sewer system. Williams will prepare water mass balance calculations to be included into the "final draft" of the work plan.

Comment No. 12

Table 4-1 - The table indicates the prescreen sized opening is 2 1/2". How does this correlated to the approximately 3 to 4 inches sizing limit mentioned on page 16. The bar and mesh screen sizing are not indicated.

The table appears to indicate that the unit contains a backup I.D. fan. Is this correct?

How will the material be collected in the liquid bag filters be disposed?

Response No. 12

Williams' material handling systems are equipped with several screen sizes. The basis of final selection of screen size is described in response to Comment NO. 8.

There is no backup ID fan.

The liquid bag filters will be cleaned of solid material and re-used throughout the project. The final disposition of the bag filters will be with the used personal protection equipment and contaminated debris at Chemical Waste Management's Arlington, Oregon, facility.

Comment No. 13

Section 5.0 - Prior to running contaminated soils in the treatment unit during startup, uncontaminated soils from the site should first be run through the unit to assure that the unit is operating properly from a particulate control stand point (both stack emissions and fugitive dust).

OSC approval will be needed prior to running contaminated soils through the system.

The work plan should discuss disposition of treated soils generated during the start up period.

OSC approval will be needed to continue operating after completion of the performance test and applying any special conditions for continued operation.

Response No. 13

Williams anticipates to begin startup operations with clean soils. After a thorough shakedown of the unit including its control systems and demonstration of the proposed AWFSOs, the unit will begin production with the contaminated soils including pesticide contaminated soils in the roll-off boxes to ready the unit and crew for the upcoming performance test.

Soil will be treated in the same manner as soil from production operations. Williams recognizes that treating contaminated soils for both the performance test and normal operations will not commence without approval from the EPA's OSC.

Comment No. 14

Section 6.1 - Figure 6 was not included in the draft work plan.

The stated purpose of the vent opening is to allow ambient air to enter the treatment unit. Can hot gases from the dryer exist through this vent? If so, under what conditions and how often are those conditions met based on past performance of this unit?

This section should discuss the procedures used to return the unit to normal operating conditions after triggering the emergency control system. How often do events occur that will trigger VO and AWFSO based on past performance.

Response No. 14

Figure 6 will be included in the "final draft" of the work plan.

The VO was discussed in Response No. 10.

VO occurrences are not recorded due to the fact that they pose no threat of releasing air emissions.

Most AWFSO's do not result in upsets of the thermal process. The AWFSO's normally result in a "no feed" condition, once the AWFSO is terminated the feed is restored with no affect to the process. The operations manual, which will be part of the "final draft" of the work plan, includes startup and shutdown procedures.

Comment No. 15

Table 6-1 - Opacity and real time air monitoring should be added to this list.

The table indicates the operating set point for the mix chamber outlet is 130°F; however, page 18 indicates that this temperature is 140°F. The table indicates the operating set point for the quench camber outlet is 165°F; however, page 26 indicates that the set point is 130°F. This table indicates the typical range of total hydrocarbons in the stack is 20 to 75 ppm with a not to exceed value of 200 ppm. These values are high and are of concern to EPA. We need more information on the composition of these hydrocarbons.

Periodic monitoring of the stack gases should be conducted for pesticides and mercury.

Response No. 15

The discrepancies concerning the mix chamber and quench chamber no longer apply since the unit is configured with a thermal oxidizer.

Williams has provided real time stack gas monitoring with its' CEM system. The present CEM system has the capability of monitoring THC and CO. Opacity can be added to the capabilities of Williams' CEM unit. The type and specifications of the CEM will be included in the "final draft" of the work plan.

Williams' thermal desorption unit is not a BIF, therefore THC is not proposed as a parameter to be measured.

Real time air monitoring can be incorporated into the air monitoring plan as discussed in response to Comment No. 1.

Periodic monitoring of the stack gases is no longer applicable. The performance test will determine the efficiencies achieved by the thermal oxidizer.

Comment No. 16

Table 6.2 - This table indicates that the loss of the draft fan will trigger the vent opening. How does VO compensate for loss of the draft fan?

Response No. 16

A vent opening does not occur when the I.D. fan drops out.

Comment No. 17

Section 6.1.3 - This section mentions auxiliary fuel to the rotary dryer burner. Does the burner have more than one source of fuel?

Response No. 17

The auxiliary fuel mentioned in Section 6.1.3 is the same as primary fuel, which is propane.

Comment No. 18

Section 6.1.6 - This section says that a high THC concentration in the stack is an indication of carbon break through. These measurement should be supplemented by periodic sample and analysis of the carbon. How is the THC concentration in the stack monitored?

Response No. 18

This comment no longer applies.

Comment No. 19

Section 6.1.7 - This section says that interruption of water flow to the quench chamber will trigger certain events including shutting down the ID fan. Where will the hot gases go if the ID fan is shut down.

Response No. 19

The interruption of water flow to the quench chamber will result in a vent opening and an AWFSO and not a shut down of the I.D. fan.

When the I.D. fan shuts down, both burners cease operation and the feed is cut off. The fans wind down at approximately the same rate. From past experience, steam from the primary will escape from the unit until the I.D. fan is restored.

Comment No. 20

How does Section 6.1.7 relate to Section 6.1.8?

Response No. 20

Section 6.1.7 describes the procedures taken when an alarm condition is satisfied. Section 6.1.8 describes procedures taken to prevent the alarm condition described in Section 6.1.7.

Comment No. 21

Section 6.1.9 - What is the established limit for pressure differential across the liquid phase carbon bed? If the liquid carbon system is shutdown for cleaning, what is the effect on the overall treatment system?

Response No. 21

Maximum design differential pressure for the aqueous phase carbon bed is 12 p.s.i. The aqueous treatment unit is designed to include two carbon beds in parallel to prevent the shutdown of the overall treatment system during backflow operations to clean an individual carbon unit.

Comment No. 22

Section 6.1.14 - What effects will occur if the combustion air fan fails? How is operation of the fan monitored?

This section should describe the orderly shut down of the system in the event of a power failure.

Response No. 22

In the event that the combustion fan fails a AWFSO will result.

All motors are monitored through an ammeter.

In the event of a power failure, all processes and operations terminate.

Comment No. 23

Section 7.1 - Air emissions performance standards are not addressed at all by the draft work plan.

Response No. 23

Williams plans to include applicable air emission performance standards in the "final draft" of the work plan.

Comment No. 24

Section 7.2.1 - This section indicates that although all 15 chemicals of concern will be analyzed during the performance test, only hexachlorobenzene and DDT will be analyzed during remaining operations. A decision to reduce the number of analytes should be based on the results of the performance test - i.e. all 15 chemicals should be analyzed until the results of the performance test are available. Analysis of treated soils and stack gases during the performance test should also include the full range of volatile and semi-volatile compounds including dioxins and furans. The detection levels for stackgases should be low enough to evaluate potential impact on human health.

Response No. 24

Treated soils will be analyzed for the 15 chemicals of concern listed in section 7.2.1 of the draft work plan during the performance test and until a decision has been made by BNRR and the EPA to reduce the number of parameters.

Stack gases will be analyzed for the 15 chemicals of concern except for mercury, arsenic, and lead - See Response to John Gilbert's Comment #1. And stack gases will also be analyzed for selected volatile and semi-volatile compounds including dioxins and furans during the performance test. Details will be presented in the "final draft" of the work plan.

Comment No. 25

Section 8.1 - The sampling program is not sufficient for the start of operations. One composite sample should be taken per shift consisting of one grab sample per hour. If these results show consistently good performance, then the sampling program may be scaled back.

This section should include more details concerning sample collection, compositing procedures and QA/QC requirements.

Table 8-1 was not included in the draft work plan.

Response No. 25

A more detailed sampling plan for treated soil will be included in the "final draft" of the work plan which includes sampling during the performance test. The sampling plan during production operations will require sampling of the day piles at a frequency of one (1) grab sample every six hours or eighty tons. The four

(4)grab samples will then be composited at the end of each day. It is anticipated that sampling will later be scaled back based upon good results.

Sampling procedures and QA/QC requirements will be described in the "final draft" of the work plan. Table 8-1 will be included in the "final draft" of the work plan.

Comment No. 26

Section 8.2 - Treated soil samples should be analyzed for all 15 chemicals of concern at least until the results of the performance test are available.

Response No. 26

Please refer to Response No. 24.

Comment No. 27

Section 9.0 - Please clarify the areas to be included in the exclusion zone. Does the exclusion zone contain only the rotary dryer or the entire treatment train? If only the dryer, then why? The untreated stockpile is said to be part of the exclusion zone. Does this include the existing north and south stockpiles or just a working stockpile to be established near the treatment system. Will haul roads be included in the exclusion zone? Where will the treated stockpiles be located? Figure 11-1 does not adequately define the exclusion zone.

Response No. 27

The "final draft" of the work plan shall include the boundaries of the exclusion zone. The exclusion zone will include the waste feed stockpile, the associated haul roads, and the rotary dryer and baghouse.

Comment No. 28

Section 11.1 - The boundaries of the exclusion zone are not clear.

Response No. 28

Please refer to Response No. 27.

Comment No. 29

Section 11.3.4 - The final disposition of the spent carbon needs to be discussed both liquid and gases. As the spent carbon will contain all the contamination removed from the site, EPA needs to be assured that it will be properly treated. Disposition of the carbon needs to comply with EPA's off-site policy.

Response No. 29

Aqueous phase carbon is anticipated to be regenerated by WestStates Carbon in Parker, Arizona.

Comment No. 30

Section 11.4 - The unit should be started up with clean soils. EPA approval will be needed prior to running contaminated soils through the unit.

Response No. 30

Please refer to Response No. 13.

Comment No. 31

Section 11.5 - After all stockpiled soils are treated, soil samples will need to be taken in areas used for treatment, for stockpiling and for hauling to assure that the treatment process did not cause soil contamination above the cleanup standards.

Response No. 31

Please refer to Response No. 6.

Comment No. 32

Appropriate insurance information needs to be submitted to EPA as required by Section 15.1 of the Consent Order.

Response No. 32

Insurance information will be included in the "final draft" of the work plan.

Comment No. 33

Who is responsible for weekly reporting and emergency reporting to EPA and for preparation of the final report?

Response No. 33

Burlington Environmental will be responsible for weekly reporting, emergency reporting to EPA, and will also be responsible for the preparation of the final report.

Comment No. 34

The work plan should include discussion of final site grading.

Response No. 34

Please refer to Response No. 9.

John M. Gilbert's Comments

Comment No. 1

Section 1.1, page 6 - What is the plan for testing metals in the stackgas? The introduction discusses metals in the soil, but nothing about monitoring during the demonstration burn.

Response No. 1

Mercury, arsenic and lead were present in some locations above cleanup levels.

During the RI, mercury was detected at some locations in the lagoon area above cleanup levels. The mercury will be treated by Williams' thermal desorption process. A Tier I analysis has been performed and no exceedance for mercury has been observed, therefore, mercury will not be monitored in the stack gas during the performance test. Lead and arsenic were only detected in a few locations above their respective cleanup levels across the site during the RI, and lead and arsenic impacted soils excavated during soil removal were placed in roll off boxes to be disposed of or treated by a different technology. In addition, a Tier I analysis has been performed for lead and arsenic and no exceedance has been observed. For these reasons, lead and arsenic are not on the parameter list for stack gas testing during the performance test.

Comment No. 2

Section 3.2, page 16 - Any oversized material that is not debris should be crushed and fed into the desorber, not considered as backfill. If this statement only pertains to debris, I have no problem with it.

Response No. 2

Please refer to Response No. 8.

Comment No. 3

Section 3.3, page 17 - The actual soil gas exit temperature will be established as a result of the demonstration burn.

Response No. 3

Williams concurs with the above comment.

Comment No. 4

Section 3.3, page 17 - Fugitive emissions can occur as a result of steam being emitted from the stacking conveyor. Williams will have to control all fugitive emissions.

Response No. 4

The necessary engineering controls (such as negative pressure in the discharge auger and the proper amount of water being added to the soil prior to being discharged) will be practiced to control fugitive dust emissions. The effects of these controls will be documented during the performance test for clean soil.

Comment No. 5

Section 6.1, page 24 - The plan needs to discuss the relation to vent openings (VO) and automatic waste feed shutoff (AWFSO).

Response No. 5

The "final draft" of the work plan will include a description of events triggering a VO and/or AWFSO.

Comment No. 6

Section 6.1, tables 6-1 & 6-2 - No discussion on a AWSFO for CO, feed rate, or quench pH.

Response No. 6

Williams proposes a 100 ppmv limit for CO based on a 60 minute rolling average. The feed rate AWFSO will be determined during the performance test. The quench pH AWFSO will be determined during the performance test.

Comment No. 7

Section 6.1.6, page 26 - The plan indicates a THC concentration greater than 200 ppm, which is too high. The desorber's THC analyzer conditions the sample prior to being analyzed. Method 25 requires an unconditioned sample.

Response No. 7

Williams will use 40 CFR Subpart O guidelines to conduct the performance test. No provisions are made to analyze for THC.

Method 25A results were compared with the conditioned sample results from the CEM during the performance test at THAN. The results were consistent enough that Region IV EPA allowed the use of the cold FID analyzer used in the CEM system for the remainder of the project.

Comment No. 8

Section 6.1.9, page 26 - What is the limit for the pressure differential? How will the pressure differential be equated to changing out the carbon?

Response No. 8

This comment no longer applies.

Comment No. 9

Section 8, page 30 - How often will the AWFSO's be demonstrated during production operations?

Response No. 9

This demonstration is expected to take place prior to the performance test and once per month thereafter.

Comment No. 10

The performance test plan needs to be submitted as soon as possible.

Response No. 10

This comment is true. Williams is currently preparing the equipment specifications for the new thermal treatment unit to be operating at the Woods Industries Site. The heat and mass balances are also being prepared.

Catherine Massimino's Comments

Comment No. 1

I recommend that agency approval of the final work plan, including the Appendices B through E, be required to be issued prior to allowing mobilization of the thermal desorption unit.

Response No. 1

This comment is true.

Comment No. 2

It is not clear whether Appendices C and D will address performing a site specific risk assessment. A site specific risk assessment should be performed addressing the target compounds listed on page 28, dioxins and furans, potential organic breakdown or reformation compounds as a result of the treatment process, HCl, and Cl. This risk assessment should also address the effects of vent stack openings. The detailed procedures/ modeling to be followed to perform the risk assessment on the expected emissions from the incinerator for the performance test and the full production operation need to be provided.

Response No. 2

Please refer to Response No. 2 of Bob Kievit's Comment No. 2.

Comment No. 3

A history of this thermal desorption system (e.g. include desorption unit and air pollution control system) with respect to Automatic Waste Feed Shutoff's (AWFSO's) and vent stack openings needs to be provided. This information should include the following:

Number of AWFSO's and Vent Stack Opening events during all phases of previous operation (i.e. shakedown, performance test, interim operation, and full production).

Events broken down by causes (e.g. - of AWFSO due to power failures, loss of water to quench, etc.).

Corrective actions (e.g. changes to operating procedures or design) taken to eliminate the event.

Long-term corrective actions taken to reduce or eliminate future occurrences of the event.

The work plan should include an evaluation of the potential for incorporation of additional/revised operational procedures and redundancies to the thermal desorption system to minimize the probability of AWFSOs and vent openings (e.g. use of heat exchanger prior to baghouse).

Response No. 3

This comment has been addressed in previous responses. The Williams' unit is being re-configured for thermal oxidation of the off-gases. The unit being proposed for the site is being reconfigured specifically for this project, therefore no history exists for AWFSO and vent openings. The work plan will incorporate an operations manual which will include procedures for corrective actions, and long term corrective actions to reduce or eliminate future occurrences of the unwanted event. The evaluation of the potential for additional procedures and redundancies will also be incorporated into the operations manual.

Comment No. 4

The soil needs additional characterization to enable a more useful heat and energy balance to be performed. This additional characterization needs to include the following: ash content; total chlorine; and heating value.

The mass balance calculations must include a breakdown of the inputs to the system into their elemental components (i.e., C, E, O, N, Cl, inerts, etc.). Streams coming out of the system must also be further broken down to include acid gases and particulates.

- It needs to be identified whether the soil is likely to present any special feeding problems (e.g. abundant large rocks requiring crushing equipment, substantial fines content resulting in excessive particulate orvery sticky when wet, etc.).

Response No. 4

The majority of this comment refers to incineration as opposed to thermal desorption (i.e. ash content). Heating value is not of concern with the pesticide concentrations present in the impacted soils.

The mass balance will be provided for the process flow diagram in the revised work plan.

Potential feeding problems are discussed in Response No. 8 of Bob Kievit's comments.

Comment No. 5

The scaled engineering drawings and piping and instrumentation diagrams for the system must be provided. Also, the ID Fan curves should be provided.

Response No. 5

A PI & D diagram and general equipment layouts have been provided in the work plan. A I.D. fan curve will be included in the "final draft" of the work plan.

Comment No. 6

Should include design analysis of the projected efficiency of each individual component of the air pollution control system (APC) and the combined efficiency of all the components of the APC for the constituents of concern (e.g. metals, acid gases, particulate, etc.).

Response No. 6

The maximum efficiencies for metal removals for APC equipment as provided in Table III-8 entitled "Air Pollution Control Devices (APCDs) and Their Conservatively Estimated Efficiencies for Controlling Toxic Metals". The removal efficiency for HCl is estimated at 99% removal.

The particulate loading at the THAN site was determined to be less than <0.05 gr/dscf.

Comment No. 7

A contingency plan needs to be prepared which addresses the elements specified under 40 CFR 264 Subpart G.

In addition the contingency plan must include notifying the Agency of the use of AWFSO's and vent opening events during operations when the soil is in the thermal desorption units or gases from the soils are in the thermal desorption system (including APC), including length of time of event, cause of event, and corrective taken.

The contingency plan must also included a requirement to obtain Agency approval prior to resuming soil feed after use of automatic waste feed cutoffs of greater than once within any operating calendar day and after any vent opening. This requirement would be applicable during all phases of the operation.

Response No. 7

Williams believes that 40 CFR 264 Subpart G - Closure and Post Closure does not apply to Williams' work at the site.

AWFSO's and vent openings should not require reporting to the Agency unless fugitive emissions result. Williams also believes that ceasing operations because of more than one AWFSO or vent opening in one calendar day is burdensome and is not requisite for all AWFSO's and vent openings.

Williams requests a list of EPA contacts and numbers that are available 24 hours a day and a procedure to begin operations when no EPA contact can be reached.

As part of standard operating procedures, Williams records all downtime events and causes on "Round Sheets." The log book in the Control Room documents the corrective actions taken to repair the failure and prevent future occurrences.

It is also Williams' policy to institute AWFSO's or vent openings that prevent fugitive emissions and equipment damage. Therefore when an AWFSO event occurs it does not necessarily represent a permit exceedance.

Comment No. 8

A limitation of operating hours for noisy feed preparation activities (e.g. crushing) should be proposed.

Response No. 8

This comment was addressed in Bob Kievit's Comment No. 4. Crushing is not expected to be necessary.

Comment No. 9

Since the contaminants contained in the soil to be processed in the thermal desorption system are very similar to those found in EPA Waste K, U, and P codes (i.e. 40 CFR Part 261) the performance standards which would be applied to the application here. I recommend the following standards be applied to the stack emissions from the unit: Destruction and Removal Efficiency of 99.99% (the mechanism applied here will be primarily removal); Particulate emission of greater than 0.015 grains per dry standard cubic foot after correction to a stack gas concentration of 7% oxygen; Metal emissions not to exceed the levels specified in 40 CFR Section 266.106; A maximum of 4 lbs/hr HCl emissions or 99% control efficiency which would not exceed the levels specified in 40 CFR Section 266.107.

A free chlorine level which does not exceed the levels specified in 40 CFR Section 266.107; A total hydrocarbon limit (THC) which would not exceed 20 ppmv based on a hourly rolling average basis reported as propane, and continuously corrected to 7 percent oxygen, dry gas basis; A dioxin and furan emission limits of 30 mg/dscm based on the sum of the tetra through octa-dioxin and furan congeners; and site specific risk assessment indicating emission levels areacceptable.

Response No. 9

The technology that is currently being proposed for treating the soils at the site includes a rotary dryer, an afterburner, and an air pollution control system. The applicable performance standards are described in 40 CFR Subpart O. These include:

a. Destruction and removal efficiency of 99.99% for principal organic hazardous constituents (POHCs);

b. Particulate emission of no greater than 0.08 grains per dry standard cubic foot after correction to a stack gas concentration of 7% oxygen;

c. A maximum of 4 lbs/hr HCl emissions or 99% control efficiency;

d. Continuous monitoring for carbon monoxide in the stack gas. Williams proposed that maintaining CO emissions below 100 ppm_V on a one (1) hour rolling average is a relevant and appropriate requirement;

e. Developing acceptable operating limits for the parameters listed in 40 CFR 264.345. Specific parameters and operational limits will be proposed in a performance test plan.

Several of the standards proposed in the EPA comment letter are not applicable, including:

c. Metals emissions not to exceed the levels specified in 40 CFR 266.106.

d. HCl emissions not to exceed the levels specified in 40 CFR Section 266.107. The thermal desorption system is not a boiler or industrial furnace, therefore, this regulation is not applicable.

e. A free chlorine level which does not exceed the levels specified in 40 CFR Section 266.107. The thermal desorption system is not a boiler or industrial furnace, therefore, this regulation is not applicable.

f. A total hydrocarbon limit (THC) which would not exceed 20 ppm_V based on an hourly rolling average reported as propane. The thermal desorption system is not a boiler or industrial furnace, therefore, this regulation is not applicable. The thermal desorption system will demonstrate compliance with a 100 ppm_V CO standard (one (1) hour rolling average, corrected to 7% oxygen). Demonstration of compliance with the THC standard is applicable under the BIF regulations only if compliance with the CO standard is not attained.

g. A dioxins and furan emission limits of 30 mg/dscm (note: probably meant ng/dscm) based on the sum of the tetra through octa-dioxin and furan congeners.

Williams proposes to operate the thermal desorption system under temperature conditions which are not conducive to the formation of dioxins and furans. These conditions include:

- Thermal desorbed soil discharge temperature greater than 750°F.
- Baghouse inlet gas temperature of less than 450°F.
- Afterburner exit gas temperature of greater than 1800°F.
- Rapid quench of baghouse exit gas to the adiabatic saturation temperature (less than 180°F).

h. Site specific risk assessment indicating emission levels are acceptable. This requirement is from the proposed EPA Draft Combustion Strategy which is not currently a regulation.

Comment No. 10

The operation of the thermal desorption unit and the baghouse within the 450 - 750°F temperature range is not desirable as it increases the potential for dioxin and furan formation. An evaluation of the system to eliminate its operation within this range should be performed.

Response No. 10

The temperature of the gas going to the baghouse will be below 450°F. The temperature of the soil discharge from the thermal desorber will be above 750°F.

Comment No. 11

The specifications (e.g. range, accuracy, precision, etc.) for the process monitoring equipment (e.g. Table 6-1 parameters) including the THC monitors needs to be provided. The THC monitors must meet the specifications in Part 266 Appendix IX, Section 2.0, Performance Specifications for Continuous Emission Monitoring Systems. Specific information needs to be also provided on method and equipment to be used to record data (i.e. strip chart speed, including a copy of an example chart, printout frequency for computer logged data, hard disk capacity, etc.). Detailed calibration procedures and frequency must be provided for all the process monitoring equipment.

Response No. 11

Williams' CEM system can meet the specifications of Part 266 Appendix IX for CO and O_2. THC is not included in this 40 CFR citing performance specification. When the appropriate data logger is selected, the specification will be incorporated into the work plan.

Comment No. 12

Amend Table 6-1 to include the following as parameters which are continuously monitored and recorded: quench water minimum pH and maximum total solids parameter for thermal desorption unit solids residence time, thermal desorption unit oxygen level, baghouse inlet temperature high, indicator of vent opening, gas flow rate high, add a THC monitor at stack exit (versus between carbon beds) and soil wastefeed rate. Also the vapor phase carbon differential pressure should be continuously monitored and recorded.

Response No. 12

Williams proposes to continuously monitor and record quench water pH soil feed rate and baghouse inlet temperature. There is no direct method to continuously monitor retention time in the thermal desorber. The best measure of retention time is analytical results of the treated soil.

A vent stack opening is associated with an event (alarm) that triggers the vent to open. When the alarm is logged on the chart paper the vent opening has been triggered. During the performance test process conditions are established for future production operations. If the process conditions are met (i.e. feed rate, thermal oxidizer temperature and minimum O_2 concentration in the thermal oxidizer) then the gas flow rate will be approximately the same. Therefore, Williams does not propose to continuously monitor stack gas flow rate.

Again, it is Williams' position that the thermal oxidizer is not a Boiler/Industrial Furnace and therefore monitoring THC is not an appropriate ARAR.

Vapor phase carbon differential pressure is no longer applicable.

Comment No. 13

Table 6-2, should add the following AWFSO's: soil feed rate high, quench water pH, specific gravity, and nozzle pressure, THC at stack exit at 20 ppm_v or above (see comment 9e, above), thermal desorption unit solids

residence time, baghouse DP, thermal desorption unit at a positive pressure for any length of time, low oxygen level in thermal desorption unit, and vapor phase carbon DP.

For all items on Table 6-2 that result in a VO evaluate the use of time delays to assume that unnecessary openings do not occur. Evaluate the installation of another vent just prior to the carbon unit versus opening the vent after the thermal desorption unit bypassing any particulate or acid gas control when the carbon unit inlet gas high is the cause of the VO.

Also, explicitly state on Table 6-2 that whenever there is a VO the soil feed will be shut off.

The control should be re-configured, if necessary, to clearly indicate in the continuously operating record whether soil is being fed.

Whenever soil feed is interrupted the operator must maintain the units operating parameters within their required ranges.

The pressure within the rotary dryer on this table and page 25 should be corrected to a negative number.

Response No. 13

Williams will provide an AWFSO for soil feed rate high, low quench water pH, baghouse DP flow, dryer pressure and low oxygen level in the thermal oxidizer. These AWFSO will be set during the performance test.

Specific quality of the quench water is not a parameter that is easily measured on-line or very useful for thermal treatment operations, therefore Williams is not proposing an AWFSO for this parameter.

Nozzle pressure for the quench chamber does not require an AWFSO because other parameters are monitored to prevent unbalanced conditions in the quench, such as quench exit gas temperature. Therefore, Williams is not proposing an AWFSO for this parameter.

THC has been addressed in other comments.

Vapor phase carbon DP is no longer applicable.

Williams will incorporate the time delay recommendation as appropriate for the items in Table 6-2. Table 6-2 will also state that when a vent opening occurs, feed is stopped.

Soil feed rate is monitored and recorded continuously.

When soil feed is interrupted it is Williams' standard operating procedure to operate the thermal desorption unit within the required control parameters.

The rotary dryer vacuum is monitored continuously. When the vacuum reaches "0.00" an AWFSO results.

Comment No. 14

Page 30, Section 8.2 the treated soil should also be analyzed for the appropriate TCLP parameters (e.g. mercury, arsenic, etc.).

Response No. 14

TCLP testing is not necessary to characterize the treated or untreated soils because TCLP testing was performed on several contaminated samples as part of the RI to evaluate disposal or treatment options. The results of all TCLP analyses show that the soils are not RCRA characteristic hazardous waste because none of the samples failed the TCLP test. This is described in detail in section 4.5.3 of the Final RI Report.

Comment No. 15

Page 38, increase the time interval for operation at 700°F to at least twice the normal solids residence time in the unit.

Response No. 15

Residence time adjustments, if any, will be dependent upon performance test results.

Comment No. 16

Page 43, provide details of the perimeter air monitoring system (e.g. parameters, equipment, exact locations, data interpretation, sampling and analysis frequency, etc.).

Response No. 16

This comment will be addressed from Bob Kievit's Comment No. 1.

Please let me know if you need assistance interpreting any of these responses.

Sincerely yours,

WILLIAMS ENVIRONMENTAL SERVICES, INC.

Mark A. Fleri
Project Manager

MAF/cd/RESPONSE.

cc Z. Lowell Taylor - Williams Environmental Services
Bruce Sheppard - Burlington Northern Railroad
David Eagleton - Burlington Environmental
Tom Hippe - Burlington Environmental
Bob Kievit - EPA
Tom Backer - Preston Thorgrimson
General File
Job File

P

APPENDIX P

CONSENT ORDER

APR 07 1993 EPA - WOO

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UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION 10

IN THE MATTER OF:

WOODS INDUSTRIES SITE

Burlington Northern Railroad,

Proceeding Under Sections 106(a) and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, 42 U.S.C. §§9606(a) and 9622

ADMINISTRATIVE ORDER ON CONSENT FOR REMOVAL RESPONSE ACTIVITIES

U.S. EPA Region 10
CERCLA
Docket No. 1087-03-18-106

I. JURISDICTION AND GENERAL PROVISIONS

1.1 This Order is issued pursuant to the authority vested in the President of the United States by sections 106(a) and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. §§ 9606(a) and 9622, as amended ("CERCLA"), and delegated to the Administrator of the United States Environmental Protection Agency ("EPA") by Executive Order No. 12580, January 23, 1987, 52 Federal Register 2923, and further delegated to the EPA Regional Administrators and the EPA Assistant Administrator for Solid Waste and Emergency Response by EPA Delegation Nos. 14-14-A and 14-14-B. This authority is conferred on the EPA Region 10 Chief, Superfund Response and Investigations

Branch by Regional Redelegation Order signed by the Regional Administrator.

1.2 This Administrative Order on Consent (Order) is entered into voluntarily by the EPA and, Respondent Burlington Northern Railroad Company ("BNR") and its receivers, trustees, successors and assigns. This Order provides for the performance of removal actions by Respondent and the reimbursement of response costs incurred by the United States in connection with the property located at 1 East King Street in Yakima, Washington, and known as the "Woods Industries Site". This Order requires the Respondent to conduct removal actions described herein to abate an imminent and substantial endangerment to the public health, welfare or the environment that may be presented by the actual or threatened release of hazardous substances at or from the Woods Industries Site.

1.3 EPA has notified the State of Washington of this action pursuant to section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

1.4 Respondent's participation in this Order shall not constitute or be construed as an admission of liability or of EPA's findings or determinations contained in this Order except in a proceeding to enforce the terms of this Order. Respondent agrees to comply with and be bound by the terms of this Order. Respondent further agrees that it will not contest the basis or validity of this Order or its terms.

II. PARTIES BOUND

2.1 This Order applies to and is binding upon EPA, and upon Respondent and its directors, officers, employees, agents, receivers, trustees, successors and assigns. Any change in ownership or corporate status of Respondent including, but not limited to, any transfer of assets or real or personal property shall in no way alter Respondent's responsibilities under this Order.

2.2 Respondent shall ensure that its contractors, subcontractors, and representatives receive a copy of this Order and comply with this Order. Respondent shall be responsible for any noncompliance by such persons.

III. FINDINGS OF FACT

3.1 The Woods Industries facility (hereinafter the "Woods site," "site" or "facility"), is a facility as defined in Section 101(9) of CERCLA, 42 U.S.C. § 9109(9), and a former pesticide formulation and distribution operation located in the city of Yakima, Washington. The site is the areal extent of contamination that consists of approximately four (4) acres of land, located at 1 East King Street in Yakima, Washington. The site is located within the city limits of Yakima, Washington, in a commercial and industrial area.

3.2 Burlington Northern Railroad Company is a Delaware corporation authorized to do business in the state of Washington. BNR's principal offices are located in Fort Worth, Texas. The mailing address of BNR for purposes of this order is:

Bruce Sheppard
Manager, Environmental Engineering
Burlington Northern Railroad Company
2200 First Interstate Center
999 Third Avenue
Seattle, WA. 98104-1105

3.3 BNR is the land owner of the site. Several individuals and corporations used the site for pesticide formulation and related operations from at least 1945 until at least 1985 under leases from BNR and its predecessors. Site operators have included, among others, Crop King Co., Richey & Gilbert Co., Akland Irrigation Co., Inc. and their respective officers and directors. Between approximately 1980 and May 1985, Woods Industries, Incorporated (hereinafter "Woods") occupied the site and operated a pesticide business on property leased from BNR.

3.4 In May 1985, the lease between BNR and Woods expired and was not renewed. Woods no longer occupies the site. No current operation is present at the site. BNR now controls the site.

3.5 A wide variety of hazardous substances, including arsenic, aldrin, strychnine, lindane, carbamates, and DDT, were used in the pesticide formulation process on the site. Site inspections and assessments conducted by EPA in October and November of 1985, revealed that a number of drums and chemical containers were present on the site. The inspections and assessments revealed chemical contamination in the soils at the site.

3.6 Pursuant to an Administrative Order on Consent for Immediate Response and Stabilization Activities issued by EPA and dated December 6, 1985 (Order No. 1085-10-02-106), BNR was ordered to perform several actions, including: restricting access to the property, securing pools or solid spills within the buildings of the property, securing drums and bottled chemicals on the property to prevent release of their contents, and securing the entrances and lower windows of buildings on the property.

3.7 In addition to these actions, the order required BNR to: analyze the on-site groundwater well and provide to EPA information on the casing, screening and depth of that well; further investigate the extent of hazardous substance contamination of soils, groundwater, and surface waters at the facility; and investigate pathways for contamination migration.

3.8 The above-mentioned actions were undertaken with the knowledge that more extensive response actions would be required to address the significant and varied environmental hazards at this facility.

3.9 BNR contracted with Morrison-Knudsen Engineers, Incorporated (hereinafter "MKE") to implement the actions required by the December 6, 1985 Consent Order. MKE conducted site characterization studies from July through October 1987 covering air, surface water, soil, and shallow groundwater investigations. The findings and conclusions from those studies are contained in the following documents which have been reviewed and accepted by EPA: 1) a Preliminary Site Characterization Report prepared by MKE and dated March 1987; 2) a letter addressed to Jeff Webb of EPA, dated March 28, 1988; 3) a letter addressed to Jeff Webb, EPA, dated July 6, 1987; and 4) quarterly groundwater monitoring data.

3.10 Pursuant to an Amended Order on Consent dated June 28, 1990, for a Remedial Investigation and Feasibility Study, BNR completed a Remedial Investigation, which was approved by EPA on Sept. 16, 1992.

3.11 The Remedial Investigation found visible evidence of chemical contamination inside the Woods buildings including dry powder above ceiling panels in the basement and stained areas on the floors and walls. Bags containing asbestos material were located in one of the buildings. The buildings were generally in a dilapidated condition.

3.12 Pursuant to an Administrative Order on Consent for Removal Response Activities issued by EPA and dated January 4, 1993 (Order No. 1087-03-18-106), BNR was ordered to demolish and dispose of buildings formerly used for pesticides formulation and to dispose of miscellaneous debris on the site. Building demolition and disposal was completed in February 1993.

3.13 The Remedial Investigation revealed extensive contamination of the surface and subsurface soils at the site. The hazardous substances of greatest concern in the soils are pesticides including DDT and Dieldrin, hexachlorobenzene, lead, mercury, and arsenic. The main sources of this contamination appears to be past waste disposal units including a sump, a washdown area, and a series of lagoons. Most of the contamination on site appears to be located in soils in and around these units. The contamination around these units extends from the surface to the watertable. The maximum concentrations detected in soils within these units are: DDT-30,000 ppm; Dieldrin-200 ppm; hexachlorobenzene- 23,000 ppm; lead- 143,800 ppm; mercury-88.5 ppm; and arsenic-543 ppm. The Remedial Investigation indicates that concentrations of contaminants outside of these areas is much lower and the contamination doesn't extend lower than 2 to 3 feet below the surface.

3.14 The Remedial Investigation found that groundwater under the site is contaminated with many of the same chemicals found in the soils including DDT, Dieldrin, and hexachlorobenzene. The highest concentrations of chemicals found in groundwater on site are: DDT- 77 ppb; Dieldrin- 16 ppb; and hexachlorobenzene- 11 ppb. Highest concentrations of contaminants were found in the upper portion of the aquifer in the area of greatest soil contamination. Concentrations of contaminants in the ground water decreases with depth.

3.15 The Remedial Investigation found that the depth to groundwater under the site varies seasonally by 5 to 8 feet in response to irrigation in the Yakima Valley. The groundwater table is lowest in late winter/early spring and rises rapidly with the onset of irrigation. The groundwater table reaches its maximum elevation in late summer/early fall. In late summer, the Remedial Investigation found high levels of contamination in soils just above the groundwater table, which represent the deepest soil samples taken to date. Soil contamination is suspected to be present below the seasonal high groundwater table. It is likely that groundwater is being contaminated each year as the groundwater table rises into soils containing elevated concentrations of hazardous substances.

3.16 Conditions presently exist at the site that may present an imminent and substantial endangerment to public health or welfare or the environment.

3.17 The conditions at the site meet the criteria for a removal action as stated in the National Contingency Plan, 40 C.F.R. Section 300.415 as follows:

A. High levels of hazardous substances or pollutants or contaminants in soil at or near the surface that may migrate - Surface soils sampled in the lagoon, sump, and washdown areas contain high concentrations of DDT, Dieldrin, Hexachlorobenzene, and other hazardous substances, which may migrate off-site through wind blown dusts and soils. The concentrations of some chemicals exceed the State of Washington cleanup standards for soils in industrial areas. For example the highest concentration of DDT in soil is 1,000 times the state cleanup standard. There are two businesses directly adjacent to the site.

B. Actual or potential exposure to nearby human population, animals, or the food chain from hazardous substances or pollutants or contaminants - Although the property is fenced and site access is restricted, there is a threat of trespassers coming into direct contact with contaminated soils. There is also a threat of contaminated soils migrating offsite through wind blown dust and soils. Many of the pesticides found on-site are known or suspected carcinogens and could pose a cancer risk.

Many of the pesticides found on-site are also known to cause nervous system disorders and liver diseases.

C. Actual or potential contamination of drinking water supplies or sensitive ecosystems - The pollutants overlie a local drinking water aquifer. Concentrations of Endrin in monitoring wells on-site are above the MCL. Concentrations of Hexachlorobenzene are above the proposed non-zero MCLG. Concentrations of pesticides which have no established MCL or MCLG such as DDT and Dieldrin exceeds state promulgated groundwater cleanup standards.

3.18 DDT is a chlorinated organic pesticide, which together with its metabolites DDD and DDE, is very persistent in the environment. DDT, DDD, and DDE are probable human carcinogens. Exposure to DDT can also result in adverse impacts to the central nervous system including excitability, tremors, and seizures.

3.19 Dieldrin is resistant to biodegradation and abiotic degradation and therefore can accumulate in the environment. Dieldrin is a probable human carcinogen. In high doses, Dieldrin is a neurotoxin that affects the central nervous system and can produce tremors, convulsions, coma, and even death. Short-term exposure can result in symptoms such as headaches, dizziness, irritability, loss of appetite, and convulsions.

3.20 Hexachlorobenzene is a probable carcinogen. Long-term exposure can result in hepatic toxicity, kidney effects, immune system abnormalities, and neurological effects.

IV. CONCLUSIONS OF LAW AND DETERMINATIONS

4.1 Based on the Findings of Fact set forth above, and the Administrative Record supporting these removal actions, EPA determines that:

(A) The Woods Industries Site is a "facility" as defined by section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

(B) Each substance identified in the Findings of Fact above is a "hazardous substance" as defined by section 101(14) of CERCLA, 42 U.S.C. § 9601(14).

(C) The Respondent is a "person" as defined by section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

4.2 Respondent is liable under section 107(a) of CERCLA, 42 U.S.C. § 9607(a) as the "owner" of the facility, as defined by section 101(20) of CERCLA, 42 U.S.C. § 9601(20), and within the meaning of section 107(a)(1) of CERCLA, 42 U.S.C. § 9607(a)(1).

4.3 The conditions described in the Findings of Fact above constitute an actual or threatened "release" into the "environment" as defined by sections 101(8) and (22) of CERCLA, 42 U.S.C. §§ 9601(8) and (22).

4.4 The conditions present at the facility constitute a threat to public health, welfare, or the environment based upon the factors set forth in the National Oil and Hazardous substances Pollution Contingency Plan (NCP), 40 C.F.R. § 300.415(b)(2).

4.5 The actual or threatened release of hazardous substances from the Site may present an imminent and substantial endangerment to the public health, welfare, or the environment within the meaning of section 106(a) of CERCLA, 42 U.S.C. §

9606(a).

4.6 The removal actions required by this Order are necessary to protect the public health, welfare, or the environment, and are not inconsistent with the NCP and CERCLA.

V. ORDER

5.1 Based upon the foregoing Findings of Fact, Conclusions of Law, Determinations, and the Administrative Record for this Site, it is hereby ordered and agreed that Respondent shall comply with the following provisions, including but not limited to all attachments, all documents incorporated by reference, and all schedules and deadlines attached to, or incorporated by reference into this Order, and perform the following actions:

5.2 Designation of Contractor, Project Coordinator, and On-Scene Coordinator. Respondent shall perform the work itself or retain a contractor(s) to implement this removal action. Respondent shall notify EPA of Respondent's qualifications or the name(s) and qualification(s) of such contractor(s) within five (5) days of the effective date of this Order. Respondent shall also notify EPA of the name(s) and qualification(s) of any other contractor(s) or subcontractor(s) retained to perform work under this Order at least five (5) days prior to commencement of such work. EPA retains the right to disapprove of any, or all, of the contractors and/or subcontractors retained by the Respondent. If EPA disapproves of a contractor selected by the Respondent, Respondent shall retain a different contractor within five (5) days following EPA's disapproval and shall notify EPA of that contractor's name and qualifications within five (5) days of EPA's disapproval.

5.3 Within five (5) days after the effective date of this Order, the Respondent shall designate a Project Coordinator who shall be responsible for administration of all the Respondent's actions required by the Order. Respondent shall submit the designated coordinator's name, address, telephone number, and qualifications to EPA. To the greatest extent possible, the Project Coordinator shall be present on site or readily available during site work. EPA retains the right to disapprove of any Project Coordinator named by the Respondent. If EPA disapproves of a selected Project Coordinator, Respondent shall retain a different Project Coordinator and shall notify EPA of that person's name and qualifications within five (5) days following EPA's disapproval. Receipt by Respondent's Project Coordinator of any notice or communication from EPA relating to this Order shall constitute receipt by Respondent.

5.4 The EPA has designated Bob Kievit of Region 10 as its On-Scene Coordinator (OSC). Respondent shall direct all submissions required by this Order to the OSC at:

United States Environmental Protection
Agency, Region 10
Washington Operations Office
C/O Washington Department Of Ecology
P.O. Box 47600
Olympia, Washington 98604-7600

EPA and Respondent shall have the right to change their designated OSC or Project Coordinator. EPA shall notify the Respondent, and Respondent shall notify EPA, five (5) days before such a change is made. The initial notification may be orally made but it shall be promptly followed by a written notice. (See Section VI - Authority of the EPA On-scene Coordinator).

5.5 Work to Be Performed. Pursuant to Section 106(a) of CERCLA, 42 U.S.C., Part 9606(a), as amended, Respondent shall conduct all removal activities in accordance with the requirements of this order. The removal action shall include the excavation and treatment of contaminated soils. Because of the immediate need to excavate soils prior to the next seasonal rise of the groundwater table (estimated to begin in early spring) and because of the long lead time needed to develop adequate work plans for soil treatment and to procure an appropriate soil treatment vendor, the removal will proceed in two phases. The first phase will include excavation and temporary storage of all soils on site that contain hazardous substances greater than the cleanup standards established for the site. The first phase shall be conducted in accordance with the Work Plan in Attachment A and in the Schedule of Deliverables in Attachment B, which are attached and incorporated in this Consent Order.

The second phase of the removal will include thermal treatment of all soils excavated in Phase I in accordance with the treatment standards established for the site. The second phase shall be conducted in accordance with the Schedule of Deliverables (Attachment B) and with the Scope of Work and the Work Plan that will be developed under and will be incorporated into this order when approved by EPA.

All such removal activities shall be conducted in accordance with CERCLA, the NCP, and EPA guidance.

5.6 Work Plan and Implementation. The Respondent has submitted to EPA an approved Final Work Plan (Attachment A) for the excavation and temporary storage of contaminated soils. The Work Plan provides a description of, and an expeditious schedule for, the activities required by Phase 1 of this Order. Within thirty (30) days after the effective date of this Order, the Respondent shall submit to EPA for approval a draft Scope of Work for conducting thermal treatment on the soils excavated in Phase 1. The draft Scope of Work shall provide a description, and expeditious schedule for the activities required by Phase 2 of this Order.

5.7 EPA may approve, disapprove, require revisions to, or modify the draft Scope of Work or Work Plan submitted for Phase 2. If EPA requires revisions, respondent shall submit a revised draft Scope of Work or Work Plan which is responsive to EPA comments within thirty (30) days of receipt of EPA's notification of the required revisions. Failure to do so will be considered violation of this order. Respondent shall implement the Scope of Work for Phase 2 and Work Plans for Phase 1 and 2 as finally approved in writing by EPA in accordance with the schedule approved by EPA. The approved Work Plans and Schedule shall be fully enforceable under this Order. Respondent shall notify EPA in writing at least 48 hours prior to performing any on-site work pursuant to an EPA-approved Work Plan. Respondent shall not commence or undertake any removal actions at the Site without prior EPA approval.

5.8 Health and Safety Plan. Ten (10) days before Respondent commences any removal action, or with the approval of the OSC if less then 10 days, the Respondent shall submit for EPA review and comment a plan that ensures the protection of the public health and safety during performance of on-site work under this Order. This plan shall be prepared in accordance with EPA's Standard Operating Safety Guide, dated November 1984, and updated July 1988. The plan shall comply with applicable Occupational Safety and Health Administration (OSHA) regulations found at 29 C.F.R. Part 1910, dated March 6, 1989. In addition, the plan shall also comply with all applicable Washington Industrial Safety and Health Act (WISHA) regulations found at WAC Chapter § 296-62. If EPA determines that it is appropriate, the plan shall also include contingency planning. Respondent shall incorporate all changes to the plan recommended by EPA, and implement the plan during the removal action.

5.9 Quality Assurance and Sampling. All sampling and analyses performed pursuant to this Order shall conform to EPA direction, approval, and guidance regarding sampling, quality assurance/quality control (QA/QC), data validation, and chain of custody procedures. Respondent shall ensure that the laboratory used to perform the analyses participates in a QA/QC program that complies with the appropriate EPA guidance. Respondent shall follow the following documents as appropriate as guidance for QA/QC and sampling: "Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures," OSWER Directive Number 9360.4-01; "Environmental

Response Team Standard Operating Procedures," OSWER Directive Numbers 9360.4-02 through 9360.4-08; and the representative Sampling Guidance for soil, air, ecology, waste, and water as this information becomes finalized and available.

5.10 Upon request by EPA, Respondent shall have the laboratory analyze samples submitted by EPA for quality-assurance monitoring. Respondent shall provide to EPA the quality assurance/quality control procedures followed by all sampling teams and laboratories performing data collection and/or analysis.

5.11 Upon request by EPA, Respondent shall allow EPA or its authorized representatives to take split and/or duplicate samples of any samples collected by Respondent while performing work under this Order. Respondent shall notify EPA not less than five (5) days in advance of any sample collection activity, or with the approval of the OSC if less than five (5) days. EPA shall have the right to take any additional samples that it deems necessary.

5.12 Respondent shall submit to EPA the results of all sampling or tests and all other data generated by Respondent or its contractor(s), or on the Respondent's behalf during implementation of this Order. This information shall be submitted to EPA, as it becomes available, in the written progress reports and shall be summarized in the final report submitted pursuant to paragraph 5.16.

5.13 <u>Post-Removal Site Control</u>. To the extent practicable, Respondent shall provide for post-removal site control consistent with the NCP, 40 C.F.R. § 300.415(k) and OSWER Directive 9360.2-02. Respondent shall provide EPA with documentation indicating that these post-removal site control arrangements have been made with the local/state governments.

5.14 Reporting. Respondent shall submit a written progress report to EPA concerning activities undertaken pursuant to this Order every seven (7) days after the date of receipt of EPA's approval of the Work Plan until termination of this Order, unless otherwise directed by the OSC. These reports shall describe all significant developments during the preceding period, including the work performed and any problems encountered, analytical data received during the reporting period, and the developments anticipated during the next reporting period, including a schedule of work to be performed, anticipated problems, and planned resolutions of past or anticipated problems.

5.15 Respondent and any Successor(s) in title shall, at least 30 days prior to the conveyance of any interest in real property at the site, give written notice of this Order to the transferee and written notice to EPA and the State of the proposed conveyance, including the name and address of the transferee. The party conveying such an interest shall require that the transferee comply with Paragraph 5.17 - Access to Property and Information.

5.16 Final Report. Within thirty (30) days after completion of the removal action required under this Order, the Respondent shall submit for EPA review and approval a final report summarizing the actions taken to comply with this Order. The final report shall conform, at a minimum, with the requirements set forth in the NCP, 40 C.F.R. § 300.165 entitled "OSC Reports". The final report shall include a good faith estimate of total costs or statement of actual costs incurred in complying with the Order, a listing of quantities and types of materials removed, a discussion of removal and disposal options considered for those materials, a listing of the ultimate destination of those materials, a presentation of the analytical results of all sampling and analyses performed, and accompanying appendices containing all available relevant documentation generated during the removal action (e.g., manifests, invoices, bills, contracts, and permits). All relevant documentation not available when the final report is submitted shall be submitted to EPA as soon as it becomes available. The final report shall also include the following certification signed by a person who supervised or directed the preparation of that report:

> Under penalty of law, I certify that based on personal knowledge and appropriate inquiries of all relevant persons involved in the preparation of the report, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

5.17 Access to Property and Information. Respondent shall provide and/or obtain access to the Site and appropriate off-site areas, and provide access to all records and documentation related to the conditions at the Site and the activities conducted pursuant to this Order. Such access shall be provided to EPA employees, contractors, agents, consultants, designees, representatives, and State of Washington representatives. These individuals shall be permitted to move freely at the Site and appropriate off-site areas in order to conduct activities which EPA determines to be necessary. Respondent shall submit to EPA the results of all sampling or tests and all other data generated by Respondent or its contractor(s), or on the Respondent's behalf during implementation of this Order.

5.18 Where work under this Order is to be performed in areas owned by or in possession of someone other than Respondent, Respondent shall use its best efforts to obtain all necessary access agreements within thirty (30) days after the effective date of this Order, or as otherwise specified in writing by the OSC. Respondent shall immediately notify EPA if after using its best efforts it is unable to obtain such agreements. Respondent shall describe in writing its efforts to obtain access. EPA may then assist Respondent in gaining access, to the extent necessary to effectuate the response activities described herein, using such means as EPA deems appropriate.

5.19 Record Retention, Documentation, Availability of Information. Respondent shall preserve all documents and information relating to work performed under this Order, or relating to the hazardous substances found on or released from the Site, for at least ten years following completion of the removal actions required by this Order. At the end of this ten year period and 30 days before any document or information is destroyed, Respondent shall notify EPA that such documents and information are available to EPA for inspection, and upon request, shall provide the originals or copies of such documents and information to EPA.

In addition, Respondent shall provide documents and information retained under this section at any time before expiration of the ten year period at the written request of EPA.

5.20 Respondent may assert a business confidentiality claim pursuant to 40 C.F.R. § 2.203(b) with respect to part or all of any information submitted to EPA pursuant to this Order, provided such claim is allowed by section 104(e)(7) of CERCLA, 42 U.S.C. § 9604(e)(7). Analytical and other data specified in section 104(e)(7)(F) of CERCLA shall not be claimed as confidential by the Respondent. EPA shall only disclose information covered by a business confidentiality claim to the extent permitted by, and by means of the procedures set forth at, 40 C.F.R. Part 2, Subpart B. If no such claim accompanies the information when it is received by EPA, EPA may make it available to the public without further notice to Respondent.

5.21 Respondent shall maintain a running log of privileged documents on a document-by-document basis, containing the date, author(s), addressee(s), subject, the privilege or grounds claimed (e.g., attorney work product, attorney-client), and the factual basis for assertion of the privilege. Respondent shall keep the "privilege log" on file and available for inspection. EPA may at any time challenge claims of privilege through negotiations or otherwise as provided by law or the Federal Rules of Civil Procedure.

5.22 Off-Site Shipments. All hazardous substances, pollutants or contaminants removed off-site pursuant to this Order for treatment, storage or disposal shall be treated, stored, or disposed of at a facility in compliance, as determined by EPA, with the EPA Revised "Off-Site Policy," OSWER Directive Number 9834.11, November 13, 1987. (see 42 U.S.C. § 9621(d)(3).)

5.23 Compliance With Other Laws. All actions required pursuant to this Order shall be performed in accordance with all applicable local, state, and federal laws and regulations except as provided in CERCLA section 121(e) and 40 C.F.R. section 300.415(i). In accordance with 40 C.F.R. section 300.415(i), all on-site actions required pursuant to this Order shall, to the extent practicable, as determined by EPA, considering the exigencies of the situation, attain applicable or relevant and appropriate requirements (ARARs) under federal environmental, state environmental, or facility siting laws ("The Superfund Removal Procedure for Consideration of ARARs for Removal Actions," OSWER Directive No. 9360.3-02, August 1991).

5.24 Emergency Response and Notification of Releases. If any incident, or change in site conditions, during the activities conducted pursuant to this Order causes or threatens to cause an additional release of hazardous substances from the Site or an endangerment to the public health, welfare, or the environment, the Respondent shall immediately take all appropriate action to prevent, abate or minimize such release, or endangerment caused or threatened by the release. Respondent shall also immediately notify the OSC at (206) 753-9014 or, in the event of his/her unavailability, shall notify the Regional Duty Officer at (206) 553-1263 of the incident or site conditions.

5.25 In addition, in the event of an actual release of a hazardous substance, Respondent shall immediately notify the National Response Center at telephone number (800) 424-8802. Respondent shall submit a written report to EPA within seven (7) days after each release, setting forth the events that occurred and the measures taken or to be taken to mitigate any release or endangerment caused or threatened by the release and to prevent the reoccurrence of such a release. This reporting requirement is in addition to, not in lieu of, reporting under CERCLA section 103(c) and section 304 of the Emergency Planning and Community Right-To-Know Act of 1986, 42 U.S.C. sections 11001 _et seq_.

VI. AUTHORITY OF THE EPA ON-SCENE COORDINATOR

6.1 The OSC shall be responsible for overseeing the proper and complete implementation of this Order. The OSC shall have the authority vested in an OSC by the NCP, including the authority to halt, conduct, or direct any work required by this Order, or to direct any other response action undertaken by EPA or Respondent at the Site. Absence of the OSC from the Site shall not be cause for stoppage of work unless specifically directed by the OSC. EPA and Respondent shall have the right to change their designated OSC or Project Coordinator. EPA shall notify the Respondent, and Respondent shall notify EPA five (5) days before such a change is made. Notification may initially be made orally, but shall be followed promptly by written notice.

VII. REIMBURSEMENT OF COSTS

7.1 Respondent shall reimburse EPA for all past response costs and response costs incurred by the United States in overseeing Respondent's implementation of the requirements of this Order. After the end of each federal fiscal year in which Respondent performs work under the original Administrative Consent Order executed on October 11, 1988, the Amended Administrative Consent Order executed on June 28, 1990, the Administrative Order on Consent for Removal Response Activities executed on January 4, 1993, and under this Order, EPA will submit to Respondent a detailed accounting of all costs, incurred by and/or billed to the United States after the effective date of the original Consent Order in connection with response, oversight, and community relations, costs and activities conducted by the United States government and its contractors and representatives with respect to the implementation of the original Administrative Consent Order, the Amended Administrative Consent Order, and this Order.

7.2 Respondent shall, within (60) days of receipt of the bill, remit a cashier's check, certified check, or corporate check for the amount of those costs made payable to the "Hazardous Substance Superfund" with a copy of such transaction sent to the EPA Project/On-Scene Coordinator. Remittances shall addressed to:

U.S. Environmental Protection Agency Region 10
Superfund Accounting
P.O. Box 360903M
Pittsburgh, Pennsylvania 15251.

Respondent shall simultaneously transmit a copy of the check to EPA.

Regional Hearing Clerk
Office of Regional Counsel
U.S. E.P.A. Region 10, SO-125
1200 Sixth Avenue
Seattle, Washington 98101

Payments shall be designated as Oversight and/or Past Response Costs and shall reference the payor's name and address, the EPA site identification number (*WAD027583525*), and the docket number of this Order.

7.3 Interest at the rate established under section 107(a) of CERCLA, 42 U.S.C. § 9607(a), shall begin to accrue on the unpaid balance from the day after the expiration of the Sixty (60) day period, notwithstanding any dispute or an objection to any portion of the costs.

7.4 Respondent may dispute all or part of a bill submitted under this Order, if Respondent determines that EPA has made an accounting error, or if Respondent alleges that a cost item that is included represents costs that are inconsistent with the NCP.

7.5 If any dispute over costs is resolved before payment is due, the amount due will be adjusted as necessary. If the dispute is not resolved before payment is due, Respondent shall pay the full amount of the uncontested costs into the Hazardous Substances Trust Fund as specified above on or before the due date. Within the same time period, Respondent shall pay the full amount of the contested costs into a market rate interest-bearing escrow account. Respondent shall simultaneously transmit a copy of both checks to the EPA OSC. Respondent shall ensure that the prevailing party or parties in the dispute shall receive the amount upon which they prevailed from the escrow funds plus interest within (30) days after the dispute is resolved.

VIII. DISPUTE RESOLUTION

8.1 The parties to this Order shall attempt to resolve, expeditiously and informally, any disagreements concerning this Order. If the Respondent objects to any EPA action taken pursuant to this Order, the Respondent shall notify EPA in writing of its objection(s) within fourteen (14) days of receipt of such notification or action, unless the objections have been informally resolved. EPA and the Respondent shall have seven (7) days from receipt of the notification of objection to reach agreement. If agreement is reached, it will be reduced to writing and will become a fully enforceable part of this Order. If agreement cannot be reached on any issue within this seven (7) day period, an EPA official will issue a written decision to the Respondent. Respondent's obligations under this Order shall not be tolled by submission of any objection for dispute resolution under this section.

8.2 Following resolution of the dispute, as provided by this section, Respondent shall fulfill the requirement that was the subject of the dispute in accordance with the agreement reached or with EPA's decision, whichever occurs. No EPA decision made pursuant to this section shall constitute a final agency action giving rise to judicial review.

IX. FORCE MAJEURE

9.1 Respondent agrees to perform all requirements under this Order within the time limits established under this Order, unless the performance is delayed by a force majeure. For purposes of this Order, a force majeure is defined as any event arising from causes beyond the control of Respondent or of any entity controlled by Respondent, including but not limited to their contractors and subcontractors, that delays or prevents performance of any obligation under this Order despite Respondent's best efforts to fulfill the obligation. Force majeure does not include financial inability to complete the work or increased cost of performance. Respondent shall notify EPA orally within forty eight (48) hours after the event, and in writing within seven (7) days, after Respondent become(s) or should have become aware of events that constitute a force majeure. Such notice shall: identify the event causing the delay or anticipated delay; estimate the anticipated length of delay, including necessary demobilization and re-mobilization; state the measures taken or to be taken to minimize the delay; and estimate the timetable for implementation of the measures. Respondent shall take all reasonable measures to avoid and minimize the delay. Failure to comply with the provisions of this section shall waive any claim of force majeure by the Respondent.

9.2 If EPA determines a delay is or was attributable to a force majeure, the time period for performance under this Order shall be extended as deemed necessary by EPA. Such an extension shall not alter Respondent's obligation to perform or complete other tasks required by the Order that are not directly affected by the _force majeure_.

X. STIPULATED PENALTIES

10.1 Stipulated penalties shall be paid by Respondent, upon notification by EPA to do so, into the Hazardous Substance Response Trust Fund according to the procedures described below. Stipulated penalties shall not apply to any act or omission that is the subject of ongoing dispute resolution under Section VIII of this Order unless EPA determines that the dispute resolution procedures were invoked by Respondent frivolously or in bad faith or for the purpose of delay. Stipulated penalties shall accrue commencing upon Respondent's receipt of an EPA written determination of disapproval, upon the failure of Respondent to meet the schedule specified in Attachment B of this Consent Order, or upon written notice from EPA to Respondent that a violation of this Order has occurred:

A. Failure to submit the following major deliverables and/or perform the following removal actions in compliance with the requirements of this Consent Order, and in accordance with the Schedules incorporated in the Work Plans and Schedule of Deliverables; in the amount up to $500 per day for the first week of violation or delay, up to $1,000 per day for the second week of violation or delay, and up to $3,750 per day for the third week of violation or delay and each day thereafter.

1) Begin Mobilization for Phase 1 project (soil excavation and temporary storage)

2) Complete Phase 1 project

3) Submit draft Work Plan for Phase 2 project

4) Begin Mobilization for Phase 2 project (soil treatment)

5) Complete Phase 2 project

10.2 Subject to paragraph 10.1, EPA may require that Respondent shall pay into the Hazardous Substances Superfund the sums set forth above as stipulated penalties with a copy of such transaction sent to EPA Project/OSC Coordinator. Certified checks or money orders shall be made out to the Hazardous Substances Superfund and specifically reference the identity of the Site and be addressed to:

U.S. Environmental Protection Agency Region 10
Superfund Accounting
P.O. Box 360903M
Pittsburgh, Pennsylvania 15251.

Nothing herein shall prevent the simultaneous accrual of separate penalties for separate violations of this Order. Penalties are assessed per violation per day. Penalties shall accrue regardless of whether EPA has notified Respondent of a violation or act of noncompliance. Respondent must perform the work even if stipulated penalties are assessed.

XI. RESERVATION OF RIGHTS

11.1 Nothing herein shall limit the power and authority of EPA or the United States to take, direct, or order all actions necessary to protect public health, welfare, or the environment or to prevent, abate, or minimize an actual or threatened release of hazardous substances, pollutants or contaminants, or hazardous or solid waste on, at, or from the Site. Further, nothing herein shall prevent EPA from seeking legal or equitable relief to enforce the terms of this Order, from taking other legal or equitable action as it deems appropriate and necessary, or from requiring the Respondent in the future to perform additional activities pursuant to CERCLA or any other applicable law.

XII. OTHER CLAIMS

12.1 By issuance of this Order, the United States and EPA assume no liability for injuries or damages to persons or property resulting from any acts or omissions of Respondent. The United States or EPA shall not be deemed a party to any contract entered into by the Respondent or their directors, officers, employees, agents, successors, representatives, assigns, contractors, or consultants in carrying out activities pursuant to this Order.

12.2 *Except as expressly provided*, nothing in this Order constitutes a satisfaction of or release from any claim or cause of action against the Respondent or any person not a party to this Order, for any liability such person may have under CERCLA, other statutes, or the common law, including but not limited to any claims of the United States for costs, damages and interest under section 106(a) and 107(a) of CERCLA, 42 U.S.C. § 9606(a) and 9607(a).

12.3 This Order does not constitute a preauthorization of funds under section 111(a)(2) of CERCLA, 42 U.S.C. § 9611(a)(2). The Respondent waive(s) any claim to payment under sections 106(b), 111, and 112 of CERCLA, 42 U.S.C. §§ 9606(b), 9611 and 9612, against the United States or the Hazardous Substances Superfund arising out of any activity performed under this Order.

12.4 No action or decision by EPA pursuant to this Order shall give rise to any right to judicial review except as set forth in section 113(h) of CERCLA, 42 U.S.C. § 9613(h).

XIII. <u>CONTRIBUTION</u>

13.1 With regard to claims for contribution against Respondent for matters addressed in this Order, the Parties hereto agree that the Respondent is entitled to such protection from contribution actions or claims to the extent provided by section 113(f)(2) of CERCLA, 42 U.S.C. § 9613(f)(2).

13.2 Nothing in this Order precludes Respondent from asserting any claims, causes of action or demands against any persons not parties to this Order for indemnification, contribution, or cost recovery.

XIV. <u>INDEMNIFICATION</u>

14.1 Respondent agree(s) to indemnify, save and hold harmless the United States, its officials, agents, contractors, and employees from any and all claims or causes of action arising from, or on account of, acts or omissions of Respondent, its officers, directors, officers, employees, agents, contractors, subcontractors, receivers, trustees, successors or assigns, in carrying out activities pursuant to this Order.

XV. INSURANCE

15.1 At least seven (7) days prior to commencing any on-site work under this Order, the Respondent shall secure, and shall maintain for the duration of this Order, comprehensive general liability insurance and automobile insurance with limits of at least one million dollars, combined single limit. Within the same time period, the Respondent shall provide EPA with certificates of such insurance and a copy of each insurance policy. If the Respondent demonstrates by evidence satisfactory to EPA that any contractor or subcontractor maintains insurance equivalent to that described above, or insurance covering the same risks but in a lesser amount, then the Respondent need provide only that portion of the insurance described above which is not maintained by such contractor or subcontractor.

XVI. MODIFICATIONS

16.1 Modifications to any plan or schedule shall be made in writing by the OSC. Minor field modifications to any plan or schedule may be made in writing by the OSC, or at the OSC's oral direction. If the OSC makes an oral modification, it will be memorialized in writing within seven (7) days; provided, however, that the effective date of the modification shall be the date of the OSC's oral direction. Any other requirements of the Order may be modified by mutual agreement of the parties and shall be in writing.

16.2 If Respondent seeks permission to deviate from any approved Work Plan or schedule, Respondent's Project Coordinator shall submit a written request to EPA for approval outlining the proposed Work Plan modification and its basis.

16.3 No informal advice, guidance, suggestion, or comment by EPA regarding reports, plans, specifications, schedules, or any other writing submitted by the Respondent shall relieve the Respondent of obligations to obtain such formal approval as may be required by this Order, and to comply with all requirements of this Order unless it is formally modified.

16.4 If EPA determines that additional response actions not included in an approved plan are necessary to protect public health, welfare, or the environment, EPA will notify Respondent of that determination. Unless otherwise stated by EPA, within thirty days of receipt of notice from EPA that additional response activities are necessary to protect public health, welfare, or the environment, Respondent shall submit for approval by EPA a work plan for the additional response activities. The plan shall conform to the applicable requirements of this Order. Upon EPA approval of the plan, Respondent shall implement the plan for additional response activities in accordance with the provisions and schedule contained therein. This section does not alter or diminish the OSC's authority to make oral modifications to any plan or schedule.

XVII. NOTICE OF COMPLETION

17.1 When EPA determines, after EPA's review of the Final Report, that all work has been fully performed in accordance with this Order, with the exception of any continuing obligations required by this Order, EPA will provide notice to the Respondent. If EPA determines that any removal activities have not been completed in accordance with this Order, EPA will notify the Respondent, provide a list of the deficiencies, and require that Respondent submit to EPA a Work Plan to correct such deficiencies. The Respondent shall implement the new and approved Work Plan and shall submit a modified Final Report in accordance with the EPA notice. Failure by Respondent to implement this approved Work Plan shall be a violation of this Order.

XVIII. SEVERABILITY

18.1 If a court issues an order that invalidates any provision of this Order or finds that Respondent have sufficient cause not to comply with one or more provisions of this Order, Respondent shall remain bound to comply with all provisions of this Order not invalidated or determined to be subject to a sufficient cause defense by the court's order.

XIX. EFFECTIVE DATE

19.1 The effective date of this Consent Order is the date on which it is signed by the EPA Region 10 Chief, Superfund Response and Investigations Branch.

The undersigned representative of Respondent certifies that it is fully authorized to enter into the terms and conditions of this Order and to bind the parties it represents to this document.

Agreed

By Bruce Sheppard

Title Mgr. Environmental Projects

It is so ORDERED and Agreed this 30th day of March, 1993.

BY: Randall F. Smith DATE: 3/30/93

for James M. Everts, Chief
Superfund Response and Investigations Branch
Region 10
U.S. Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

Reply To
Attn Of: HW-113

September 7, 1994

Mr. Bruce A. Sheppard
Manager Environmental Projects
Burlington Northern Railroad
Environmental Engineering
Suite 2000, 999 Third Avenue
Seattle, Washington 98104-1105

Dear Mr. Sheppard:

On July 29, 1994 you submitted to U.S. Environmental Protection Agency (EPA), a proposed revised schedule for completing soil treatment activities at the Woods Site. The schedule you proposed was based on discussions between EPA and Burlington Northern Railroad (BNRR).

According to Section XVI. Modifications of the Administrative Order on Consent for Removal Response Activities at the Woods Site (Docket No. 1087-03-13-106), the Order may be modified by mutual agreement of the parties. EPA has reviewed your proposed schedule and has agreed to modify the existing Order accordingly. EPA has revised Attachment B of the Order to reflect the schedule you proposed in your letter of July 29, 1994. A copy of a revised Attachment B is attached for your records.

Please call me if you have any questions. My number is (206) 553-1987.

Sincerely,

Lynda E. Priddy

Lynda E. Priddy
Environmental Protection
Specialist
Hazardous Waste Division

Attachment

cc: David Eagleton, Burlington Environmental - Columbia
Tom Hippe, BE - Houston
Rick Roeder, Ecology (CRO)
Tom Becker, Preston
Bill Glasser, EPA (HW-113)
Bob Hartman - EPA (SO-155)

ATTACHMENT B

Schedule of Deliverables

	Activity	Deadline
1.	Submit proof of bid award to EPA	August 22, 1994
2.	"EE/CA Addendum" submitted to EPA	August 22, 1994
3.	Submit Draft Soil Treatment Work Plan to EPA	October 7, 1994
4.	BNRR gives contractor notice to proceed with site preparation	December 9, 1994
5.	Startup/Shakedown begins	January 15, 1995
6.	Project Complete/Final Report submitted to EPA	June 30, 1995

<u>ATTACHMENT B</u>

Schedule of Deliverables

	Activity	Deadline
1.	Begin mobilization for Phase 1	March 29, 1993
2.	Complete Phase 1	June 15, 1993
3.	Submit draft completion report for Phase 1	July 15, 1993
4.	Submit draft Scope for Work for Phase 2	Thirty days after effective date of order
5.	Submit draft detailed Work Plan for soil treatment	June 1, 1993
6.	Award contract for soil treatment	30 days after EPA approval of work plan
7.	Begin mobilization for Phase 2	30 days after contract awarded
8.	Complete demonstration test and submit report	45 days after mobilization
9.	Complete Phase 2	1 year from effective data of order
10.	Submit final report	30 days after completing Phase 2

Q

APPENDIX Q

CALCULATIONS

DRE CALCULATIONS

Selected POHC: Hexachlorobenzene

Required DRE: 99.99%

Concentration in Roll-Off Box: 3432.83 mg/kg

Detection Limit: 10 µg /sample

Safety Factor: 10 x Detection Limit ⇒ 100 µg /sample

Sample Volume Required: 106 dscf

Need to have a minimum of 100 µg /sample of HCB in the stack gas in order to show 99.99% DRE.

$$\frac{100\ \mu g}{0.0001} = 1 \times 10^{6}\ \mu g =$$ 1000 mg HCB required in the feed to show 99.99% DRE

The concentration of HCB in the feed for the performance test averages 3432 ppm. Therefore, no spiking of the feed will be necessary.

HCl Analysis

A maximum of 4 lb/hr HCl emissions or 99% control efficiency is required.

Organochloro Compounds	Avg. Conc. in Soil (mg/kg)	Chlorine Percentage (%)	Chlorine Concentration (mg/kg)
Hexachlorobenzene	729.69	74.70	545.08
Heptachlor	0.32	66.48	0.21
Heptachlor Epoxide	0.18	66.48	0.12
Methoxychlor	57.05	30.77	17.55
Chlordane	0.91	69.22	0.63
Aldrin	6.09	58.30	3.55
alpha-BHC	0.73	73.14	0.53
beta-BHC	0.26	73.14	0.19
gamma-BHC	9.78	73.14	7.15
Dieldrin	19.95	55.85	11.14
Endrin	10.83	55.85	6.05
DDD	454.26	50.01	227.18
DDE	51.67	50.01	25.84
DDT	1696.03	50.01	848.18
Toxaphene	109.38	68.00	74.38
		TOTAL	1767.78 mg/kg

Avg. Feed Rate = 20 TPH

Avg. Chlorine Concentration in the Soil = 1767.78 mg/kg

Avg. Emission of HCl (uncontrolled) = $\frac{36.5}{35.5} \times \frac{20 \times 2000 \times 1767.78}{10^6}$ = 72.70mg/kg

The acid gas scrubber utilized by the system will remove in excess of 99% of the HCl.

At 99% DRE, average emission of HCl = (72.70)(.01) = 0.727 lb/hr HCl.

Tier 1 Analysis for Metals

For Tier 1 Analysis of metals, assume the entire concentration of metals in the feed soil bypasses the APCE and is emitted to the atmosphere. If these values are greater than allowable emissions, then stack testing for metals must be performed.

Metal	**Average Concentration in Soil (mg/kg)**	**Metal Emission (lb/hr)(1)**
Arsenic	9.75	0.39
Lead	86.67	3.47
Mercury	6.24	0.25
Antimony		
Barium	369.5	14.78
Beryllium		
Cadmium	6.55	0.26
Chromium	25.02	1.00
Selenium	0.75	0.03
Silver	2.00	0.08
Thallium		

(1) Based on average soil feed rate of 20 tons per hour.

R

APPENDIX R

NOISE EXPOSURE MONITORING

BENCHMARK ENGINEERING

Consulting Engineers and Scientists

Benchmark Engineering Inc.
1550 Pumphrey Avenue
Auburn, Alabama 36830
205/821-9250
Fax 205/821-9765

November 11, 1993

Mr. Mark A. Fleri
WILLIAMS ENVIRONMENTAL SERVICES
2075 West Park Place
Stone Mountain, Georgia 30087

RE: Noise Exposure Monitoring - THAN, Albany, Georgia
Benchmark Project No. 1100-100-110

Dear Mr. Fleri:

Attached are tabulated summaries of the results of noise monitoring efforts for the above-referenced project. Sampling was conducted during the setup and operation of Thermal Processing Unit I (TPU I) at the Albany site; sampling periods ranged from six to nine hours. Both personal and area samples were collected using a Quest M27 Noise Logging Dosimeter. The dosimeters were calibrated daily using a Quest CA-12B calibrator.

Sampling was also conducted to determine the noise level at the site perimeter. For this effort, the ID fan, since it appeared to be the most significant source, was selected as the center point. Monitoring points were then selected around the perimeter of the site as illustrated on the attached figure.

Based on this data, there is no question that a hearing conservation program should be established, and signs posted around some portions, if not all of unit number one. Hearing conservation programs are required by regulation once the 8-hour time-weighted average of employees exceeds 85 dBA. Hearing protection must be provided when the TWA exceeds 90 dBA.

Please review the information and contact me with any questions.

Sincerely,

BENCHMARK ENGINEERING

Roger W. Thompson, CIH, CHMM
Vice President

RWT:ps

Enclosures

Benchmark Engineering Inc.
Riverchase Office Plaza
Bldg. 3, Suite 208
Birmingham, Alabama 35244
205/988-4305
Fax 205/988-5249

Benchmark Engineering Inc.
2075 West Park Place
Stone Mountain, Georgia 30087
404/879-4000
Fax 404/469-0178

Deep South Laboratory
225 Oxmoor Circle, Suite 808
Birmingham, Alabama 35209
205/945-8260
Fax 205/945-0739

WILLIAMS ENVIRONMENTAL SERVICES

PERIMETER NOISE LEVEL ASSESSEMT

THAN SITE, ALBANY, GEORGIA

Benchmark Engineering Project: 1100-100-110

DATE	LOCATION/ GRID POINT	SPL(a)		COMMENTS
10Jul93	N-12s	Void		Monitor not set for community noise.
11Jul93	N-12s	*		Approx. 54 dB Visual readings throughout the day
12Jul93	N-12s	69.3		TPU ran 1st 4 hrs
12Jul93	N-14w	72.9		TPU ran 1st 4 hrs
13Jul93	N-22s	65.4		TPU off/on all day
13Jul93	N-24w	68.7		TPU off/on all day
14Jul93	N-32s	68.9		TPU ran all day
14Jul93	N-0	65.2		TPU ran all day
14Jul93	N-34w	66.8		TPU ran all day
15Jul93	N-44w	61.0		TPU did not run
15Jul93	N-42s	66.1		TPU did not run
16Jul93	N-49.5s	67.3		Towards Hwy.
16Jul93	N-49.5s	65.7		Towards unit
				Total dBA= 69.3
16Jul93	N-0	62.4		TPU ran all day
21Jul93	N-14w	80.2		TPU ran all day
21Jul93	N-12s	68.4		TPU ran all day
04Aug93	N-44w,32s	72.9		TPU down
04Aug93	N-44w,22s	74.6		TPU down
04Aug93	N-44w,12s	66.5		TPU down
12Aug93	N-44w	58.7		TPU up 4:25 comp
12Aug93	N-49.5s,14w	65.4		Facing highway
12Aug93	N-49.5s,14w	65.8		Facing unit
13Aug93	N-34w	70.3		TPU up 1:35 comp
13Aug93	ID fan	91.1		ID fan
13Aug93	Shaker (EZ fence)	91.4		Shaker

WILLIAMS ENVIRONMENTAL SERVICES

PERIMETER NOISE LEVEL ASSESSEMT

THAN SITE, ALBANY, GEORGIA

Benchmark Engineering Project: 1100-100-110

DATE	LOCATION/ GRID POINT	SPL(a)	COMMENTS
13Aug93	N-24w	Void	Dead Battery
13Aug93	N-49.5s,24w	74.5	Facing highway
13Aug93	N-49.5s,24w	74.2	Facing unit
15Aug93	N-14w	103.6	TPU runnning
15Aug93	N-49.5s,34w	Void	Dead Battery
15Aug93	N-49.5s,34w	65.3	Facing unit
16Aug93	N-44s,42w	61.5	Facing RR & Hy
16Aug93	N-44s,42w	65.1	Facing unit
19Aug93	N-44w,42s	66.0	TPU off all day Facing highway
19Aug93	N-44w,42s	63.8	Facing unit
19Aug93	N-44w,12s	44.2	TPU off all day
			TPU off all day
20Aug93	N-12s	67.1	Facing unit
20Aug93	N-12s	77.8	Facing weld shop
20Aug93	N-44w,32s	61.6	TPU off all day
29Aug93	N-44w,12s	65.2	TPU up all night
29Aug93	N-44w,22s	59.4	TPU up all night
29Aug93	N-44w,32s	64.6	TPU up all night
02Sep93	N-42s	60.7	TPU up all day
02Sep93	N-44w,42s	64.4	Facing unit
02Sep93	N-44w,42s	64.3	Facing hwy./RR

NOTES:
(a) SPL = Sound Pressure Level measured as dBA

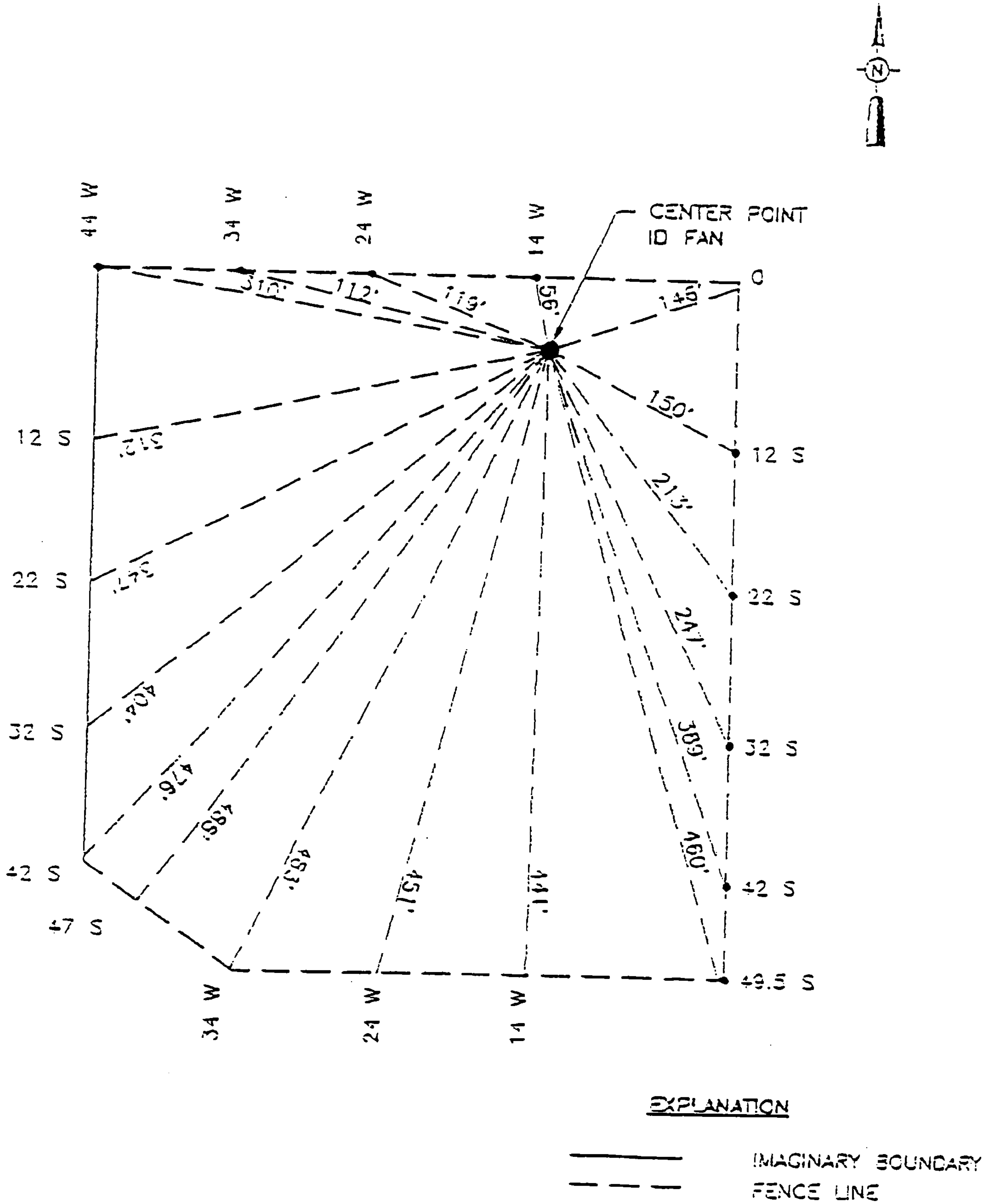


FIGURE NO.	DATE: 8-10-93	TH AGRICULTURE & NUTRITION 1401 SCHLEY AVE. ALBANY, GA.	BENCHMARK ENGINEERING Consulting Engineers and Scientists 1550 HUMPHREY AVE. AUBURN INDUSTRIAL PARK AUBURN, ALABAMA 36830-4599 (205) 821-1050
1	DESIGNED BY: TJR		PROJECT NO.: 1100-100-110
	DRAWN BY: JDM		SCALE:

WILLIAMS ENVIRONMENRTAL SERVICES

NOISE EXPOSURE ASSESSMENT

THAN SITE, ALBANY, GEORGIA

Benchmark Engineering Project: 1100-100-110

DATE	LOCATION/EMPLOYEE	SPL(a) TWA(dBA)	SPL(b) DOSE(%)	COMMENTS
30Jun93	Jason Weed	74.4	11.57	Mobil/set-up
30Jun93	Bob Kelby	78.5	20.27	Mobil/set-up
01Jul93	Lance Keller	83.6	41.0	Mobil/set-up
01Jul93	Art Terrell	79.4	22.96	Mobil/set-up
02Jul93	Wes Richards	75.4	13.24	Mobil/set-up
02Jul93	Leslie Weed/3 hrs Glenn Weed/6 hrs	82.8	36.9	Mobil/set-up
03Jul93	Ivan Richards	82.4	34.8	Mobil/set-up
03Jul93	Jack McClure	78.9	21.45	Mobil/set-up
06Jul93	Jason Weed	77.7	18.15	106 min act run 81.8% proj dose
06Jul93	Art Terrell	80.9	28.32	8-hr dose 29.92%
06Jul93	Bob Kelby	82.0	33.1	Mobil/setup
07Jul93	Leslie Weed	80.7	27.39	TPU ran from 7:45
07Jul93	Lance Keller	void	void	COMPUTER ERROR
07Jul93	Wes Richards	84.9	49.0	TPU ran from 8:10
08Jul93	Jack McClure	80.7	27.54	Mobil/set-up
08Jul93	Ivan Richards	75.1	12.62	Mobil/set-up
08Jul93	Jason Weed	74.1	10.94	Mobil/set-up
09Jul93	Leslie Weed	82.9	37.3	TPU Running 8-hr dose 37.9%
09Jul93	Art Terrell	93.4	160.6	TPU Running Stack Conveyor
09Jul93	Lance Keller	89.0	87.1	TPU Running Feed Conveyor
10Jul93	Jack McClure	82.1	33.2	TPU ran from 7:00
10Jul93	Wes Richards	86.3	59.9	TPU ran from 7:00 Stack conveyor:
11Jul93	Jason Weed	72.6	9.0	Final Set-up

WILLIAMS ENVIRONMENRTAL SERVICES

NOISE EXPOSURE ASSESSMENT

THAN SITE, ALBANY, GEORGIA

Benchmark Engineering Project: 1100-100-110

DATE	LOCATION/EMPLOYEE	SPL(a) TWA(dBA)	SPL(b) DOSE(%)	COMMENTS
11Jul93	Ivan Richards	86.8	63.8	Was wearing hearing protection.
13Jul93	Area--demister	88.9	85.6	Personnel were wearing hearing protection.
19Jul93	Area-Air Compressor	81.3	29.78	Personnel were wearing hearing protection. 96% of the time dBA was 85 to 95.
19Jul93	Area-Stack Conveyor	81.4	30.2	Personnel were wearing hearing protection. 97.3% of the time dBA was 85 to 95.
18Aug93	Area Fr end loader	79.7	23.86	
18Aug93	Area-Stack conveyor	93.0	150.9	Personnel were wearing hearing protection.
18Aug93	Area-Shaker	89.6	94	Personnel were wearing hearing protection.
18Aug93	Area-Shaker	95.0	198.9	Personnel were wearing hearing protection.
18Aug93	Area Fr end loader	87.3	68.4	Personnel were wearing hearing protection.
18Aug93	Area-Shaker	92.7	145.7	Personnel were wearing hearing protection.
21Aug93	Area-Stack conveyor	Void	Void	Wrong setting
21Aug93	Area-Shaker			Wrong setting

WILLIAMS ENVIRONMENRTAL SERVICES

NOISE EXPOSURE ASSESSMENT

THAN SITE, ALBANY, GEORGIA

Benchmark Engineering Project: 1100-100-110

DATE	LOCATION/EMPLOYEE	SPL(a) TWA(dBA)	SPL(b) DOSE(%)	COMMENTS
21Aug93	ID fan area	*	*	Wrong setting
29Aug93				
29Aug93	W. Knox/Stc Cavy	Void	Void	Comp Error
29Aug93	J. Whatley/FMU	82.7	36.3	
29Aug93	J. McClure/Cnt Rm	83.2	39.0	

NOTES:

(a) SPL = Sound Pressure Level Recorded in dBA as 8-hour time-weighted average (TWA).

(b) Values represents the percentage of the allowable dose to which the employee would have been expose had hearing protection not been in place.

S

APPENDIX S

DOBSON COLLAR CUTAWAY VIEW

DOBSON COLLAR

The Dobson Collar is a device developed to allow for the introduction of solid or liquid material into a horizontal rotating drum. The design consists of placing an inner shell within an outer shell known as a Dobson Collar. A chute opening is placed on the Dobson Collar, surrounding the inner shell, allowing gravity to drop the materials into the upper side of the space between the inner shell and Dobson Collar. The inner shell contains a series of openings resembling a waterwheel, that scoop the material from the location between the inner shell and Dobson Collar into the interior of the drum, where it can mix with the existing hot material. As the relatively small flow of material mixes with the hot material that has progressed through the entire drum, it is heated through convection. While this is taking place, the entirety of material is still being heated by the radiant heat given off by the close proximity of the open flame. In this portion of the drum, the material is showered through the air flow; however, the velocity of the air flow is greatly reduced due to the enlargement of the drum diameter, thus minimizing the amount of material carried back through the air pollution control devices.

The purpose of the Dobson Collar on Williams' third operable thermal treatment unit is to allow for the thermal treatment of the baghouse dust. The dusts are re-introduced into the drum near the burner to take advantage of the existing high temperatures. To prevent pulling the fine dusts back into the airstream, the air velocity from the burner flow is reduced by increasing the drum diameter from eight and one half feet to ten feet (see diagram for cutaway view). By increasing the drum diameter, the speed at which the soils move through the drum is reduced, thus increasing the residence time for the baghouse dusts.

Assuming that no further heat is added to the system, the temperature at which the baghouse dust is treated will be approximately 870°F. Of course, the actual temperature will be higher due to the proximity of the burner. This temperature is more than adequate to treat any remaining contamination in the baghouse dust. The following calculation shows how this temperature was determined:

$$M_1\ C_{p,1}\Delta T_1 = M_2\ C_{p,2}\Delta T_2$$
$$C_{p,1} = C_{p,2}$$
$$0.95\Delta T_1 = 0.05\Delta T_2$$
$$19\Delta T_1 = \Delta T_2$$
$$19(900 - \Delta T_2) = (\Delta T_2 - 300)$$
$$\Delta T_2 = 870°F$$

where

M_1 = mass flow rate of soil
M_2 = mass flow rate of baghouse dust
(assumed to be 5% of soil feed)

Assumptions:

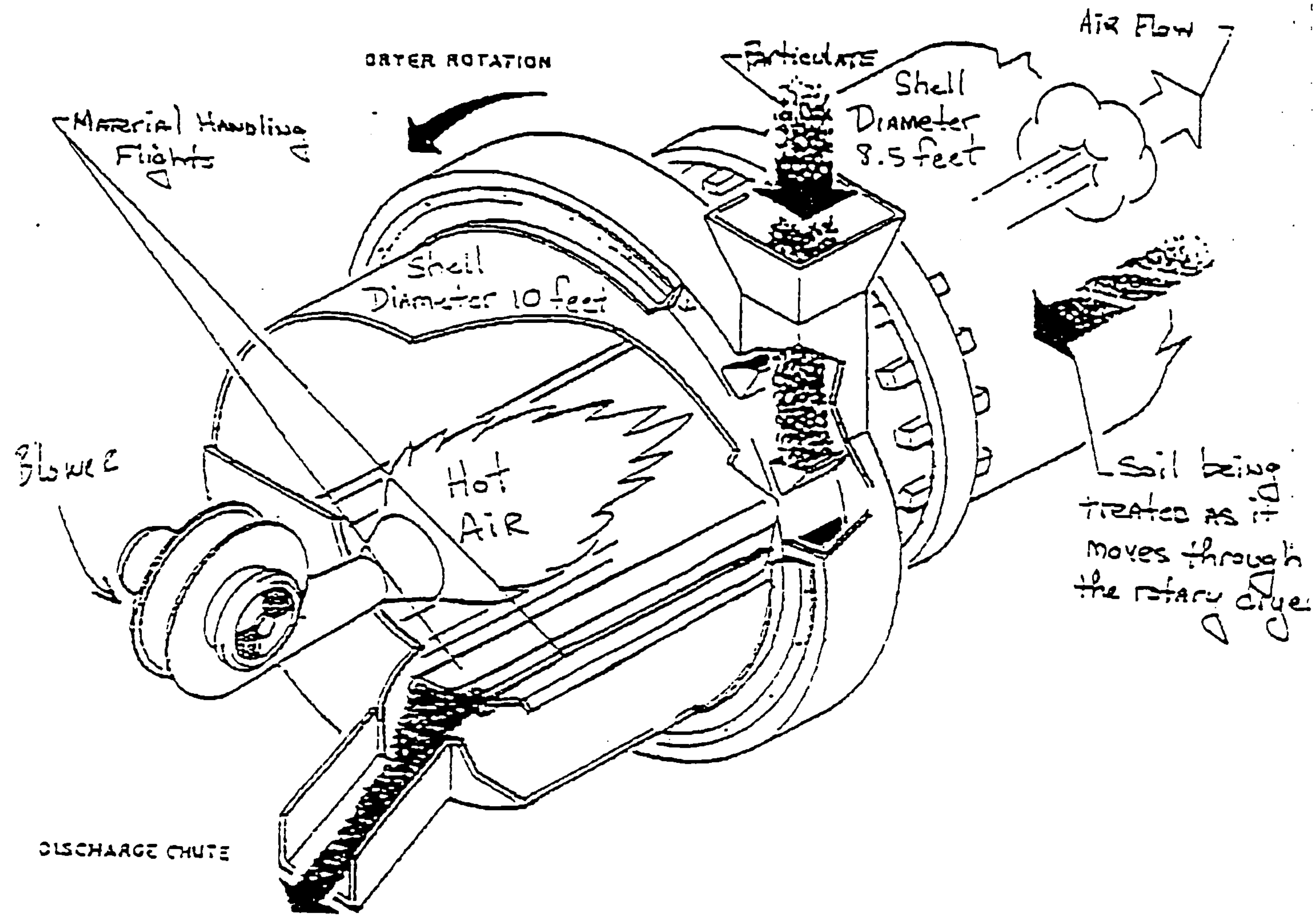
1) Temperature of treated soil = 900°F
2) Temperature of baghouse dust = 300°F

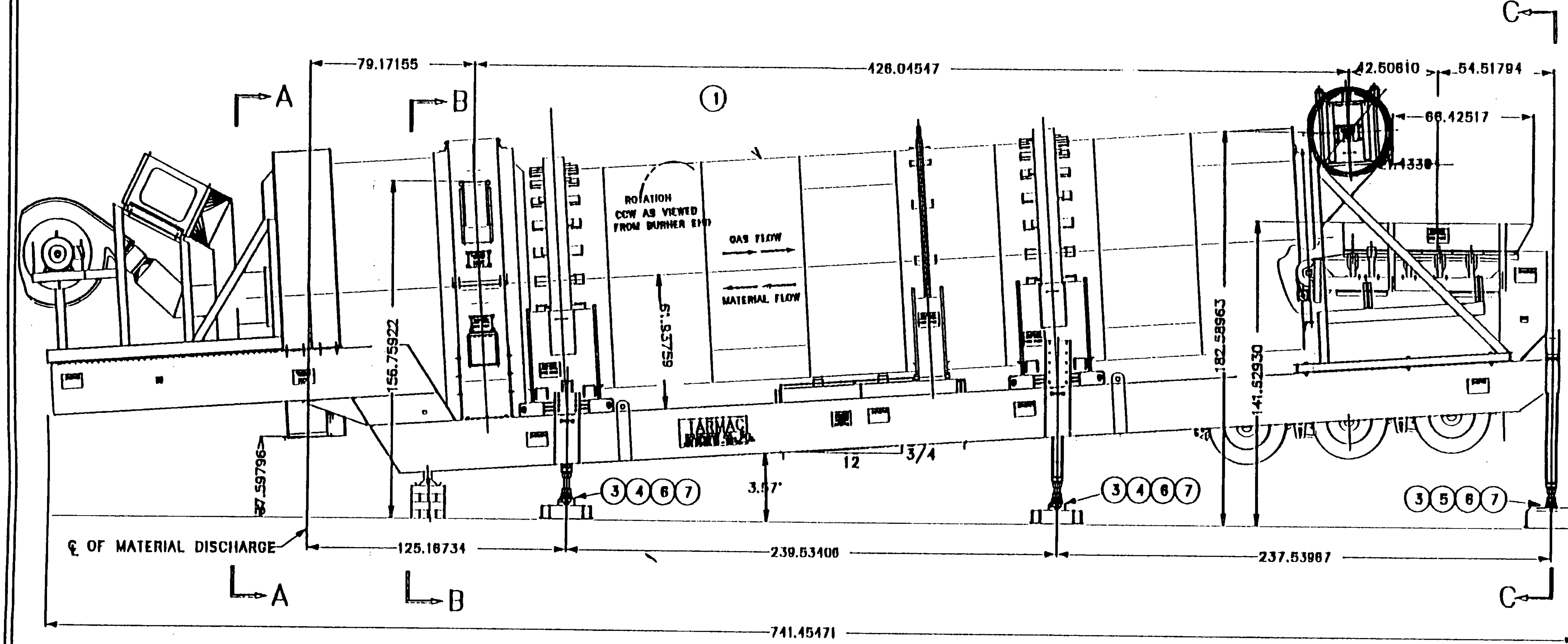
— DRAFT —

— For Discussion Purposes —

Here's a schematic of the "Dobson Collar" design to be implemented on the Woods Project.

— Thermal Desorption with the Dobson Collar —





ITEM	QTY	DESCRIPTION	DWG.	WT.
7	12	HAIR PIN, 1/4" FOR 1-1/2" SHAFT, ISSCO WW CLIP #235		
6	6	RACHET LOAD BINDER, CAMPBELL #620-7805 FOR 1/2" SYSTEM 4 CHAIN		10
5	2	CHAIN, 1/2" SYSTEM 4 WITH CLEVIS GRAB HOOK EACH END, 14' LONG, (CAMPBELL)		39
4	4	CHAIN, 1/2" SYSTEM 4 WITH CLEVIS GRAB HOOK EACH END, 13' LONG, (CAMPBELL)		37
3	6	PIN, STEEL TIMBER CHAIN, 6-1/2" LONG	31-246	3
2	6	PIN, LEG CHAIN, 9-1/4" LONG	31-245	5
1	1	DRYER ASSEMBLY	31-27	96067

TARMAC EQUIPMENT COMPANY

TITLE: DRYER ASSEMBLY, 8' 6" x 40' (SHIPPING WT. 96,400#)

BY	© DATE	SCALE	CADD	DWG. NO.		REV
DRA	1/11/94	1/4"=1'-0"	DRYER	31-272	1/3	0

Williams Environmental
2075 West Park Place
Stone Mountain, GA 30087
404/879-4107 (fax) 404/879-4831

TPU

Drawing Title
Sub-title

DATE 3/31/94
FILENAME 3127201.dwg
3127201

T

APPENDIX T

APRIL 2, 1994 COMMENTS & RESPONSES

May 6, 1994

Ms. Lynda Priddy
Hazardous Waste Coordinator
U. S. Environmental Protection Agency Region X
1200 Sixth Avenue
Seattle, Washington 98101

Subject: Woods Industries Site
Yakima, Washington
Transmittal No.: 0024
Number of Pages: 33

Re: Transmittal of Responses to USEPA Region X
April 14, 1994 Comment Letter on the Work Plan
Williams Project No. 0365-001-110

Dear Ms. Priddy:

In response to U.S. Environmental Protection Agency (USEPA) Region X's April 14, 1994, comments on the Work Plan, dated March 14, 1994, Burlington Northern Railroad (BNRR), through Williams Environmental (Williams) and Burlington Environmental Inc. has prepared this letter and is in the process of revising the Work Plan.

GENERAL COMMENTS ON THE WORK PLAN

Section 3: Process Description

1. Page 17, section 3.2, Feed Processing, last six lines: Prior to "resampling" a failed soil pile, the Work Plan states that the failed soil pile will be " ' recycled' to the waste feed area and placed in piles for further treatment. . . . This 'recycled' feed will not necessarily be stored separately from the 'virgin' feed but . . . feed processed." EPA is not certain what is meant by these statements. Please clarify further. What is the reason for resampling a second time a failed soil pile?

<u>Reply</u>

The last portion of paragraph 3.2 has been re-written to read "If the treated samples pass the clean-up criteria, the soil will not be re-treated. However if the treated soil samples fail to meet the clean-up criteria, the treated soil pile will be re-sampled using a composite of several grab samples. If the composite samples pass the clean-up criteria, the soil will not be re-treated. However, if the second sampling event demonstrates that the treated piles fail to achieve the clean-up criteria, these treated soils will be re-treated. The failed pile will be moved from

2075 West Park Place Stone Mountain, Georgia 30087 404/879-4107

the verification holding area to the wastefeed stockpile area. The failed pile will be treated as the production schedule allows. The amount of re-treated material will be deducted monthly based on the production sheets. (One pile represents one day's production.)"

2. Page 18, 1st full paragraph: this is an appropriate location to add some discussion about how the Dobson Collar will work. Additionally, some discussion should be added to page 21, section 3.5.5 and page 24, 4th paragraph. Added information to appropriate sections should address: residence time, feed control, expectations, etc.

Reply

Appendix U has been added to include the correspondence and drawings submitted to date. The text has been revised to reflect the above comment.

3. Page 20, 4th full paragraph: " . . . hauling soils to secondary stockpiles as is shown in Figure 12-1". Figure 12-1 could not be located. Is it Figure S-1? Figure S-1 does not identify a secondary pile. Is it the same thing as the waste feed stockpile or is the secondary stockpile different?

Reply

Figure S-1 is Figure 12-1. The drawings will be revised to show Figure 12-1. The secondary stockpile is the same as the wastefeed stockpile. The document will be revised to reflect wastefeed stockpile.

4. Page 20, 2nd to the last sentence: While the carbon can treat the water, what about the "sludgy" material that settles out from the water in the sumps? This questions also applies to the "sludgy" material that may result from cleaning off the pad during decon. Carbon treatment will probably not work for waste rich in particulate material. Will you have a settling tank?

Reply

The "sludgy" material that settles from the water in the sumps is removed periodically, mixed with the contaminated soil and processed through the thermal desorption unit. The sump pumps are positioned 2" to 6" off the sump bottom to prevent clogging of the pumps with sludge and to prevent large amounts of solids from being carried over to the water treatment system. The sump water and blowdown water are pumped to a frac tank to allow additional time for settling prior to being filtered (200 µm filter maximum) and treated by the carbon units for use as process water. Page 27 of the workplan has a brief summary of the water treatment system.

5. Page 20, 3rd full paragraph: How will contaminated debris be distinguished from clean debris?

Reply

The approach is the same as that used during building demolition and soil removal activities. A paragraph will be inserted on page 20 and will read as follows:

The ultimate fate of the debris found at the Woods Site will be limited by the individual material's character and degree of contamination. Where appropriate, the material will be re-used or recycled. No visibly contaminated material will be recycled or disposed of in a sanitary landfill or municipal landfill. If the material is believed to be contaminated based on visual observation, the material will be cleaned, if practical, or disposed of at a facility permitted to accept the waste as appropriate.

6. Section 3.5 add quench water to the list of residual streams.

Reply

Scrubber water blowdown is the same as quench water and is listed in paragraph 3.5.

7. Westates is presently out of compliance and is not acceptable as a location for accepting the spent carbon until they are in compliance. BNR[R] may want to locate some other alternative disposal facilities that are in compliance.

Reply

Westates has another facility located in Morgantown, West Virginia. According to Westates, the Parker, Arizona facility had another inspection which was conducted by Region 9 of the USEPA and found to be in compliance.

8. Section 3.5.3 Run-off Water: Water from run-off will be collected in modu-tanks, how will that water be transferred to the carbon waste water treatment equipment?

Reply

The text has been revised to read " . . . stored in three frac tanks . . . . This is consistent with Figure 12-1. Water will be transferred via pumps and piping. The process flow for this operation is included in Figure 3-1.

9. Section 3.5.3 Run-off Water: Language should be added to this section that states that carbon-treated run-off water will not be used to control dust from treated soil or condition treated soil AFTER that soil has been sampled and determined to comply with cleanup levels. For soils that have already been confirmed as meeting cleanup levels, only city water may be used for dust control and conditioning of these soils.

Untreated run-off water may not be used for dust control or conditioning associated with ANY treated soils. What will be used for dust control on haul roads?

Reply

Section 3.5.3 has been revised to concur with this comment. City water will be used as a dust control on haul roads.

10. Section 3.5.4 Scrubber Water Blowdown: Similar to the above comment, only city water can be used to condition soil or control dust on treated soils that have already passed confirmatory sampling and been shown to meet cleanup levels. This paragraph should state as such. This requirement is based on the assumption in the work plan that sampling of the treated water is not necessary because "acceptability is determined by the criteria that it does not affect treated soil quality (pg. 21 section 3.5.3).

Reply

Section 3.5.4 has been revised to concur with the above comment.

11. Section 3.5.5 Baghouse Dust: This section does briefly discuss the Dobson Collar, however, somewhere in the work plan a more detailed discussion should be made that explains the length of the residence time and how it was determined, the impact of the decreased air velocity, how the baghouse will be receiving "full, controlled treatment", how the baghouse feed will be controlled back into the dryer, etc. Additionally, a mechanical drawing or engineering diagram of the collar should be included. Additionally, page 24 of the Work Plan, Thermal Desorber section is a place that a detailed discussion of the Dobson Collar should appear.

Reply

Appendix U has been added to include additional information about the Dobson Collar. The text has been revised to reflect the above comment.

12. TPU3, Process Flow Diagram: In this diagram, oversized materials are specified as going to off-site disposal. Disposal depends on sampling results. As agreed, if sample results are below clean-up levels, then the cobbles can be disposed on-site. If data shows that the cobbles will be disposed on-site, please correct this statement.

Reply

The Process Flow Diagram has been revised to reflect the above comment.

13. Page 51, Table 7-2: Add nickel to the list of metals. What about Table 7-3 starting on page 53.

Reply

Nickel has been added to Table 7-2. Nickel was not analyzed for during RI/FS.

Section 4: Equipment Description

1. Page 23: EPA would like more information about the equipment used to separate the cobbles, e.g., how is it designed and will it be on the pad? The Agency is concerned that the undersized cobbles and fines could fall off the separator and on to the ground instead [of] entering the feed mechanism?

Reply

The screening operation will either be done on the wastefeed pad or in the immediate area of the pre-existing stockpiles so as not to contaminate any additional areas. The screening equipment will be selected upon approval of the work plans. This machine will be leased from local vendors in the area.

2. Page 24; 1st eight lines: This paragraph discussed engineering controls to minimize dust emissions. However, specifics regarding the use of engineering controls are not provided. EPA understands that BNR intends to use water to control dust that may be generated from haul roads or the stockpiles. However, what engineering controls will be used to control dust that will be generated from, unloading soils from the front end loader, the screening process to separate cobbles and the feeding of soil into the treatment unit. EPA and BNR have briefly discussed these concerns but at present these concerns are still unresolved. BNR has agreed to find out more about the construction of the screening equipment and feed conveyor, for example, can the conveyor be covered or is it constructed to mitigate effects from wind?

Reply

The text has been edited such that engineering controls have been changed to administrative controls such as speed limits, and covering dump trucks during transport, if necessary. One additional sentence was added to the last line of the paragraph and reads as follows: "Depending on the site conditions, engineering controls such as Williams covering conveyors and screens for the feed handling equipment will be implemented upon agreement between Williams, Burlington Environmental, BNRR and the EPA."

3. Page 26, Quench Tower section: This section states that the blowdown water will be treated by the unit's wastewater treatment unit. The Process Flow Diagram TPU3 does not show quench water entering the wastewater treatment unit.

Reply

The Process Flow Diagram shows the blowdown line leaving the quench tower and scrubber.

Section 5: Project Schedule

1. Page 34 and Figure 5-1: The time frames described in these 2 pages appear to contradict each other.

Reply

Page 34 has been revised to reflect the schedule in Figure 5-1.

2. Page 34, 4th paragraph, last sentence: Add "interim" after "performance test" and before "and normal."

Reply

The text has been revised to reflect this comment.

3. Page 34, 4th paragraph, 1st sentence: add "only the" after "roll-off boxes, including."

Reply

The text has been revised to reflect the above comment.

Section 6: Process Control, Monitoring, and Emergency Procedures

1. page 40. n: Where does the solids from inside the scrubber go?

Reply

Solids from the scrubber will be blown down and/or vacuumed from the unit and processed through the thermal desorber. No addition to text.

Section 7: Performance Criteria

1. Page 49, clean-up goals and Table 1-1 in the Performance Test Plan: Do not round off the numbers. Use the number as specified in the MTCA Method B Tables.

Reply

The table will be modified to agree exactly with MTCA Method B Tables.

2. Page 51, add dioxin and furans to the list of PICs.

Reply

These compounds have been added to Table 7-2.

3. Page 51, footnote 2: provide the data as an addendum to the Work Plan or future revisions.

Reply

TIER I and TIER II levels are shown in Table 7-3 on pages 53 and 54.

Section 8: Performance Test Plan

1. Page 58, 2nd paragraph, last sentence: The Work Plan specifies that the independent oversight [stack testing] contractor's qualifications will be submitted for EPA review and approval. When will this information be provided?

Reply

The stack sampling contractor's qualifications will be submitted after the approval of the work plan and performance test plan so that competitive bidding can be performed for contracting purposes.

2. Pages 60 and 61: These two tables specify that sampling locations are the "discharge screw conveyor or treated soil." Note that samples should not be taken before soil conditioning with treated water has occurred.

Reply

Sample points from either the discharge screw conveyor or treated soil stockpiles occur after soil conditioning has occurred.

Section 12: Mobilization

1. Site Layout Map - The boundaries of the exclusion zone and the support zone are not clear. For example, does the support zone include everything not in the exclusion zone? Does this mean that the proposed verification holding area and the contaminated stockpiles are not in an exclusion zone but rather a support zone? The lines defining the exclusion zone are difficult to differentiate from other lines on the map. We assume the exclusion zone includes all the equipment the waste feed stockpile area and the verification holding area (as opposed to the proposed verification holding area at the south end of the site). If this assumption is correct, workers involved in hauling

contaminated dirt or are in close proximity to the stockpiles should wear appropriate protective equipment. Other people should be prohibited from these areas.

Reply

The exclusion zone includes the following: wastefeed stockpile, the portion of the equipment pad supporting the dryer and baghouse, and the treated soil verification holding area. The support zone includes the area adjacent to the exclusion zone, including the equipment pad for the oxidizer, quench/scrubber and frac tanks. Excavation areas will be considered to be exclusion zones as well. Revisions have been made to Figure 12-1 to more clearly define the exclusion zone.

2. Haul roads, material handling areas and traffic flow patterns should be identified on a similar map. A plan describing the sequence of moving soil from the stockpile areas to the treatment unit should be provided. Are you planning on completing the treatment of the north pile before starting on the south pile or are you considering doing the south pile first?

Reply

Hauling routes are shown on Figure 12-1. All material handling operations will take place on the wastefeed material pad. Williams proposes to begin hauling soil for treatment from the south stockpile. This material will be stored on the wastefeed pad to await processing by the unit. After the soil has been treated and verified to meet clean-up levels, it will be used to begin backfilling the excavation area directly behind the Ackland Building. Williams plans on completing treatment of the north stockpile first to enable additional soil removal activities to begin from under the storage area.

3. Does the proposed verification holding area in the south end of the site have a different purpose than the verification holding area located near the treatment unit? Is there going to be a pad to prevent run-off and an underlining to prevent contamination in the proposed verification holding area? How do you plan to keep holding piles separate, especially piles being held pending sample results from piles that require re-treatment because they failed to meet cleanup levels? Is there adequate space to hold all piles on the holding area near the equipment or is overflow expected to end up in the proposed verification holding area?

Reply

The verification holding areas (north and south) serve the exact same purpose - to hold treated stockpiles pending analytical results. There will be a pad to prevent run-off, but no underlining. Stockpiles will be kept separate by visual observation. Piles will be kept in the verification holding area until analytical results indicate the piles have passed the clean-up criteria.

4. Are you going to be using an oxygen supplement? If so, it should not be stored near the gas supply.

Reply

Williams will not be using an oxygen supplement.

5. Where is figure 12-1? Is it S-1? Figure numbers and references to figures in the text do no always match.

Reply

See comment #3 of Section 3. No addition to the text.

6. Only one fire hydrant is identified on the Site Layout. It is located outside the fence line. Will it be accessible from inside and outside the fence? Are other hydrants located on-site to be used for emergencies? Other hydrants should be identified.

Reply

One fire hydrant is located just north of the main entrance gate outside the fence. Another fire hydrant is located on-site just southwest of the Akland office building, which is accessible from on-site only. Both fire hydrants are accessible for use in case of an emergency.

7. The Site Layout only shows one access point into the site. I believe there is also one on the north end of the site, but it is not shown. Will this access be used and for what purposes? There should be some access on the south end of the site for emergency exits.

Reply

There are three (3) access gates to the site. There is one along the north fence line at the northwest corner of the site. There is one along the south fence line at the southwest corner of the site. The eastern gate is the main gate which will be used for general delivery and parking. This can be seen in Figure 12-1.

8. The location of the personnel decon is in an inconvenient location for leaving the exclusion zone and entering the support area, leaving the site or entering the office area. It should be better located.

Reply

Figure 12-1 will reflect the addition of a decon unit. The decon trailer has been located adjacent to the control trailer. See revised figure 12-1.

9. How will the public be handled? Can they enter the office or the support area? What about deliveries to the site? How is access controlled? A security booth should be located at the east access to the site.

__Reply__

See Section 10, page 62 of the work plan. No addition to the text.

10. Will haul roads be cleaned automatically or is BNR going to sample first? Will the roads could be scraped with the earth moving equipment and then treated in the thermal unit? If BNR is going to sample first in lieu of scraping, EPA will need to review and approve a sampling plan for the haul roads.

__Reply__

Two composite samples will be collected of surface soils in the areas used for haul roads. One composite sample will be collected from roadways north of the feed processing area and one composite sample will be collected from roadways south of the feed processing area. Each composite will be formed from three (3) aliquots collected from stations evenly spaced along the roadway. Analytical results will be compared to the clean-up levels for p,p'-DDT, hexachlorobenzene, DDD, DDE, and dieldrin developed for the site and used during soil removal activities. Should analytical results indicate a roadway containing concentrations above the clean-up level for any of these parameters, the roadway will be cleaned and re-sampled for verification purposes.

11. How will run-off from the haul roads and storage areas (south holding area) be handled?

__Reply__

Provisions for run-off from the haul roads are not being considered because dump trucks will be used to transport the contaminated material to the wastefeed area. Precipitation is generally light, with the rate of evaporation exceeding precipitation. If necessary, the treated stockpiles in the south verification holding area will be covered to prevent water from coming in contact with the piles.

12. On TPU #3 Soil Remediation Unit - General Arrangement the guy wires specify 10 degrees of rotation. What does this mean?

__Reply__

Two of the guy wires have been rotated 10° off-center so that they would fit the site constraints and unit configuration.

13. How are the pads constructed? Do they overlap with existing concrete pads such that seams may be present or will new concrete be pored over the existing concrete surface? Our concem is that the seams could leak. A detailed plan of the pad is needed e.g., ensure liquid containment, are expansion joints going to be used? Where will the sumps be located? How are you going to be catching drippings from equipment?

Reply

New pads will be poured over the existing concrete pads where appropriate (either concrete or concrete/asphalt). Pad details have been submitted to the USEPA. Drawings of the pad are shown on Figures 12-3 and 12-4.

14. Discuss the precautions that will be taken to protect the public and workers in the area from hazards associated with the construction of the unit on-site.

Reply

Precautions taken during construction of the unit on-site are outlined in Section 6 of the Site Specific HASP. The public will not be at risk during this time.

15. There is some lack of consistency between the language used in the text and that used on diagrams, for example, the text refers to "treated" and "untreated piles" while the diagram specifies "verification areas". Also, is the interim storage area the same as the "verification holding area"?

Reply

Figure 12-1 has been corrected to identify treated soil verification holding areas. Interim storage area is the same as verification holding area. The text has been revised to reflect the above comment.

16. The text refers to the vehicle entrance while the diagram does not identify one.

Reply

The vehicle entrance is identified as the main gate in Figure 12-1. No addition to the text is required.

17. BNR is apparently responsible for sampling undemeath the stockpiles and the haul roads. However, who is responsible for cleaning up the pad and haul roads (assuming they are found to exceed cleanup levels?)

Reply

The pad will be cleaned by pressure washing as outlined in Section 12.5, page 69 of the Thermal Desorption Work plan. All water will be collected in the sumps and treated. Haul roads will be cleaned as necessary and as directed by BNRR in agreement with the EPA.

18. What are your plans for vehicle control and parking?

Reply

Only vehicles needed for operations on-site will be allowed within site boundaries. Parking will be available for a limited number of vehicles directly in front of the Ackland Building. No addition to the text is required.

19. What is the design of the decon equipment pad? Is this the best location for it? How will run-on and run-off be controlled?

Reply

Williams' equipment will be decontaminated on the equipment pad to be constructed. The equipment decon pad shown in Figure 12-1 is an existing pad from the previous removal/remedial action. All water collected will be pumped to the frac tanks prior to carbon treatment.

20. Where will the pressure cleaning be done? How will that area be cleaned?

Reply

Pressure cleaning of the equipment will be done on the equipment pad. The pad, as per page 69, paragraph 2, will then be given a final cleaning by high pressure wash. All water will be collected in the sumps and treated.

21. Page 68, section 12.5, Pad and Equipment Decontamination, 2nd paragraph: What happens with the soil residues removed from the unit?

Reply

Soil residues are removed from the unit by heating the soil to approximately 800°F for one hour, as per paragraph 3, Section 12.5, page 68. Residues exiting the unit are handled as treated soils and removed to the interim storage area for subsequent analysis.

22. Page 68-9, section 12.5: The sequencing of the decontamination of the thermal unit and work areas is not clear. This process should be listed in steps. Where will the remaining soil and baghouse residues go? How will the remaining residual material be

treated if the equipment is being cleaned out? What will happen to soil collected during the decontamination and dismantling process? How will it be disposed of?

Reply

Decontamination Sequence:

- Operate unit at 800°F for one hour to treat and remove all remaining soil residue. Any remaining baghouse dust is fed into the Dobson Collar for further treatment prior to discharge. All soils exiting the unit are removed to the interim storage area for subsequent analysis. All soils and sediment collected from the work pad will be processed through the unit.

- Clean interior of scrubber of any residues. Test residues for contamination and process accordingly.

- Pressure clean feed system and stacking conveyor and dismantle.

- Pressure clean screw conveyor and remove.

- Wash and pressure clean exterior of rotary dryer and baghouse. The interior of the baghouse will be free of residues because of its pulse jets of compressed air.

- Clean the exterior surface of the quench.

- Wash and pressure clean exterior surfaces of remaining equipment.

- Disassemble equipment.

- The containment pad will be given a final cleaning by high pressure wash.

- All decon water will be collected and treated on-site by activated carbon adsorption.

23. Page 69, 2nd and 3rd paragraph: A "decontamination (or interface) trailer" is mentioned but does not appear on the site diagram. The text mentions 2 access gates. These do not appear on the site diagram. What are normal operating hours? How will the entrance be controlled? How will people be kept from just wondering on-site?

Reply

A decon trailer is not mentioned on page 69, paragraphs 2 & 3, but will be included on Figure 12-1. Security and site access are detailed in Section 10, page 62. Four (4) access gates will be shown on Figure 12-1. Normal operating hours will be 24-hours per day.

24. Page 69, 1st full paragraph, 2nd sentence: delete "if necessary".

Reply

No

25. Page 69. Has Williams obtained the City of Yakima wastewater discharge permit?

Reply

No. Water would need to be collected and sampled prior to obtaining a city discharge permit.

Section 14: Health and Safety

1. Page 71: Who is the Health and Safety Officer?

Reply

No Health and Safety Officer has been assigned to this project yet. No addition to text.

Section 15: Project Quality Assurance/Quality Control

1. Page 74: What labs are going to be used?

Reply

No lab has been selected yet; however, Williams will submit the selected laboratory Qualifications and Experience and their Quality Assurance plan when a lab has been selected. Selection of the lab will be made after the workplan and performance test plan approvals and the work required goes out for bid. No addition to text.

Section 16: Remedial Action Plan

1. Page 78, number 5: add the EPA OSC name and telephone number and the EPA Technical Advisor. They are as follows: Lynda Priddy (206) 553-1987 and Cathy Massimino (206) 553-4153, respectively.

Reply

Text has been revised to reflect above comments.

Appendix A: Performance Test Plan

1. Table 1-2: I believe Ecology has a new ASILs for DDD [DDE]. That number should be used.

Reply

The ASIL for p'p'-DDE will be added to Table 1-2.

2. QA/QC procedures and plans for additional excavation under the north and south stockpiles should be supplied.

Reply

This additional excavation does not affect the Performance Test Plan.

QA/QC procedures and plans for additional excavation under the north and south stockpiles are the same as those used and approved by the EPA for soil removal activities and are described in the Soil Removal Work Plan, dated March 17, 1993.

3. Figure 3-3: Sampling spot 5 is not described on page 3-13.

Reply

No sampling is planned at this location. Figure 3-3 will be modified and the sampling location removed.

4. Table 3-6: Add to the procedures that samples should be taken after the treated water is added to the soil for conditioning or quenching.

Reply

The procedure will be clarified in Table 3-6.

5. Pages 3-22 and 3-23: Nickel should be listed with the other metals.

Reply

Nickel is listed on both pages. No addition to text.

Attachment 1: Quality Assurance Project Plan

1. Table 5-1: What about samples for metals in treated soil?

Reply:

Specifying samples for analysis for metals in the treated soil on Table 5-1 was inadvertently omitted. The table will be modified.

Cathy Massimino's Comments

General Comments

1. The modifications to the thermal treatment process to address the baghouse dust treatment (e.g., Dobson collar, dust feed rate monitoring mechanism, setting AWFCO for maximum dust feedrate, engineering drawing and equipment descriptions including the Dobson Collar, heat balance, etc.), need to be cohesively added to the workplan. Except for indications on some of the figures (e.g., Figure 3-1, etc.) the document does not describe or reflect the necessary revisions to incorporate this modification. The revisions are expected to be reflected in the narrative, tables, figures and appendices.

Reply

The baghouse dust feed rate is a direct function of the waste feed rate that will be an AWFSO. The performance test will be run using "worse-case" material from the site and soil cleanup criteria will be demonstrated. Return rate of baghouse dust will always be a similar percentage of the waste feed. The volume of baghouse dust is estimated to be less than 5% of the feed volume and will be controlled by the feed rate. Separate measurement is not necessary since sampling of the treated soil will be done on a routine basis during normal operation throughout the site cleanup. However, during shakedown, Williams will incorporate a solids flow meter to measure the flow of baghouse dust to the Dobson Collar. If the device doesn't work as expected, the EPA will relieve Williams of the AWFSO requirement on baghouse dust flow for the remainder of the project. No addition to the text is required.

2. Any additional revisions to this document should be provided in the form of revised pages. It is also recommended that the pages be annotated to reflect the changes.

Reply

The text has been revised to reflect the above comment.

Specific Comments

1. The baghouse was not listed in mass balance, but its particulate removal was accounted for.

Reply

The "kiln off-gas" outlet and "secondary off-gas" are shown on the heat and mass balance to account for the particulate removal from the baghouse. No addition to text.

2. Page 19, revised to reflect that >2" material will be screened out while page 25 [23] still reflects 3".

Reply

The text has been revised to reflect the above comment.

3. Page 35, should reflect that authorization for full production will be based on the final performance test report including the risk assessment addendum.

Reply

The text has been revised to reflect the above comment.

4. Figure 5-1, still does not reflect interim operation.

Reply

Interim operation is reflected in the production schedule.

5. Page 36, §6 should reflect feedrate monitoring and recording on a per minute frequency not per hour.

Reply

Monitoring and recording is on a per minute basis. The units are on a unit per hour basis.

6. PIDs and Table 6.2, only some of the AWFSO parameters are reflected with pre-alarms to alert the operator of a problem so it can be corrected before it goes outside of the acceptable limits. It is strongly recommended that all AWFSO parameters have pre-alarm limits set.

Reply

The PID drawings and Table 6.2 have been checked for accuracy and correlated accordingly. Williams is currently reviewing control philosophy and making

recommendations for engineering pre-alarm limits for various AWFSO parameters.

7. Pages 38-45, should be reviewed for consistency with pages 3-18 and 3-19 of the performance test plan (Appendix A).

Reply

The text has been revised to reflect the above comment.

8. Page 38, item e, should reflect that an instantaneous desorber off-gas temperature of 450°F will result in waste feed shut-off. The concept of totally shutting down the desorber and the thermal oxidizer if maximum temperature are exceeded, is a matter grave concern. The fuel should be cut back as necessary to return to a safe operating mode maintaining the system within required operating temperatures while waste is still within the system. The AWFSO's apply at all times while waste is within the system.

Reply

It is implicit in the operation of the burner management package that if the burner is shut down an AWFSO results. See Table 6.2, page 45. A response for this comment has been inserted into the text and reads as follows:

A thermal oxidizer temperature of approximately 1800°F (permit condition) has been selected. If the temperature rises above 2000°F, the operator will manually begin to decrease the fuel to the burner. If the temperature is still increasing and exceeds 2100°F then the thermal oxidizer burner will be shut-down causing both an AWFSO and primary burner to be shut down, also. The 2100°F limit is to protect all down stream equipment.

9. Page 38, item c, should reflect a feedrate in pounds/minute, and include an instantaneous feedrate AWFSO limit.

Reply

The read out of the present scale is in tons/hour. Williams will add an instantaneous high feed rate AWFSO limit. The AWFSO limit will be determined during the shake down and performance test period.

10. Page 39, item g, should also reflect an instantaneous low soil temperature cut-off.

Reply

No. See response #15(1).

11. Page 39, item h, should also reflect an AWFSO.

Reply

The text has been revised to reflect the above comment. See also Table 6.2, page 49.

12. Page 40, items s. and q, and Table 6.3, a demonstration of whether a back-up emergency generator is necessary needs to be addressed.

Estimated risks associated with power failure causing a shut down of the unit are presented in the revised AAQIR. The conclusion is that a backup generator is not required.

13. Page 41, item v. the AWFSO for these parameters will initially be set during clean soil shakedown. These limits must be accepted by the Agency prior to start-up with contaminated soil. Final limits will be based on the performance test.

Reply

Williams concurs. No addition to the text is required.

14. Table 6.1, pages 42-44, this table incorrectly reflects only exceedences of the CO limit as an AWFSO. Also, needs to be revised to reflect CO corrected to 7% O_2 and revised range of 3000 ppm.

Reply

The text has been revised to reflect the above comment.

15. Table 6.2, need to revised as follows:

1) Include thermal desorber exit soil temperature instantaneous minimum limit and reflection that soil temperature parameter does not apply during first 20 minutes a after start-up.

Reply

During our meeting of February 2, 1994, it was discussed that either gas temperature or soil exit temperature would be used as an AWFSO. Williams has chosen the soil exit temperatures to be used to initiate the AWFSO based on a 20 minutes rolling average. A twenty minute delay has also been agreed to for the first twenty minutes of starting to allow one retention volume of soil to approach the thermocouple. Williams disagrees with an instantaneous AWFSO for low soil temperature. Again, if there is a stoppage of feed for several minutes, that stoppage of feed will be seen as a low temperature one retention time volume

later. If instantaneous feed AWFSO is initiated, the unit would be forced down because no soil was passing over the thermocouple. Therefore, Williams respectfully requests that no instantaneous AWFSO for low soil exit temperature be imposed.

2) See comment 13, above for packed bed scrubber flowrate, APC purge rate, and stack gas flowrate.

Reply

Williams concurs. No addition to text is required.

3) See comment 9, above for the thermal desorber maximum feedrate.

Reply

No.

4) Footnote 4 should also reflect recorded continuously except for ID Fan Failure, Power Failure, Loss of water to Quench.

Reply

The text has been revised to reflect the above comment.

16. Pages 48-49, needs to be amended to include dioxins and furans.

Reply

One sample of the treated soil will be collected for dioxin and furan analysis during each run of the performance test, for a total of three samples. The samples will be composited from 15-minute grab samples collected during the testing. These results will be compared to the levels agreed to between BNRR and the EPA.

17. Page 51, needs to be amended to include nickel and dioxins and furans.

Reply

The text has been revised to reflect the above comment.

18. Table 7-3, needs to be evaluated in conjunction with the risk assessment/air quality document. It is assumed that these documents will address the site specific dispersion modeling for the compounds that failed the Tier II analysis, as well as performance of a total risk evaluation versus per compound. Also, the level of free chlorine should be assumed to be 20% of the HCl level.

Reply

The revised AAQIR addresses site specific dispersion modeling for compounds that failed the TIER II analysis as well as performance of a total risk evaluation versus per compound. The assumption regarding free chlorine has been incorporated into the revised AAQIR. All values are less than TIER III limits.

19. Page 74, indicates data from Kaye data logger will be used to fill out the roundsheet. According to page 3-5 of the performance test plan, Appendix A, certain AWFSO parameters (e.g., baghouse pressure, packed bed pH, stack gas flow indicator) are missing from the data logger. The data logger must be upgraded to continuously record all AWFSO parameters, as well as indicating when a parameter has exceeded its AWFSO limit. Provide an example print-out from the Kaye data logger with the AWFSO parameters for this project.

Reply

The description on page 3-5 of the performance test plan will be changed to reflect the comment. All parameters with AWFSOs will be continuously recorded. An example of the print-out form from the Kaye will be provided when it is programmed specifically for the Woods project.

Appendix A

1. Page 1-2, revised first bullet to address dioxins and furans. Also, replace discussion on what will occur if standards are not met.

Reply

One sample of the treated soil will be collected for dioxin and furan analysis during each run of the performance test, for a total of three samples. These results will be compared to the levels agreed to between BNRR and the EPA. There is no discussion on page 1-2 on what will occur if standards are not met.

2. Page 1-3, discussion on PIC needs to clearly state that meeting acceptable risk limits is one of the performance standards which must be met for the performance test to be deemed successful.

Reply

A general statement has been made as requested.

3. Pages 1-3, 3-12, 3-13, and Table 3-4, should provide the correct EPA method numbers for all the sampling protocols.

Reply

Addition of the appropriate method numbers will be made as follows:

- Particulates, hydrogen chloride, and chlorine using EPA Method 5 sampling train modified for the collection of acid gases (BIF Method 0050)
- OCL Pesticides and Semi-volatile Organic using EPA Modified Method 5 sampling train (SW-846 Method 0010)
- Volatile organics by Volatile Organic Sampling Train (VOST SW-846 Method 0030)
- Metals by EPA Multiple Metals Train (BIF Methods Manual --NOTE: THEY WANT DRAFT METHOD 29)
- PCDDs/PCDFs by EPA Method 23
- Continuous Emission Monitor for CO by EPA Method 10(40 CFR 60) and O2 by EPA Method 3A (40 CFR 60).

4. Page 1-1, revise to include dioxins and furans.

Reply

There is no appropriate place to include dioxins and furans on page 1-1. Change will be made per comment 1 to page 1-2.

5. Table 1-2 needs to be evaluated in conjunction with the risk assessment/air quality document. The evaluation of dioxins and furans needs to be broader, not just 2,3,7,8-TCDD.

Reply

As stated in the text, total equivalent 2,3,7,8-TCDD (TEQ) will be calculated. It is planned to compare this total equivalent to the ASIL for 2,3,7,8-TCDD. Table 1-2 will clarify that the allowable stack gas emission is TEQ. A footnote will be added to the table. No change is planned at this time to incorporate remaining PICs since individual limits are not the concern, rather the total risk comparison.

6. Table 2-1, the operating range for ID fan current and APC recycle water flow rate must be established during the clean soil shakedown. These limits must be accepted by the Agency prior to start-up with contaminated soil. Final limits will be based on the performance test.

Reply

As specified, these limits will be established during clean soil shakedown, approved by the agency and verified during the performance test. This will be clarified by changing Footnote c of Table 2-1.

7. Page 3-6, the thermal desorber exit gas temperature low limit for use during the first 20 minutes of operation after startup will be set based on the performance test.

Reply

Based on past experience, the 250°F unit is an excellent alarm setpoint because it prevents the possibility of water condensation while maintaining a wide operating range during start-up which minimizes both AWFSO and unit shutdowns. It should also be noted that the exit gas temperature does not impact the efficiency of the thermal oxidizer.

8. Page 3-6, the concept of totally shutting down the desorber and the thermal oxidizer, if maximum temperatures are exceeded is a matter of grave concern. The fuel should be cut back as necessary to return to a safe operating mode maintaining the system within required operating temperatures while waste is still within the system. The AWFSO's apply at all times while waste is within the system.

Reply

In the event the high temperature from the thermal oxidizer is exceeded, shutdown of the fuel is required to protect downstream equipment. The control system already would have cut back in an attempt to control the exit temperature. The condition would indicate that a problem existed in the burner control which would need to be corrected. The burner would be restarted as soon as the high temperature condition cleared and the associated burner control problem was corrected.

Also see comment #8 of Cathy Massimino's General Comments.

9. Page 3-7, the operating range for ID fan current must be established during the clean soil shakedown. This limit must be accepted by the Agency prior to start-up with contaminated soil. Final limits will be based on the performance test.

Reply

This is consistent with comment 6 above. A statement will be added to clarify that the limit will initially be established during clean soil start-up and accepted by the agency before start-up on contaminated soil.

10. Page 3-14, §3.6.1, provides procedures for how blending will be performed to assure minimum concentrations provided in the DRE calculation will be achieved.

Reply

The 5 roll-off boxes represent approximately 10% of the total feed planned during the test. Blending will thus be aimed at 1/10 roll-off soil to site soil. Blending should not be critical since the average site concentration of approximately 700 ppm of HCB offers a 1 to 2 order of magnitude safety factor for demonstration of 99.99% DRE. Section 3.6.1 will be modified to state that the soil will be blended approximately 1 part roll-off soil to 9 parts site soil.

11. Page 3-15, §3.6.3, add to bullets the following:

- Compliance with acceptable health based limits for emissions based on the risk assessment/air quality document.

Reply

The text will reflect the above comment.

- **Compliance with acceptable health based limits for emissions based on the risk assessment/air quality document.**

12. Page 3-19, the operating range for ID fan current, APC purge rate and APC recycle water flow rate must be established during the clean soil shakedown. These limits must be accepted by the Agency prior to start-up with contaminated soil. Final limits will be based on the performance test.

Reply

The comment is understood and modification as requested will be made to previous sections of the Plan. This section of the Plan is describing A-1 parameters which will be established as part of the test. At this point in time limits established during shakedown have already been approved. No change is required in this section of the plan.

13. Page 3-20, the thermal desorber exit gas temperature low limit for use during the first 20 minutes of operation after startup will be set based on the performance test data (A-1 parameter).

Reply

See Massimino Comment #7.

14. Page 3-12, the baghouse minimum limit of 1" is based on the baghouse being operated between 1-2" during the performance test. If the baghouse is operated outside of this range during the performance test, the DP will be set based on the performance test data.

Reply

It is recognized that the test will need to be run near the limit as is stated in the plan. No change to the plan language is required.

15. Page 3-23, add risk assessment addendum reflecting results of performance tests.

Reply

A bullet will be added to page 3-23 to indicate the performance test report will contain a risk assessment addendum reflecting the results of the performance tests. The text will reflect the above comment.

16. Table 3-2, amend to include the following:

- instantaneous limits for feedrate and desorber exit soil temperature
- specify soil feed limit in pounds/min
- specify that desorber exit soil temperature not applicable during first 20 minutes of operation
- footnote c and b should refer to clean soil shakedown for setting initial parameter levels
- instrument numbers for failure of ID fan, burner system, and power failure. For the power failure, this is assuming that the data logger has not gone off-line due to the failure.

Reply

All changes will be made except the change to pounds/minute on soil feed rate. This change would require an instrument modification which is not necessary. Instantaneous values of feed rate are recorded each minute and integrated to a 60-minute rolling average value. The units on this recorded value are tons/hr.

17. Tables 3-4 and 3-5, feed soil should be sampled every 15 minutes.

Reply

30 minute intervals were specified since this frequency has been accepted by the EPA at other cleanup sites. Tables 3-4 and 3-5 will be changed to reflect the change to 15 minute frequency. The bracketed amount of (approximately 8 ounces) will be deleted since with the increased frequency one 4-ounce scoop will be sufficient.

18. Tables 3-13 and 3-15, add dioxins and furans.

Reply

One sample of the treated soil will be collected for dioxin and furan analysis during each run of the performance test, for a total of three samples. These results will be compared to the levels agreed to between BNRR and the EPA. This will require modifications to Tables 3-13, 3-14 and the addition of a new table (3-15A Analysis of Dioxins and Furans in Treated Soil).

19. Table 3-25, the operating range for ID fan current, and APC recycle water flow rate must be established during the clean soil shakedown. These limits must be accepted by the Agency prior to start-up with contaminated soil. Final limits will be based on the performance test.

Reply

Footnote b will be changed to say that these operating ranges will be established during clean soil shakedown and approved by the agency.

20. Table 3-26, see comment 12, above on page 3-19, see comment 13, above, on page 3-20, see comment 14, above, on page 3-12, and see comment 16, above on Table 3-2.

Reply

Changes to the table include modification of footnotes c and b to reflect establishment of limit during clean soil shakedown, addition of instantaneous limits on waste feed, minimum thermal desorber soil discharge temperature, footnote that thermal desorber exit soil temperature limits are not in effect during the first 20 minutes after start-up, and addition of a footnote that minimum thermal desorber exit gas temperature will also be established by the test for use during first 20 minutes after startup.

21. Page 4-1, should reflect that authorization for full production will be based on the final performance test report including the risk assessment addendum.

Reply

Page 4-1 will be changed to reflect that authorization for full production will be based on submittal and approval of the final performance test report including the risk assessment addendum.

Attachment 1

1. Page 2-1, see comments 1, 2, and 3, above, under Appendix A.

Attachments 1, 2, and 3 should be provided to the Agency with the performance test notification.

Reply

Section 2 of the QAPP will be made consistent with the changes to the introduction to the PTP.

Donald Matheny's Comments

It appears that the selection of a contract lab(s) is still pending for this project. Once the lab(s) has been selected, a copy of the Laboratory's QA Plan should be forwarded to EPA for review against the requirements found in Tables 1-1 & 1-2 of the Performance Test Plan and Table 10-1 of the QA Plan. These plans should also be incorporated into the site file as relevant supporting documents. Our past comments (11-29-93) regarding the adequacy of past data validation reports for this site are still relevant.

Reply

See Comment 1 of Section 15.

WESTON/Paul Meeter's Comments

General Comments

- Did the emergency release modeling dictate whether a backup ID fan and/or generator were required?

Reply

Estimated risks associated with a power failure causing a shut down of the unit are presented in the revised AAQIR. The conclusion is that a back-up generator is not necessary.

- If treated blowdown water is used during the production burn then it should be used during the performance test and treated soil samples should be taken after treated water application.

Reply

Soil sampling will be occurring throughout operations. Williams does not believe this is necessary. No addition to text.

Work Plan Comments

- Page 32 references an opacity monitor, I thought we agreed to have them perform visible emissions readings. Is opacity an Air Authority requirement?

Reply

Opacity meter will be omitted from text.

- Williams must install an AWFSO for high instantaneous feed rate in addition to the 60 minute rolling average.

Reply

Williams concurs with the above comment.

- What are the detection limits for Cadmium and Mercury in Table 7-3 and how do they compare to the TIER I and TIER II limits.

Reply

The detection limits for Cadmium and Mercury in Table 7-3 are 0.30 mg/kg and 0.10 mg/kg, respectively. Assuming a value for Cadmium and Mercury equal to half the detection limit, as is typical, both metals pass the TIER I and TIER II limits. These results will be reflected in Table 7-3.

- Does Williams have any partitioning and removal efficiencies from other projects instead of using guidance document values in Table 7-3.

Reply

No data is available at this time.

- Table 7-2 must include a full volatile and semi-volatile scan plus the next 10 highest peaks should be identified as TICs.

Reply

Williams concurs with this comment.

- The LTTD roundsheet does not contain all of the required operational parameters that will have AWFCO. How will the additional data be provided.

Reply

The text has been revised to reflect the above comment.

Performance Test Plan Comments:

Page 1-3 - Particulate and HCl are measured by Method 5 and 26 or 0050.

Reply

Method clarification will be made consistent with response to Catherine Massimino comment 3.

Page 1-4 - Volatile organics are measured by EPA Method 0030 not Modified Method 5.

Reply

Change will be made as noted consistent with comment 3 by Catherine Massimino.

Page 1-4 - Multi Metals by Draft Method 29.

Reply

Since Method 29 is a Draft method, we will need to compare to the accepted method from the BIF Manual.

Page 3-6 - Should the auxiliary fuel be shut off or just reduced when the thermal oxidizer or the quench exit gas temperature are exceeded. I don't like the idea of zero combustion while waste is still inside the unit.

Reply

No change is planned per the response to general comment 8 by Catherine Massimino.

Page 3-18 - Why is the soil feed rate limit not activated for the first 20 minutes after startup.

Reply

The soil feed rate is activated during the first 20 minutes after startup as was discussed in detail during the February 2, 1994 meeting in Washington. However, it was agreed that the minimum soil discharge could not be measured during the first 20 minutes of operation. Limits for the first 20 minutes of operation following

start up will be consistent with responses to comments by Catherine Massimino on this subject.

Page 3-22 - What information will be included in the draft performance test report. Will it enable our people to do laboratory data validation.

<u>Reply</u>

The data to be supplied for reduction, validation, and reporting is described in section 9 of the QAPP. No change is planned in response to this comment.

Table 3-5 - Feed soils should be sampled every 15 minutes.

<u>Reply</u>

The change will be made consistent with comment 17 by Catherine Massimino.

Table 3-6 - Treated soils should be sampled every 15 minutes.

<u>Reply</u>

The change will be made consistent with comment 17 by Catherine Massimino.

Table 3-8 - The back half impinger water should be saved and analyzed. The entire train should be rinsed with toluene not just the back half.

<u>Reply</u>

Method 23 clearly states in section 4.2.5 that the impinger water is discarded. The procedure will be modified to direct rinsing of the entire train with toluene as specified.

Table 3-10 - The front half rinse should be 50/50 methanol/methylene chloride.

<u>Reply</u>

The procedure will be corrected as noted to rinse with 50/50 methanol/methylene chloride. Both the front and back half rinses will be changed. Correction will also be made to Table 3-14 and 3-23.

Table 3-14 - Semi-volatiles to include full scan plus 10 highest peaks.

<u>Reply</u>

Tables 3-14 and 3-23 will be modified to include this note.

Table 3-21 - Toluene rinse is analyzed separately.

Reply

Our latest direction from the EPA (Larry Johnson) has been to combine these rinses. No change is required.

Table 3-23 - The semi-volatile samples must be spiked with surrogate standards prior to extraction.

Reply

The procedure will be changed to reflect addition of surrogate standards prior to any manipulation of samples consistent with analysis procedures of EPA Method 0010.

Table 3-24 - VOST tube will be analyzed separately for breakthrough determination.

Reply

A statement will be added to Table 3-24 that VOST tubes will be analyzed separately to check for possible breakthrough. The table will also be changed to note the addition of surrogate standards.

Figure 3-5 - The sample probes at ports A and B represent flow disturbances therefore the traverse point criteria for ports C and D will be different than those shown in Figure 3-5.

Reply

The two levels of sampling ports A, B and C, D are approximately 10 feet apart. The projected area of the sampling probe is insignificant compared to the cross sectional area of the stack. It would be expected that the air flow pattern within the stack would reestablish within a few inches of the probe at the A, B level. Therefore it would not be expected that the A, B probe would represent a flow disturbance at the C,D level several feet away.

Figure 3-7 - Does not indicate the required XAD inlet thermocouple.

Reply

Figure 3-7 will include indication similar to Figure 3-9.

Quality Assurance Project Plan

7. Table 4-1 — Under OCL Pesticides for stack gas samples: Precision for the duplicate analysis should be within 20 RP if pesticide concentration is above the lowest calibration standard. Precision for the surrogate should be ± on dibutyl chlorendate (DBC) if DBC not diluted out.

Reply

Table 4-1 is consistent with Table 7-3 Summary of QA/QC Procedures for SVOST, EPA Handbook Quality Assurance/Quality Control Procedures for Hazardous Waste Incineration, for all semi-volatiles (OCL pesticides, hexachlorobenzene and other semi-volatiles) that are to be analyzed.

9. Table 10-1 — Under OCL Pesticides: Linearity check frequency should be before sample analysis and once every 72 hours. Single point calibration check frequency should be once every 12 hours. Need to specify an injection blank once every 12 hours, as well. Under Total Chlorine: Assume this refers to chloride. Work plan does not specify either potentiometric titration or specific ion electrode. For ion chromatography: no parameters are listed for QA/QC such as, initial calibration/linearity check, continuing calibration, blanks, matrix spikes, etc.

Reply

The text will be revised to reflect the above comment.

General Comments from Conference Call

Comment - Williams should propose a sampling scheme during shakedown operations.

Reply

Table 9-2 of the Work Plan outlines the soil sampling procedures for pre-performance test operations. This period will include shakedown of the unit.

If you have any additional questions, please feel free to call me at 404/879-4075.

Sincerely yours,

WILLIAMS ENVIRONMENTAL SERVICES, INC.

Mark A. Fleri
Project Manager
MAF:js

cc: Z. Lowell Taylor, Williams Environmental Services
Bruce Sheppard Burlington Northern Railroad
David Eagleton - Burlington Environmental
Tom Hippe - Burlington Environmental
Bob Kievit - EPA
Tom Backer - Preston Thorgrimson
General File
Job File

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APPENDIX U

NOVEMBER 1994
COMMENT & RESPONSE LETTERS

WILLIAMS ENVIRONMENTAL SERVICES, INC.

November 18, 1994

Ms. Lynda Priddy
Environmental Protection Specialist
Hazardous Waste Specialist
United States Environmental Protection Agency, Region X
1200 Sixth Avenue
Seattle, Washington 98101

Subject: Woods Industries Site
Yakima, Washington
Transmittal No.: 0047
Number of Pages: 5

Re: Responses to EPA's Comments Received October 24, 1994
Williams Project No. 0365

Dear Ms. Priddy:

Williams Environmental Services, Inc. (Williams) has received the EPA's comments on the April 1994 revised pages to the Thermal Desorption Workplan and has provided the responses outlined below. Where applicable, these responses have been incorporated into the workplan. In addition, the workplan has been finalized to reflect the use of TPU #4 at the Woods site.

Comment 1

The workplan is not internally consistent with respect to the AWFSOs that are required for this project. Appendix A, Table 3-2, accurately reflects the AWFSOs for this project, until revisions are approved by the Agency based on the clean soil shakedown or performance test. It is strongly recommended that other Tables or narrative in the workplan that list these AWFSOs refer to this table.

Response 1

The workplan has been made internally consistent with respect to the AWFSOs shown in Appendix A, Table 3-2. Additionally, reference is made to Table 3-2 in the narrative portion of the workplan.

Comment 2

Page 17,§3.2, if treated soil does not pass the required treatment criteria, and there is not a legitimate reason to question the acceptability of the sampling procedures or the analytical results (i.e., QA/QC requirements are not met, etc.), the treated soil must be retreated and not resampled.

Response 2

Williams concurs with this comment.

Comment 3

Pages 20 and 25, §3.5 and 4.1, there is still an inconsistency with the limitation of the size of debris to process in the desorber. We originally agreed that the cobble cut-off size would be 3" unless it was demonstrated the equipment could not handle 3".

Response 3

Sections 3.5 and 4.1 have been revised to show a cutoff size of 3" unless it is demonstrated that the equipment cannot handle debris this size.

Comment 4

Page 21, item 19, provide example print-out of desorber AWFSO data logger with the final work plan.

Response 4

An example printout from the data logger has been provided in Appendix X.

Comment 5

Page 21, §3.5.2, the sump sludgy material, when fed to the desorber with or without the contaminated soil, must comply with the operating and feed restrictions on the desorber, as well as assuring that the performance test adequately addresses this material.

Response 5

Sludgy material collected in the sumps will be fed to the desorber in compliance with all operating and feed restrictions. No change to the text is required.

Comment 6

Page 22, §3.5.3, the issue of the compliance status of the facility that will receive the spent carbon should be revisited prior to sending the material off-site.

Response 6

Westates Carbon's disposal/regeneration facilities have already been shown to be in compliance with applicable rules and regulations. However, their compliance status can be re-verified prior to sending any carbon off site.

Comment 7

Page 28, the issue of whether the baghouse dust feedrate monitoring proves successful does not affect the requirement for shutdown of the feed of the baghouse dust to the desorber during AWFSOs.

Response 7

If an AWFSO occurs, the baghouse dust feed to the desorber will be stopped along with the waste feed to the desorber.

Comment 8

Page 53, Table 7.1, add dioxins and furans to this table.

Response 8

Dioxins and furans have not been added to Table 7.1. As stated in the USEPA's April 20, 1994, comments on the March 14, 1994, workplan, it was agreed that the quenched (previously contaminated) treated soil would be sampled only once for dioxins during the performance test.

Comment 9

TPU Round Sheet, still does not include all AWFSOs.

Response 9

Figure 15.2 has been updated to show the LTTD roundsheet currently being used.

Comment 10

Section 15, a separate daily manually logged form should be maintained for AWFSOs including description of AWFSO (i.e., low thermal oxidizer temperature), instrument number, instrument reading during event, date and time of the event, duration of the event, cause of the event, corrective actions taken to address the event and minimize future occurrences, time waste feed restarted, record of report of event and time of approval for restart from Agency if greater than 7 AWFSOs within a week.

Response 10

Williams concurs with this comment and has developed a separate daily manually logged form to document AWFSOs. A copy of this form is included in Section 15.

Comment 11

Appendix A, pages 1-4, and 3-13, stack sampling protocols for the continuous emission monitoring should specify 40 CFR Part 266 Appendix IX, Section 2.

Response 11

Williams' LTTD is neither a boiler nor an industrial furnace and its CEMs should not be subject to the BIF regulations as outlined in 40 CFR Part 266, Appendix IX, Section 2. Williams does agree to abide by the regulations as stated in 40 CFR Part 60, Appendices B and F.

Comment 12

Appendix A, Table 3-10, last bullet, correct misspelling of methanol.

Response 12

The requested correction has been made.

Comment 13

Page 68-9, §12.5, the minimum number of baghouse pulse cycles planned, and internal inspection planned to assure the baghouse interior and bags are free of residue needs to be addressed.

Response 13

The minimum number of baghouse pulse cycles planned will be determined once operations have begun. The frequency at which the baghouse is pulsed will depend upon the soil characteristics and the amount of dust carryover that is experienced. In order to ensure that the baghouse interior and bags are free of residue, the baghouse will be inspected upon its arrival on site. It will again be inspected two weeks after operations have commenced and monthly thereafter.

Comment 14

Each pile of treated soil must be labeled with information that correlates with sample numbers and dates of sampling or some system as suggested by Burlington. The purpose is to prevent pile mix-up.

Response 14

All treated soil piles are segregated and tracked to prevent any chance for pile mix-ups. Soil piles can also be identified by flag markers if necessary.

Comment 15

If public interest increases at the site a methodology for accounting for unidentified compounds may need to be added to the performance test plan. For the methodology refer to pages 4-7 of EPA's DRAFT EXPOSURE ASSESSMENT GUIDANCE FOR RCRA HAZARDOUS WASTE COMBUSTION FACILITY (EPA-530 R-94-021).

Response 15

This issue will need to be addressed by both Burlington Environmental and Burlington Northern Railroad if public interest increases to a point that such discussions are deemed necessary.

As mentioned previously, these responses have been incorporated into the workplan where applicable. If you have any questions, please call me at (404) 879-4854 or Mark Fleri at (404) 879-4075.

Sincerely,

WILLIAMS ENVIRONMENTAL SERVICES, INC.

Greg Whetstone
Project Engineer
GTW:cl

cc: Mark A. Fleri
George Harbour
David Eagleton (Burlington Environmental)
Bruce Sheppard (Burlington Northern Railroad)
Paul Meeter (Weston)
Rick Roeder (Washington State Dept. of Ecology)
John Gilbert (USEPA)
Job File 0364

November 18, 1994

Ms. Lynda Priddy
Environmental Protection Specialist
Hazardous Waste Specialist
United States Environmental Protection Agency, Region X
1200 Sixth Avenue
Seattle, Washington 98101

Subject: Woods Industries Site
Yakima, Washington
Transmittal No.: 0048
Number of Pages: 7

Re: Responses to EPA's Comments Received November 1 and 8, 1994
Williams Project No. 0365

Dear Ms. Priddy:

Williams Environmental Services, Inc. (Williams) has reviewed EPA's comments on the revised Thermal Desorption Work Plan dated October 7, 1994, and has provided the responses outlined below. Where applicable, these responses have been incorporated into the plan.

November 1, 1994, Comments

Comment 1

The Performance Test Plan portion of the Work Plan was not included in this submission.

Response 1

A revised Performance Test Plan will be included with the next submission of the work plan.

Comment 2

Page 5, number 2 and page 25, last paragraph: EPA disagrees with the last sentence "(d)epending on the site conditions, engineering controls such as Williams covering conveyors and screens for the feed handling equipment will be implemented upon agreement between Williams, Burlington Environmental (BE), BNRR and EPA." EPA will review monitoring results or based on visual observations EPA may require mitigation practices which could include engineering controls or shutting down operations until the causes/situations have been remedied (e.g., weather conditions change or other controls are implemented and found effective). Yakima is a non-attainment area for PM10. Because of EPA concerns for PM10, EPA has discussed the use of engineering controls with Williams and BE. BE agreed to investigate the use of engineering controls and to report back to EPA. To date, BE has not reported back to EPA on the potential use of engineering controls such as conveyor and screen covers.

The document states that the "vibratory screening of oversized material will only be performed as needed" to reduce the potential for dust formation. How will this affect the availability of a reliable steady stream of untreated soil to keep the TDU in consistent operation? Why would the screening operation only produce "significant dust" at certain times?

Response 2

Williams has discussed the use of engineering controls with Burlington Environmental (BE) and has agreed to cover the feed soil and stacking conveyors. Additionally, Williams has modified the work plan text to reflect the comment.

Vibratory and shaker screening will be performed to separate cobbles and other debris from the soil stockpiles. The screening operation will not affect the availability of feed soil to the unit for maintaining consistent operations. Enough feed soil will be stockpiled in the waste feed storage area to maintain thermal operations should screening operations stop. Screening operations have the potential to produce dust depending upon soil conditions and characteristics, but Williams will make every effort to minimize fugitive dust emissions.

Comment 3

Page 21, 5th sentence: The "and then processed" we assume means that the sludge will be "processed" through the TDU and will meet cleanup standards. Is this a correct assumption.

Response 3

The comment as stated is correct.

Comment 4

Page 53, footnote 2: Treated soils must meet the cleanup numbers for metals (arsenic, lead and mercury) or be retreated or deposited of as specified in the consent order.

Response 4

Williams' LTTD does not operate at temperatures high enough to volatilize metals from the soil, with the exception of mercury. Williams does not purport that its units treat metals and will not be responsible for treated piles that fail based on analysis for metals. If cleanup goals for metals are exceeded, the soil will be deposited as specified in the consent order.

Comment 5

Page 8, reply number 2: The reply first states that Williams plans to start hauling from the south pile first and later in the reply it is stated that Williams plans to complete treatment of the north pile first. Please correct or clarify. Sampling (and treatment if treatment goals are exceeded) will be necessary under both the south and north piles.

Response 5

Williams will haul from either stockpile as needed but plans to complete treatment of the north stockpile first. Sampling will be performed by BNRR under both piles and additional soil treated if contaminant levels exceed industrial soil cleanup levels established for the site.

Comment 6

Site Layout Map, Figure 12-1: It is unclear from the site layout plan whether there is a decontamination area that permits easy access from the TDU exclusion zone into the office area/parking lot area. There is apparently a decon trailer south of the TDU exclusion area; however, from the site plan it does not seem apparent that someone leaving the TDU exclusion zone and using this decon trailer can enter the office/parking lot area or main entrance area without crossing back over the TDU exclusion area. Previously EPA and BE discussed having the decon area in close proximity to the office.

According to the plan legend, the exclusion area is the area inside the area defined by -x-x-x-x. However, on the plan such an area is also identified as being a support zone (near the tool trailer). Please clarify whether this area is an exclusion zone or a support zone. EPA and BE need to discuss site arrangements in more detail including:

a. the placement of EPA office space;

b. an adequate barrier zone along the Woods fence line as it borders the Haas parking lot in the vicinity of the TDU;

c. parking. The designated parking area apparently will not be big enough to meet all parking needs; and

d. site security. EPA requires that access to the site be controlled at all times. Williams' plan to have visitors report to the office is not controlled access. Whatever controlled access approach is adopted for the Woods site, the approach must ensure that people inside the site can quickly escape in case of an emergency.

Response 6

Figure 12-1 has been revised to reflect the use of TPU #4. As shown in Figure 12-2, the decontamination trailer has been re-located to provide easy access between the exclusion zone and the office area. Additionally, the figure has been revised to delineate the exclusion and support zones. Exclusion zones will include the soil stockpiles, feed and treated soil storage areas, and the thermal desorber and baghouse. Support zones will include those areas around the thermal oxidizer, quench, scrubber, and control trailer.

Items a-d have been discussed between EPA and Burlington Environmental. Currently, it is Williams' understanding that the EPA office will be north of the Ackland building. Parking may be available along the fence line east of the site or at another offsite location. Finally, Williams, BE, and BNRR are currently working on a revised control access approach for discussion with the EPA.

Comment 7

Page 12 of response letter, reply to number 17: Who is responsible for cleaning the haul roads if sampling shows that cleanup levels are exceeded? Is Williams responsible for cleaning the pad?

Response 7

Williams will be responsibile for cleaning the haul roads if sampling shows that industrial cleanup levels are exceeded, provided that Burlington Environmental supplies Williams with the necessary data to verify the cleanliness of the haul roads prior to Williams mobilizing to the site. Williams is responsible for pressure washing the pad at the completion of the project.

Comment 8

Page 13 of response letter, reply to number 22: What happens to the contaminated material collected from performing the activities described in the last nine bullets?

Response 8

Soils or sludge generated as a result of cleaning the unit will be processed through the unit and verified clean before the unit is disassembled. All decon water collected will be treated by activated carbon adsorption.

Comment 9

Page 10 of response letter, reply to number 10: In general the approach seems OK. Regarding the number of grab and composite samples to be taken to determine whether the haul roads and other similar areas meet cleanup levels will be determined toward the end of operations based on the experience of the OSC/oversight staff.

Response 9

Williams believes this issue needs to be settled prior to the end of operations to avoid any unnecessary delays that may arise as a result of differing opinions. Therefore, Williams proposes to sample the haul roads at a frequency of one composite sample per 100 feet of road.

General Comment 1

Spare parts should be readily available on-site for equipment necessary for on-going operations.

Response

Williams concurs with this comment and will store spare parts and tools in the warehouse portion of the Akland building.

November 8, 1994 Comments

General Comment 2

The proposed alternate monitoring parameter and operating range to be utilized instead of soil temperature for the initial 20 minutes must be provided in the workplan.

Response

During the initial 20 minutes of operation, no soil will be discharging from the thermal desorber. Additionally, prior to each time the unit is shut down, Williams will make an effort to empty the desorber of all soil so that no soil will be discharging during the subsequent 20 minutes of startup. Therefore, no alternate monitoring parameter is required.

Comment 1

Pages 19 and 25 are now consistent with respect to the size limitations for input to the desorber.

<u>Response 1</u>

Williams concurs with this comment.

<u>Comment 2</u>

Page 23, the discharge conveyor has been deleted from trailer 1. Indicate which trailer the conveyor will be located at.

<u>Response 2</u>

The discharge conveyor will no longer be included with Trailer 1 or the other five primary trailers. The discharge conveyor will be shipped separately.

<u>Comment 3</u>

Page 31, the drive for the feed belt has been revised to reflect half the horse power of what was originally proposed, though the feedrate projected and the size of the belt and hopper has not changed. Provide data reflecting Williams experience with failure or breakdown of this feed system with this smaller size drive and the originally proposed size drive at the feedrates proposed for this project. If the failure or breakdown frequency is greater with the smaller drive the larger drive should be substituted.

<u>Response 3</u>

The drive for the feed belt on TPU 4 is actually an 8.9 horsepower variable speed drive. The belt drives are designed for site specific characteristics and conditions. Currently, TPU 4 is in use at a Superfund site in New Jersey and the feed system has not experienced any failures or breakdowns. Additional data reflecting Williams' experience with failure or breakdown of the feed system with the smaller size drive versus the originally proposed size drive is not available, though it is very similar to the one originally proposed and in use on TPU 3. However, by the end of the current project, Williams will have knowledge of its performance.

<u>Comment 4</u>

Page 31, based on the revised dimensions of the desorber is the estimate of 20 minutes solids residence time still expected to be reflective of the system?

<u>Response 4</u>

The internal drum dimensions for TPU #4 are the same as those for TPU #3. Therefore, the estimated solids residence time in the desorber remains unchanged.

Comment 5

Drawing 4ABS, it is not clear that this is a complete PID for the revised quench/scrubber system. For example, as depicted there is only one pump feeding the quench system. Since a number of conditions related to the quench relying on this pump can result in AWFSO's (i.e., loss of water, high quench tower outlet temperature, etc.) additional pumps would be expected as part of this system (previous design had 3 pumps feeding the quench). A similar comment can be made concerning the acid scrubber system which previously had two main headers bringing in water while the system now proposed has only one header.

It should be confirmed that the Drawing 4ABS is complete and the system should be updated to assure adequate redundancy/backup to minimize AWFSO's.

Response 5

There are four pumps feeding the quench/scrubber system of TPU 4. One pump supplies city water to the quench, one pump (P27) supplies water to the scrubber packing, and two pumps (P28 and P32) recycle water to the quench. The scrubber system on TPU 4 has only one main header bringing in water instead of the two headers for TPU 3. The scrubber vessel for TPU 4 consists of a single chamber, while the TPU 3 scrubber consists of two scrubbing chambers.

Williams has incorporated these responses into the work plan where applicable. All revisions have been marked accordingly so that they are easily identifiable.

Sincerely,

WILLIAMS ENVIRONMENTAL SERVICES, INC.

Greg Whetstone

Greg Whetstone
Project Engineer
GTW:pc

cc: Z. Lowell Taylor
Mark A. Fleri
George Harbour
David Eagleton (Burlington Environmental)
Bruce Sheppard (Burlington Northern Railroad)
Paul Meeter (Weston)
Rick Roeder (Washington State Dept. of Ecology)
John Gilbert (USEPA)
Job File 0365

Christine Todd Whitman
Governor

State of New Jersey
Department of Environmental Protection

Robert C. Shinn, Jr
Commissioner

Post-it™ brand fax transmittal memo 7671 # of pages ▸ 2
To Greg Whetstone | From J. Bunker
Co. Williams Envr | Co. NJDEP
Dept. | Phone # 609 530 4041
Fax # 404 879 5748 | Fax #

RECEIVED NOV 18 1994 WILLIAMS ENVIRONMENTAL

November 18, 1994

Mr. Greg Whetstone
Williams Environmental Services, Inc.
2075 West Park Place
Stone Mountain, GA 30087

RE: LTVS - Lipari Off-Site Remediation
Trial Burn Plan
Log No. 01-94-0845

Dear Mr. Whetstone:

This office is in receipt of your letter dated October 25, 1994. All of the issues in your letter are acceptable with the exception of item five.

Based on the information provided by you, it is agreed that with a stack gas moisture content 56% an additional 2.3 liters of condensation will be additionally accumulated in the sample train. In order to accommodate the excess moisture, an empty 2-3 liter flask shall be placed before the HNO_3/H_2O_2 impingers as an extra condensate trap. This additional moisture knock-out trap will be sufficient to handle the excess moisture problem.

Regarding the analysis of impingers one through three, EPA Method 29 requires that Fraction 2A (as per Section 5.3.4) be reduced to 20 ml. This is a standard procedure in the method. Section 5.3.4.1 then details how fraction 2A shall be digested and diluted to 150 ml or the appropriate volume for the expected metals concentration. This digested fraction then becomes known as the "Concentrated Fraction 2A". It is this dilution volume that my September 27 letter refers to as a volume of 15 ml. The same is true for Section 5.3.3, instead of diluting to 300 ml the volume shall only be diluted to 30 ml.

If the above procedures are implemented, the test consultant for your facility should be able to obtain the necessary minimum detection limits (mdl) for metals.

A written response to this letter is required before the final protocol approval and the stack tests can be conducted. Failure to provide such a response could result in possible enforcement action.

If you have any questions please feel free to contact me at (609) 530-4041.

Sincerely,

Richelle Burkeen
Sr. Env. Engineer
Bureau of Technical Services

c Gordon McDonald - Sevenson
Edward Choromanski - SRO

V

APPENDIX V

DATA LOGGER EXAMPLE PRINTOUT

08/05/94 14:22:22 LIMIT 102 KILN VAC 0.00P ROTARY DRYER VACUUM HIGH
08/05/94 14:25:26 RETURN 102 KILN VAC -0.13P ROTARY DRYER VACUUM HIGH

W.E.S. 15 MIN. SHIFT REPORT. LAPARI SITE.

08/05/94 14:30:00 15 MIN. REPORT (KORA).

	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.3P	-0.14P	0.0A	0.3P	0.3P	0.0T	0.00	0.P
	THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
	0.C	0.C	82.4F	82.9F	0.C	74.6F	80.8F	82.1F
	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	81.9F	94.G	0.G	0.G	0.G	0.G	7.43U	8.57U
	PCC-02						CMCAL-SW	MAN-TRND
	25.0P						0.005M	OPEN M
	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1			
300	0.0C	0.0C	0.0T	1.T	0.0C			

08/05/94 14:45:00 15 MIN. REPORT (KORA).

	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.3P	-0.14P	0.0A	0.3P	0.3P	0.0T	0.00	0.P
	THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
	0.C	0.C	81.6F	81.9F	0.C	74.2F	79.6F	81.4F
	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	81.2F	85.G	0.G	0.G	0.G	0.G	7.43U	8.56U
	PCC-02						CMCAL-SW	MAN-TRND
	25.0P						0.004M	OPEN M
	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1			
300	0.0C	0.0C	0.0T	1.T	0.0C			

W.E.S. 15 MIN. SHIFT REPORT, CHEMET SITE.

08/05/94 15:00:00 15 MIN. REPORT (KORA).

	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.3P	-0.14P	0.0A	0.3P	0.3P	0.0T	0.00	0.P
	THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
	0.C	0.C	80.8F	80.9F	0.C	73.6F	78.5F	80.6F
	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	80.4F	91.G	0.G	0.G	0.G	0.G	7.46U	8.54U
	PCC-O2						CMCAL-SW	MAN-TRND
	25.0P						0.004M	OPEN M
	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1			
300	0.0C	0.0C	0.0T	1.T	0.0C			

08/05/94 15:15:00 15 MIN. REPORT (KORA).

	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.3P	-0.14P	0.0A	0.3P	0.4P	0.0T	0.00	0.P
	THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
	0.C	0.C	79.5F	79.7F	0.C	72.3F	77.2F	79.5F
	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	79.4F	89.G	0.G	0.G	0.G	0.G	7.45U	8.53U
	PCC-O2						CMCAL-SW	MAN-TRND
	25.0P						0.003M	OPEN M
	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1			
300	0.0C	0.0C	0.0T	1.T	0.0C			

08/05/94 15:30:00 15 MIN. REPORT (KORA).

	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.3P	-0.14P	0.0A	0.3P	0.4P	0.0T	0.00	0.P
	THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
	0.C	0.C	78.2F	78.5F	0.C	71.4F	75.9F	78.3F
	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	78.3F	89.G	0.G	0.G	0.G	0.G	7.48U	8.52U
	PCC-O2						CMCAL-SW	MAN-TRND
	25.0P						0.004M	OPEN M
	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1			
300	0.0C	0.0C	0.0T	1.T	0.0C			

08/05/94 15:45:00 15 MIN. REPORT (KORA).

	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.3P	-0.14P	0.0A	0.3P	0.4P	0.0T	0.00	0.P
	THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
	0.C	0.C	77.1F	77.5F	0.C	70.6F	74.6F	77.5F
	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	77.5F	86.G	0.G	0.G	0.G	0.G	7.46U	8.52U
	PCC-O2						CMCAL-SW	MAN-TRND
	25.0P						0.003M	OPEN M
	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1			
300	0.0C	0.0C	0.0T	1.T	0.0C			

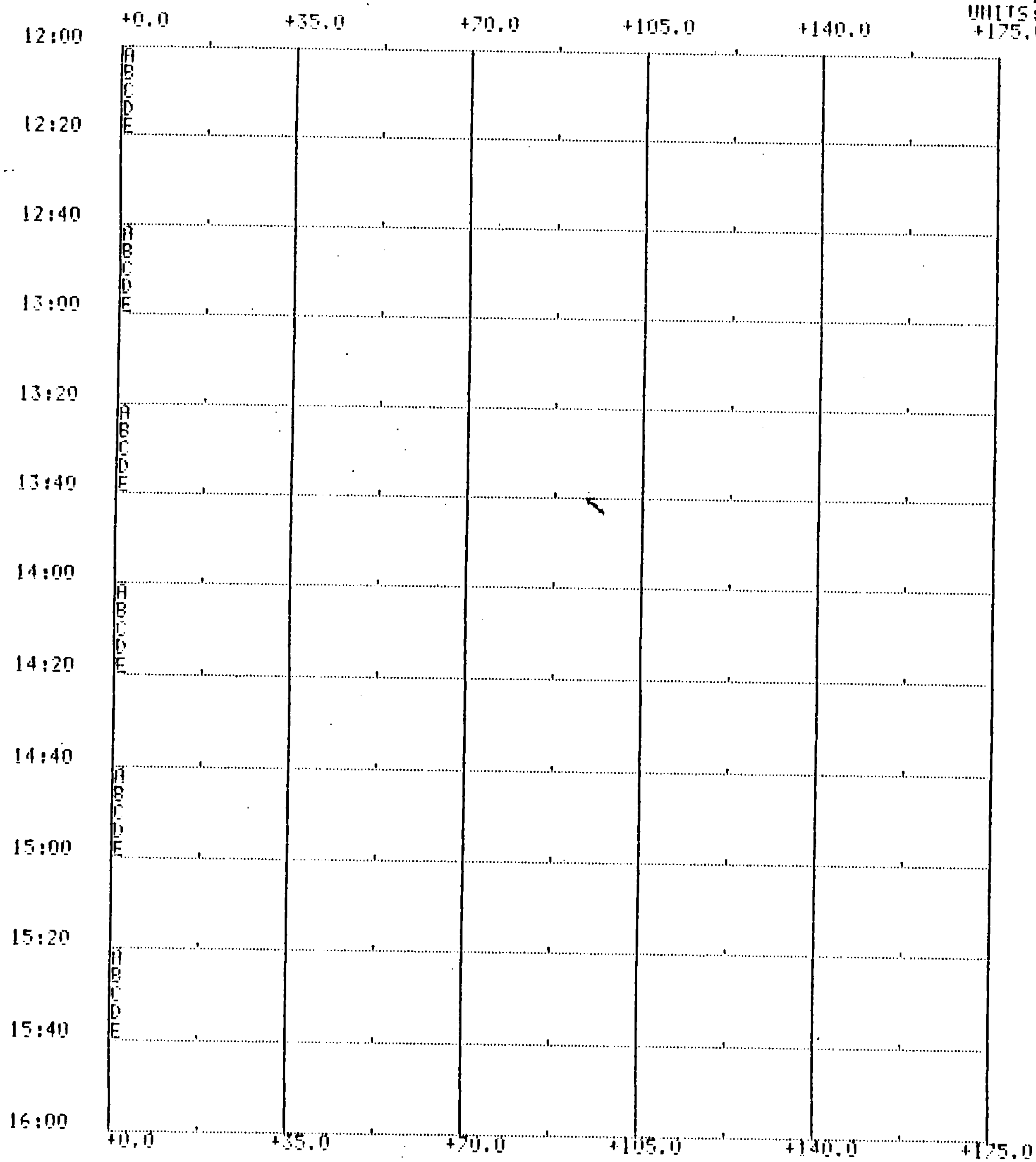
W.E.S. 15 MIN. SHIFT REPORT, LAPARI SITE.

08/05/94 16:00:00 15 MIN. REPORT (KORA).

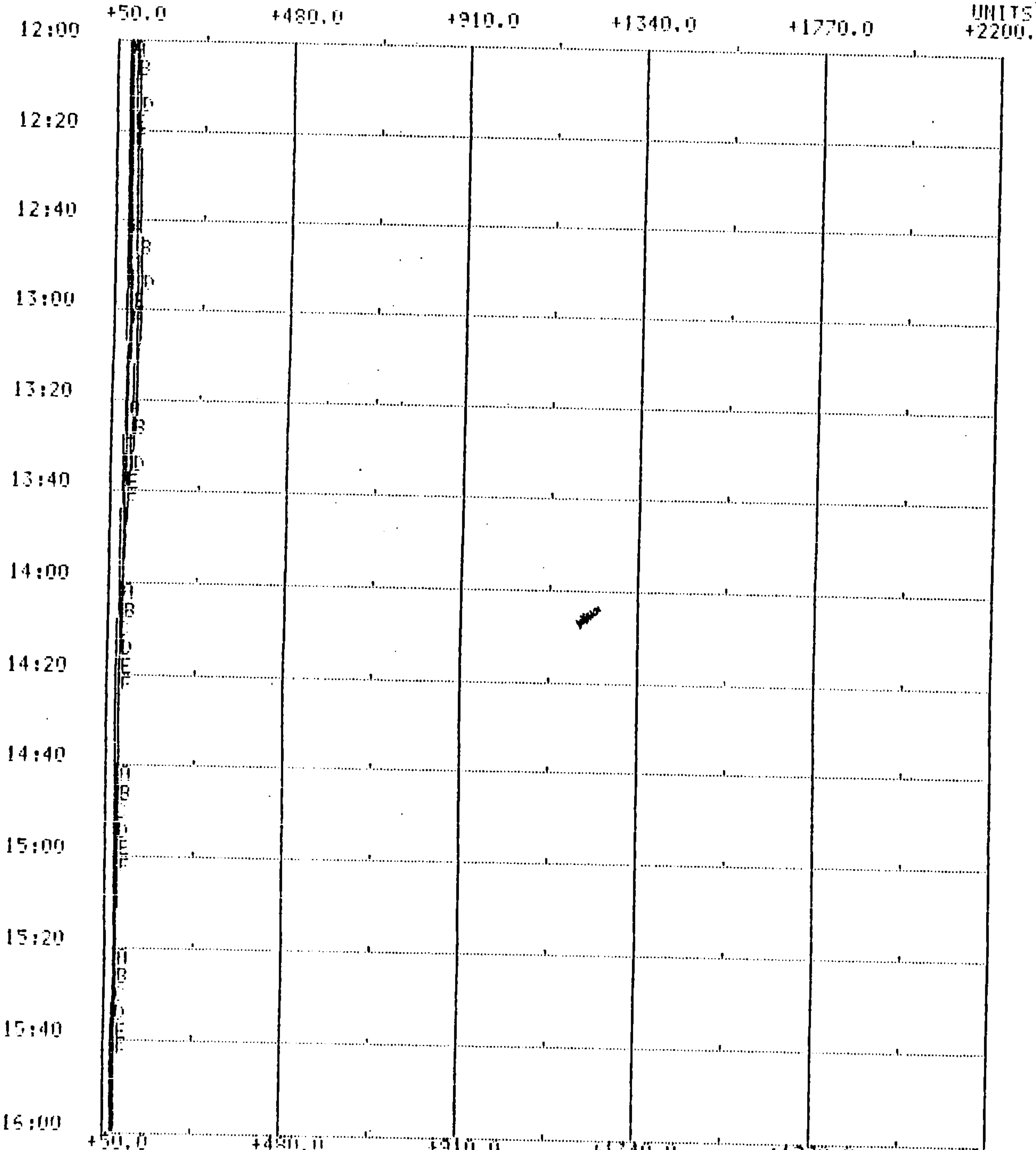
	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.4P	-0.14P	0.0A	0.4P	0.4P	0.0T	0.00	0.P
	THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
	0.C	0.C	76.6F	76.3F	0.C	69.7F	73.4F	76.5F
	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	76.7F	88.G	0.G	0.G	0.G	0.G	7.48U	8.50U
	PCC-O2						CMCAL-SW	MAN-TRND
	25.0P						0.004M	OPEN M
	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1			
300	0.0C	0.0C	0.0T	1.T	0.UC			

WILLIAMS ENVIRONMENTAL 8 HOUR SHIFT REPORT, LAPARI SITE.

SUMMARY: HIST, HDR1, TRIG48, SLOW, CS02

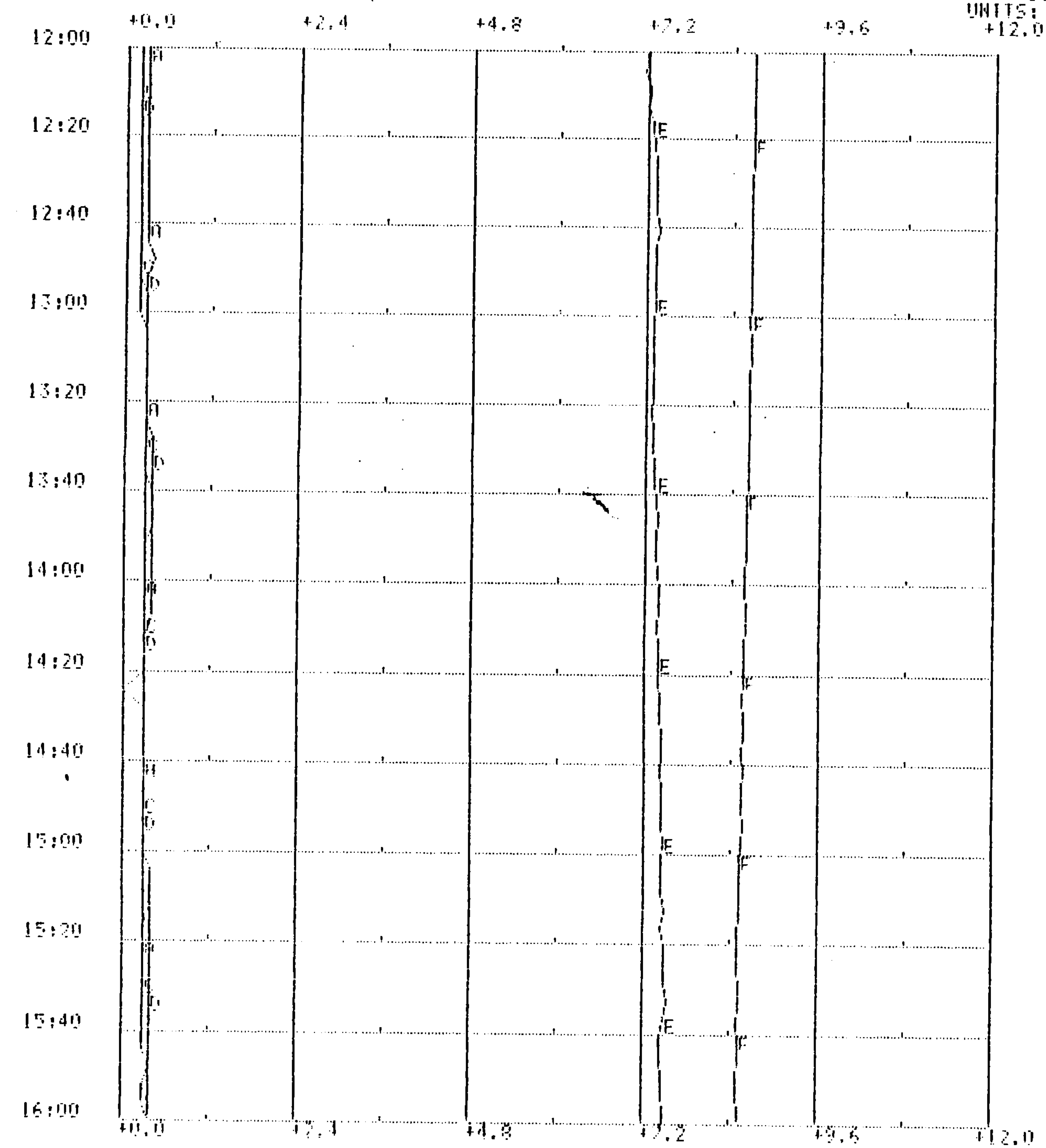


A I.D.AMPS	B SCALE	C OXYGEN	D CO2	E TRIBOFLO
UNITS: A	T	O	C	C
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.
0.0	0.0	0.0	0.	0.



A SCC-TEMP F	B QNCHTEMP F	C SOILTEMP F	D BHSTEMP F	E SCB-TMPF F	F SCB-TMPF F
86.5	99.6	81.9	104.7	90.5	89.8
86.6	100.2	82.1	105.7	90.6	90.1
86.8	100.6	82.2	106.6	90.8	90.4
86.9	101.0	82.4	107.4	91.0	90.5
87.1	101.7	82.5	108.5	91.2	90.8
87.3	102.2	82.6	109.5	91.4	91.0
87.4	102.8	82.8	110.4	91.7	91.2
87.6	103.4	83.0	111.2	91.8	91.5
87.7	103.8	83.1	111.9	92.0	91.8
87.9	104.3	83.2	112.7	92.2	92.0
88.0	105.0	83.3	113.5	92.3	92.2
88.3	105.8	83.6	114.6	92.6	92.4
88.4	106.5	83.7	115.6	92.8	92.6
88.6	106.9	84.0	116.2	93.0	92.6
88.7	107.0	84.1	116.3	93.2	92.8
88.8	106.9	84.2	116.0	93.2	92.8
89.0	106.6	84.3	115.4	93.2	92.7
89.0	106.1	84.4	114.4	93.0	[illegible]
89.1	105.4	84.4	113.3	92.9	92.5
89.1	104.5	84.5	112.1	92.6	92.2
89.0	103.5	84.6	110.6	92.4	91.9
88.9	101.8	84.5	108.5	92.0	91.5
88.8	99.5	84.3	106.1	91.4	90.9
88.4	97.3	83.5	103.2	90.6	90.2
87.9	95.2	82.0	100.0	89.5	89.4
87.3	93.0	80.6	96.8	88.5	88.4
86.7	91.0	79.5	94.0	87.6	87.6
86.1	89.6	78.6	91.5	86.7	86.7
85.5	88.2	77.7	89.3	85.8	85.8
84.5	87.1	76.8	87.5	85.0	85.0
84.1	86.2	76.2	85.8	84.3	84.5
83.8	85.5	75.8	84.6	83.7	84.0
83.5	85.0	75.4	83.6	83.3	83.5
83.3	84.6	75.1	82.9	83.0	83.2
82.9	84.1	74.9	82.3	82.6	82.7
82.7	83.7	74.8	81.8	82.4	82.4
82.4	83.4	74.7	81.3	82.2	82.1
82.4	83.1	74.6	81.0	82.1	82.0
82.2	82.8	74.6	80.7	82.0	81.8
82.0	82.5	74.4	80.3	81.8	81.6
81.8	82.2	74.3	79.9	81.6	81.4
81.6	81.9	74.2	79.6	81.4	81.2
81.5	81.6	74.1	79.3	81.2	81.1
81.2	81.4	73.9	79.1	81.0	80.8
81.0	81.2	73.8	78.8	80.8	80.7
80.8	80.9	73.6	78.5	80.6	80.4
80.5	80.6	73.4	78.2	80.3	80.3
80.2	80.3	73.0	77.9	80.0	80.0
79.9	80.0	72.7	77.5	79.8	79.7
79.5	79.7	72.3	77.1	79.5	79.3
79.1	79.3	72.0	76.7	79.1	79.0
78.7	79.0	71.7	76.4	78.7	78.7
78.4	78.7	71.5	76.0	78.5	78.4
78.0	78.3	71.2	75.6	78.2	78.1
77.7	78.0	71.0	75.3	77.9	77.9
77.4	77.7	70.8	75.0	[illegible]	77.6
77.1	77.5	70.6	74.6	77.6	77.5
76.9	77.2	70.5	74.5	77.4	77.3
[illegible]	77.0	70.2	74.2	77.1	77.2
76.8	76.6	69.9	74.2	76.7	76.9
76.6	76.3	69.7	73.4	76.5	76.7

08/05/94



A B.H.-DP P	B KILN VAC P	C SCRB-DPL P	D SCRB-DPR P	E SMP-PH-R U	F SMP-PH-F U
0.3	-0.14	0.2	0.2	7.19	8.67
0.3	-0.14	0.2	0.2	7.17	8.67
0.3	-0.14	0.2	0.2	7.23	8.67
0.3	-0.14	0.2	0.2	7.22	8.67
0.3	-0.14	0.2	0.2	7.28	8.68
0.3	-0.14	0.2	0.2	7.30	8.68
0.3	-0.14	0.2	0.2	7.32	8.67
0.3	-0.14	0.2	0.2	7.33	8.65
0.3	-0.14	0.2	0.2	7.33	8.65
0.3	-0.14	0.2	0.2	7.33	8.65
0.3	-0.14	0.2	0.2	7.38	8.65
0.3	-0.14	0.2	0.2	7.33	8.64
0.4	-0.14	0.2	0.2	7.33	8.66
0.3	-0.14	0.2	0.2	7.32	8.64
0.3	-0.14	0.2	0.3	7.33	8.64
0.3	-0.14	0.2	0.3	7.31	8.63
0.3	-0.14	0.3	0.3	7.30	8.64
0.3	-0.14	0.3	0.3	7.31	8.64
0.3	-0.14	0.3	0.3	7.30	8.63
0.3	-0.14	0.3	0.3	7.30	8.62
0.3	-0.14	0.3	0.3	7.28	8.63
0.3	-0.14	0.3	0.3	7.30	8.62
0.3	-0.14	0.3	0.4	7.31	8.62
0.3	-0.14	0.3	0.4	7.32	8.62
0.3	-0.14	0.3	0.4	7.33	8.62
0.3	-0.14	0.4	0.4	7.36	8.60
0.3	-0.14	0.4	0.4	7.32	8.61
0.3	-0.14	0.4	0.4	7.35	8.60
0.3	-0.14	0.3	0.4	7.36	8.60
0.3	-0.14	0.3	0.4	7.37	8.59
0.3	-0.14	0.3	0.4	7.40	8.59
0.3	-0.14	0.3	0.4	7.41	8.60
0.3	-0.14	0.3	0.4	7.39	8.61
0.3	-0.14	0.3	0.3	7.40	8.58
0.3	-0.14	0.3	0.3	7.40	8.58
0.3	-0.14	0.3	0.3	7.41	8.58
0.0	0.00	0.3	0.3	7.42	8.56
0.3	-0.14	0.3	0.3	7.43	8.57
0.3	-0.14	0.3	0.3	7.45	8.57
0.3	-0.14	0.3	0.3	7.44	8.56
0.3	-0.14	0.3	0.3	7.43	8.58
0.3	-0.14	0.3	0.3	7.45	8.55
0.3	-0.14	0.3	0.3	7.44	8.55
0.3	-0.14	0.3	0.3	7.46	8.57
0.3	-0.14	0.3	0.3	7.47	8.55
0.3	-0.14	0.3	0.3	7.46	8.54
0.3	-0.14	0.3	0.4	7.45	8.53
0.3	-0.14	0.3	0.4	7.45	8.52
0.4	-0.14	0.3	0.4	7.50	8.52
0.3	-0.14	0.3	0.4	7.46	8.51
0.3	-0.14	0.3	0.4	7.50	8.51
0.3	-0.14	0.3	0.4	7.51	8.51
0.3	-0.14	0.3	0.4	7.50	8.52
0.3	-0.14	0.3	0.4	7.55	8.52
0.5	-0.14	0.3	0.4	7.49	8.51
0.3	-0.14	0.3	0.4	7.46	8.52
0.3	-0.14	0.3	0.4	7.46	8.52
0.4	-0.14	0.4	0.4	7.48	8.51
0.3	-0.14	0.3	0.4	7.48	8.51
0.4	-0.14	0.3	0.4	7.49	8.53
0.4	-0.14	0.4	0.4	7.48	8.50

08/05/94 16:15:00 15 MIN. REPORT (KURN).

	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.3P	-0.14P	0.0A	0.3P	0.4P	0.0T	0.00	0.P
	THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
	0.C	0.C	75.4F	75.3F	0.C	68.7F	72.3F	75.4F
	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	75.5F	84.6	0.G	0.G	0.G	0.G	7.49U	8.50U
	PCC-O2						CMCAL-SW	MAN-TRND
	25.0P						0.002M	OPEN M
	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1			
300	0.0C	0.0C	0.0T	1.T	0.0C			

W.E.S. 15 MIN. SHIFT REPORT. LAPARI SITE.

08/05/94 16:30:00 15 MIN. REPORT (KORD).

	B.H.-DP	KILN VAC	I.D.AMPS	SCRB-DPL	SCRB-DPR	SCALE	OXYGEN	CO INST.
100	0.3P	-0.14P	0.0A	0.3P	0.4P	0.0T	0.00	0.P

THC INST	CO2	SCC-TEMP	QNCHTEMP	TRIBOFLO	SOILTEMP	BHSTEMP	SCB-TMPF
0.C	0.C	74.6F	74.6F	0.C	68.2F	71.8F	74.8F

	SCB-TMPR	SCRB B.D	SCB-FL-F	SCB-FL-R	QCH-FL-R	QCH-FL-F	SMP-PH-R	SMP-PH-F
200	75.1F	79.G	0.G	0.G	0.G	0.G	7.54U	8.50U

PCC-O2	CMCAL-SW	MAN-TRND
25.0P	0.003M	OPEN M

	CO-R-1HR	CO-R-10M	SCLE 24H	TOT-*10	THC-RL-1
300	0.0C	0.0C	0.0T	1.T	0.0C

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08/05/94 16:43:39 RETURN 107 OXYGEN      9.50  STACK OXYGEN CONTENT LOW
08/05/94 16:43:39 RETURN 107 OXYGEN      9.50  STACK OXYGEN CONTENT LOW LOW
08/05/94 16:43:50 LIMIT  107 OXYGEN      0.00  STACK OXYGEN CONTENT LOW
08/05/94 16:43:50 LIMIT  107 OXYGEN      0.00  STACK OXYGEN CONTENT LOW LOW
08/05/94 16:43:50 RETURN 107 OXYGEN      9.60  STACK OXYGEN CONTENT LOW
08/05/94 16:43:50 RETURN 107 OXYGEN      9.60  STACK OXYGEN CONTENT LOW LOW
08/05/94 16:43:53 LIMIT  107 OXYGEN      1.90  STACK OXYGEN CONTENT LOW
08/05/94 16:43:53 LIMIT  107 OXYGEN      1.90  STACK OXYGEN CONTENT LOW LOW
08/05/94 16:43:54 RETURN 107 OXYGEN      3.40  STACK OXYGEN CONTENT LOW LOW
08/05/94 16:43:56 RETURN 107 OXYGEN      9.10  STACK OXYGEN CONTENT LOW

08/05/94 16:48:10 LIMIT  107 OXYGEN      0.00  STACK OXYGEN CONTENT LOW
08/05/94 16:48:10 LIMIT  107 OXYGEN      0.00  STACK OXYGEN CONTENT LOW LOW
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