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1. **Restrictive Covenant**

*244 pgs
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*205089

Reference Number(s) of Documents assigned or released:

Additional numbers on page of document

Grantor(s): (Last name first, then first name and initials)

1. **Lake Forest Park Town Center**

Additional names on page of document

Portions of the document may be illegible.
Recorded at customer's insistance
By Genevieve Jenesque

Grantee(s): (Last name first, then first name and initials)

1. **Public**
2.

Additional names on page of document

Abbreviated Legal Description as follows: (i.e. lot/block/plat or section/township/range/quarter/quarter)

New Lot 2 of City of Lake Forest Park Short Plat No. SP99-79, recorded March 7, 2000 under recording No. 2000030700002, In King Co. WA

Complete legal description is on page 10 of document

Assessor's Property Tax Parcel/Account Number(s):

401930-1655-01, 401930-1656-00

NOTE: *The auditor/recorder will rely on the information on the form*

I AM REQUESTING AN EMERGENCY NONSTANDARD RECORDING FOR AN ADDITIONAL FEE AS PROVIDED IN RCW 36.18.010. I UNDERSTAND THAT THE RECORDING PROCESSING REQUIREMENTS MAY COVER UP OR OTHERWIST OBSCURE SOME PART OF THE TEXT OR THE ORIGINAL DOCUMENT.

Genevieve R. Jenesque 7/21/06

RESTRICTIVE COVENANT

Former Magic Cleaners Site

Lake Forest Park Town Center
Bothell Way NE & Ballinger Way NE
Lake Forest Park, Washington

The undersigned, Lake Forest Park Associates, a Washington joint venture partnership ("Declarant"), is the fee owner of certain real property and improvements located in the County of King, State of Washington, as described in Schedule A attached hereto (the "Property"). Declarant desires to impose certain limitations, restrictions and covenants on the use and operation of the Property for the purpose of mitigating potential health and safety risks to owners, occupants and visitors of and to the Property which may be associated with the historical release of Hazardous Substances (as defined below) that have occurred on certain portions of the Property. Some of the limitations, restrictions, and uses described in this Restrictive Covenant apply to the entire Property, while others apply to a portion of the Property only, as more fully set forth herein.

Background

Declarant previously conducted an independent remedial action (the "Remedial Action") to address a release of Hazardous Substances that historically occurred on portions of the Property. The Remedial Action is described in the following documents (including all attachments thereto), which are on file at the Washington Department of Ecology's Northwest Regional Office ("Ecology") at 3190 - 160th Ave. SE, Bellevue, WA 98008-5452 (collectively, the "File Documents"):

1. Report of Findings, Lake Forest Park Town Center, by Ecova Corporation, October 23, 1989.

2. Site Characterization Report, Former Coin-Operated Dry Cleaning Site, by Dames & Moore, January 11, 1996.

3. Supplemental Site Characterization Report, Former Magic Cleaners, by Dames & Moore, April 28, 1998.

4. Letter to Cyma Tupas, Ecology from Dames & Moore re "Notification of Completion of Independent Remedial Action, Former Magic Cleaners," April 28, 1998.

5. Transmittal Sheet to Ecology (Joanne Polayes), Request for Assistance, Voluntary Cleanup Program, May 21, 1998.

6. Letter from Ecology to Dames & Moore Re: Request for Review, May 22, 1998.

7. Groundwater Remediation Work Plan, Former Magic Cleaners, by Dames & Moore, August 31, 1998.

8. Letter to David Raubvogel, Dames & Moore from Ecology re "Request for Review and Opinion Letter," September 14, 1998.

9. Letter to Ecology (Nnamdi Madakor) from Dames & Moore Re: Work Plan – Revision #1, Groundwater Remediation, December 3, 1998.

10. Letter to Ecology (Nnamdi Madakor) from Dames & Moore Re: Groundwater Investigation/Remediation Report and Monitored Natural Attenuation Work Plan, February 11, 2000.

11. Facsimile Transmittal to Ecology (Nnamdi Madakor) from Dames & Moore Re: Recent Groundwater Analytical Data, May 10, 2000.

12. Letter to Dames & Moore from Ecology (Nnamdi Madakor) Re: Request for Review and Opinion Letter, Work Plan-Groundwater Investigation/Remediation Report and Monitored Natural Attenuation Work Plan, VCP, Former Magic Cleaners, June 22, 2000.

13. Letter to Ecology (Nnamdi Madakor) from URS Corporation Re: Former Magic Cleaners, August 23, 2000.

14. Letter to Ecology (Nnamdi Madakor) from URS Corporation Re: Remedial Action Plan for Former Magic Cleaners, September 25, 2000.

15. E-mail record from Nnamdi Madakor, Ecology to David Raubvogel, URS dated November 20, 2000.

16. Letter to Ecology (Nnamdi Madakor) from URS Corporation Re: Response to

Ecology Questions on the Remedial Action Plan, Former Magic Cleaners, January 11, 2001.

17. Letter to Nnamdi Madakor, Ecology from URS re "Remedial Action Plan," dated February 26, 2001.

18. Letter Report to Ecology (Nnamdi Madakor) from URS Corporation Re: Offsite Groundwater Sampling, Former Magic Cleaners, April 11, 2001.

19. E-mail record dated Friday, May 4, 2001 from Jay Manning to Nnamdi Madakor, Ecology with attached draft letter dated April 27, 2001.

20. Letter from Ecology (Nnamdi Madakor) to URS Corporation Re: Magic Cleaners Site, May 14, 2001.

21. Report, Voluntary Cleanup Action & Performance Monitoring, Former Magic Cleaners, by URS Corporation, April 17, 2003.

22. Letter from Ecology (Nnamdi Madakor) to Brown Reavis & Manning Re: Voluntary Cleanup Program, Cleanup Actions & Performance Monitoring, Former Magic Cleaners, January 29, 2004.

23. Letter from URS Corporation to Ecology (Nnamdi Madakor) Re: Response to Ecology Cleanup Action & Performance Monitoring, Former Magic Cleaners, March 17, 2004.

24. URS "Letter Report, Bi-annual Performance Monitoring, Former Magic Cleaners," dated November 4, 2004.

25. URS "Letter Report, Bi-annual Groundwater Performance Monitoring, Former Magic Cleaners," dated February 24, 2005.

26. URS "Indoor Air Quality Assessment, Former Magic Cleaners, Lake Forest Park Town Center," dated June 16, 2005 and cover letter to Ecology from Cascadia Law Group dated July 19, 2005.

27. URS "Statement of Work, Sub-Slab Ventilation System" dated July 28, 2005 and cover letter to Ecology from Cascadia Law Group dated July 29, 2005.

28. URS "Letter Report, Bi-annual Groundwater Performance Monitoring, Former Magic Cleaners," dated November 1, 2005.

29. URS "As-Built Report Sub-Slab Ventilation System, Former Magic Cleaners," dated February 9, 2006.

Declarant makes no representation or warranty as to the completeness or accuracy of the File Documents.

Hazardous Substances Remaining on the Property: As of the date hereof, groundwater beneath portions of the Property contains concentrations of tetrachloroethylene ("PCE"), trichloroethylene ("TCE"), and vinyl chloride ("VC") that exceed, or have historically exceeded, the Model Toxics Control Act ("MTCA") Method A Cleanup Levels for groundwater established under WAC 173-340-720. The area shown on Figure 1 attached hereto and identified as the "Groundwater Plume Area" generally depicts the boundaries of the groundwater plume containing these substances.

In addition, as of the date hereof, air inside a portion of a building on the Property contains concentrations of PCE, TCE, and 1,2-dichloroethane ("1,2-DCA") that exceed the MTCA Method B Cleanup Levels for air established under WAC 173-340-750. The area shown on Figure 2 attached hereto and identified as the "Impacted Air Area" generally depicts the area inside the building where these substances have been detected.

As used in this Restrictive Covenant, the term "Hazardous Substances" refers collectively to PCE, TCE, VC, and 1,2-DCA.

Engineered Controls to Remediate Hazardous Substances: Two Density-Driven Convection remediation systems ("DDC Systems") have been installed and are being operated to remediate PCE, TCE, and VC in the Groundwater Plume Area. DDC System 1 includes four DDC wells (DDC-1, DDC-2, DDC-3, and DDC-4). DDC System 2 includes three DDC wells (DDC-5, DDC-6, and DDC-7). Both DDC Systems are shown on Figure 1 attached hereto.

Wells ("Monitoring Wells") used to monitor groundwater quality in connection with the Remedial Action are also located on the Property. These monitoring wells are referred to as

MW-2, MW-4, and MW-6. In addition, two wells used to monitor groundwater quality in connection with the Remedial Action are located on the Property. These monitoring wells are referred to as MW-3 and MW-5. The Monitoring Wells are shown on Figure 1 attached hereto.

A Subslab Ventilation System (the "Subslab Ventilation System") has been installed to minimize vapor intrusion into the Impacted Air Area from underlying soil. An as-built drawing of the Subslab Ventilation System is attached hereto as Figure 3.

Covenants and Restrictions

Declarant makes the following declaration as to covenants, limitations, restrictions, and uses to which the Property, or certain portions of the Property more fully described below may be put and specifies that such declarations shall constitute covenants to run with the land, as provided by law and shall be binding on all parties and all persons claiming under them, including all current and future owners of any portion of or interest in the Property (hereafter "Owner").

Section 1. Owner shall continue to operate and maintain both DDC Systems as specified in the DDC System O&M Manual dated October 21, 2001 and attached hereto as Exhibit I (attached to *Report, Voluntary Cleanup Action & Performance Monitoring, Former Magic Cleaners, by URS Corporation, April 17, 2003*).

Section 2. Owner shall continue to maintain and monitor MW-2, MW-3, MW-4, MW-5 and MW-6 as specified in the document attached hereto as Exhibit II entitled *Letter from URS Corporation to Ecology (Nnamdi Madakor) Re: Response to Ecology Cleanup Action & Performance Monitoring, Former Magic Cleaners* dated March 17, 2004.

Section 3. No groundwater may be taken from any location on the Property for any use, except for purposes of conducting monitoring activities, remedial action or dewatering the Property.

Section 4. Owner shall continue to operate and maintain the Sub-Slab Ventilation System as specified in Exhibit III attached hereto entitled *Sub-Slab Ventilation System Operation and Maintenance Manual, Rite Aid Store #5225, Lake Forest Park Towne Center*, dated February 2006.

Section 5. Except as provided in Section 7 below, Owner shall prohibit use of the surface of the Groundwater Plume Area and the Impacted Air Area (collectively, the "Restricted Areas") and the ground floor of any building located on the Restricted Areas for residential, educational, or recreational purposes, and for day cares, nursing homes, assisted living centers, or similar facilities (collectively, the "Restricted Uses").

Section 6. Except as provided in Section 7 below, if any construction is undertaken in or around the Restricted Areas, Owner shall take such actions as are necessary to ensure that workers and other persons are not exposed to Hazardous Substances at concentrations that are potentially harmful (collectively, the "Restricted Construction Activities").

Section 7. The prohibitions and requirements described in Sections 5 and 6 shall not apply if Owner takes remedial actions, including but not limited to performing a risk assessment, installing additional barriers or employing other technologies or mitigants, and thereafter Ecology issues either (a) an opinion letter pursuant to RCW 70.105D.030(1)(i) (or any successor statute thereto) that remedial actions taken at the Property affirmatively meet the substantive residential use requirements of MTCA for characterizing and addressing the

vapor exposure pathway for Hazardous Materials or (b) an opinion letter stating that no further remedial action is necessary for residential use at the Property under MTCA.

Section 8. Owner shall not consummate any conveyance of title, easement, lease, or other interest in the Property without adequate and complete provision for continued compliance with the terms of this Restrictive Covenant. Owner shall provide to any successor(s) in interest notice of this Restrictive Covenant and a copy of each of the following documents:

(a) *Report of Voluntary Cleanup Action & Performance Monitoring for Former Magic Cleaners* dated April 17, 2003, together with all attachments;

(b) *Letter from URS Corporation to Ecology (Nnamdi Madakor) Re: Response to Ecology Cleanup Action & Performance Monitoring, Former Magic Cleaners* dated March 17, 2004; and

(c) *Sub-Slab Ventilation System Operation and Maintenance Manual, Rite Aid Store #5225, Lake Forest Park Towne Center*, dated February 2006.

Section 9. Owner shall restrict leases within the Restricted Areas to uses and activities consistent with this Restrictive Covenant and notify all lessees within the Restricted Areas of the restrictions on use set forth herein.

Section 10. Owner reserves the right to record an instrument that provides that this Restrictive Covenant shall no longer limit use of the Property or be of any further force or effect after Ecology issues an opinion letter stating that no further remedial action is necessary at the Property under MTCA.

LAKE FOREST PARK ASSOCIATES

By: SEATTLE LFP ASSOCIATES, L.P.,
a Delaware limited partnership

By: LFP REALTY CORPORATION,
a Delaware corporation, its General Partner

By: Roland V. Siegl
Roland V. Siegl
Vice President

DATE: July 5th, 2006

STATE OF California)
) ss.
COUNTY OF Los Angeles)

On this 5th day of July, 2006, before me, Laura A. Garrick, ~~a~~ Notary Public in and for the State of California, duly commissioned and sworn, personally appeared Roland Siegl, to me known to be the person who signed as Vice President of LFP Realty Corporation, the corporation that executed the within and foregoing instrument, and acknowledged said instrument to be the free and voluntary act and deed of said corporation for the uses and purposes therein mentioned, and on oath stated that he was duly elected, qualified and action as said officer of the corporation, that he was authorized to execute said instrument and that the seal affixed, if any, is the corporate seal of said corporation.

IN WITNESS WHEREOF I have hereunto set my hand and official seal the day and year first above written.

LAURA ANN GARRICK
Commission # 1450597
Notary Public - California
Los Angeles County
My Comm. Expires Nov 22, 2007

Print Name: Laura A. Garrick
Notary Public in and for the State of CA.,
Residing at Los Angeles
My commission expires: November 22, 2007

LA1 792510v.2

Schedule A

LEGAL DESCRIPTION OF PROPERTY

NEW LOT 2 OF CITY OF LAKE FOREST PARK SHORT PLAT NO. SP99-79, RECORDED MARCH 7, 2000 UNDER RECORDING NO. 20000307900002, IN KING COUNTY, WASHINGTON.

Figure 1

[attach site plan showing location of Plume, DDC Wells and Monitoring Wells]

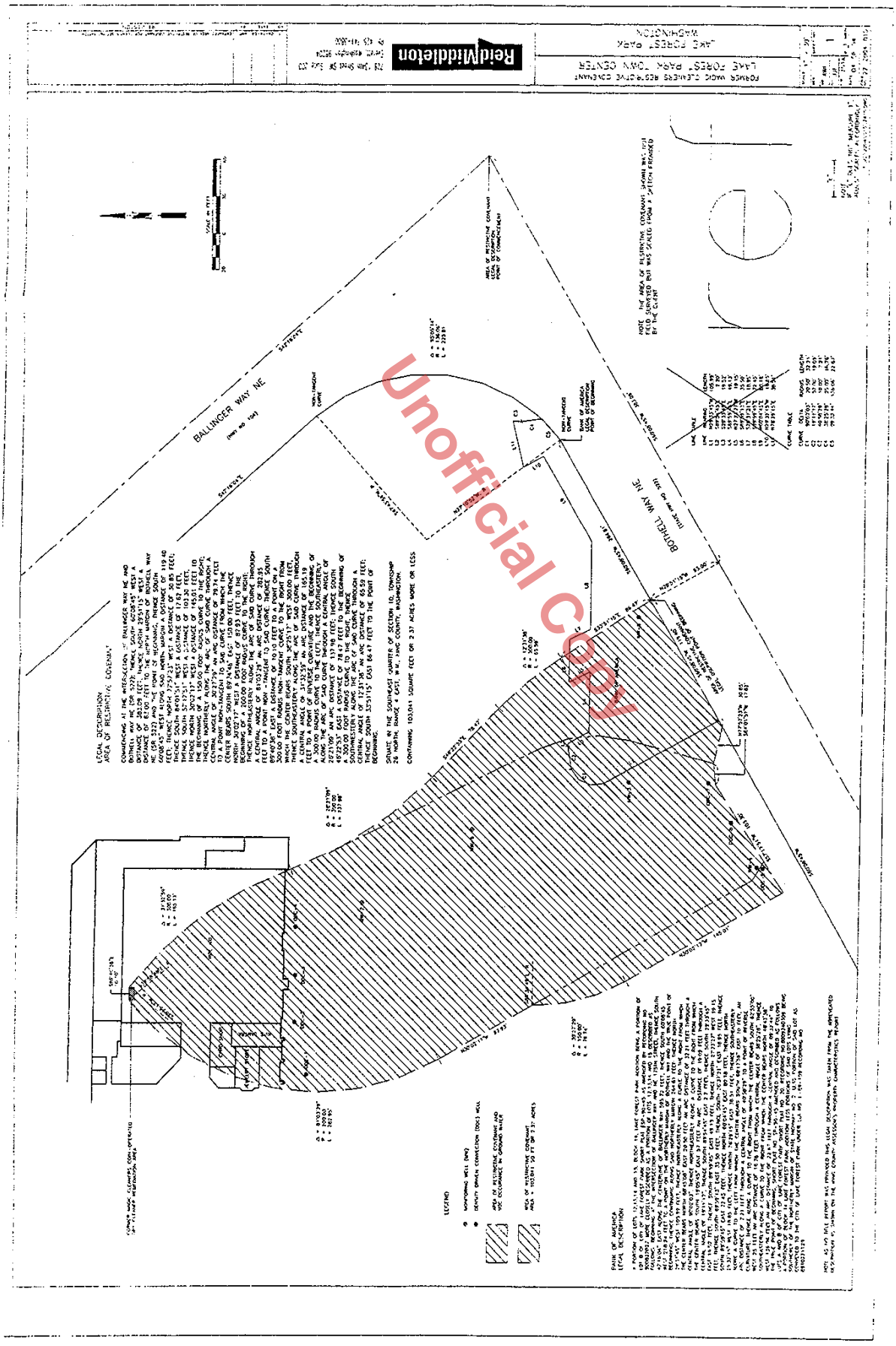
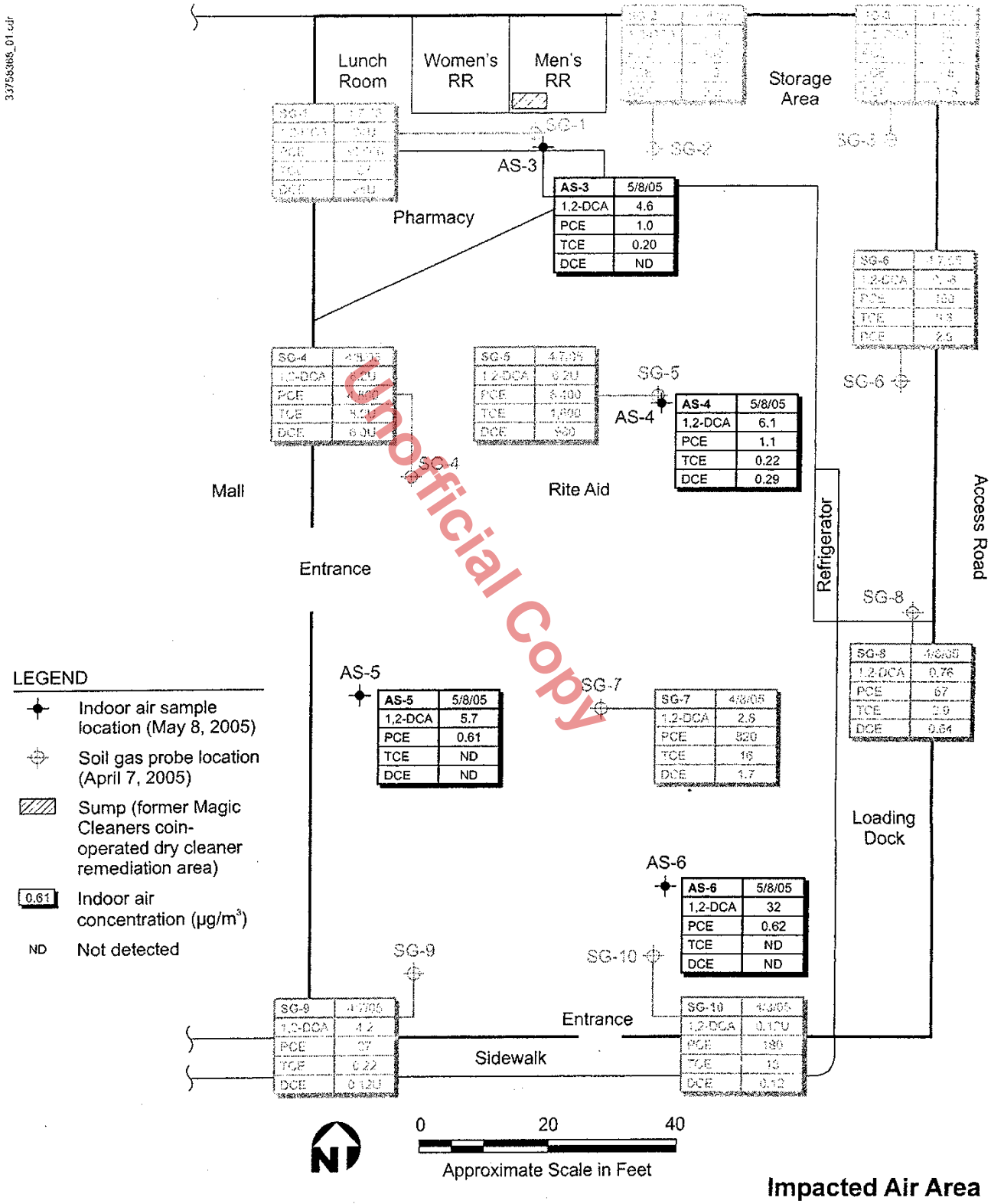

Unofficial Copy
BALLINGER WAY NE
BOTHELL WAY NE
LEGAL DESCRIPTION
AREA OF RESTRICTIVE COVENANT
LEGEND

Figure 2

Impacted Air Area

[attach site plan of impacted Rite Aid Area]



Impacted Air Area
(From URS Indoor Air Quality Assessment Report Dated June 16, 2005)

Job No. 33758368

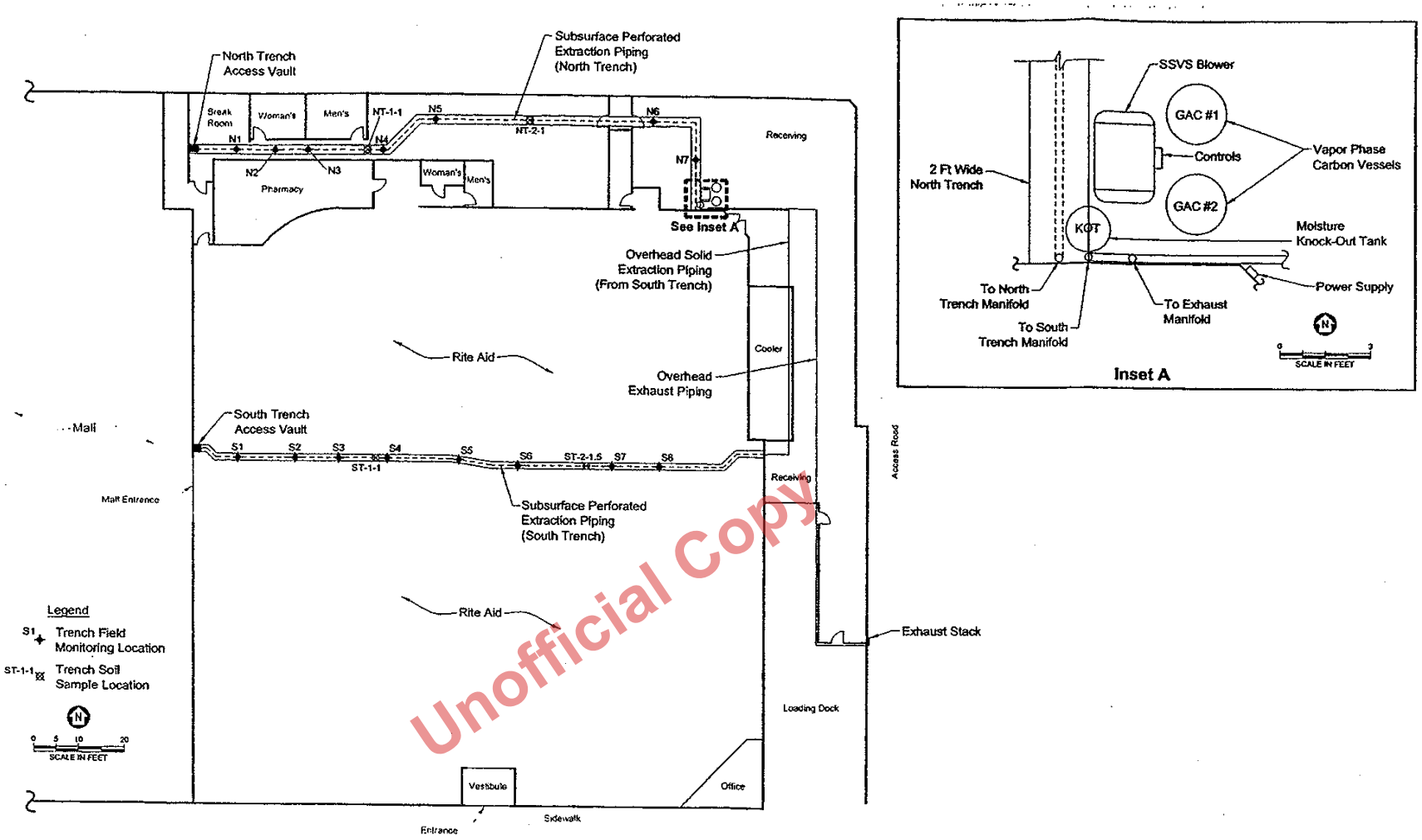
URS

Former Magic Cleaners
Lake Forest Park, Washington

Figure 3

Subslab Ventilation System

[show site plan of location of Subslab Ventilation System]



FILENAME: O:\geo\Rite Aid\Figure 5.dwg
Job No. 33757930 EDIT DATE: 02/09/06 AT: 14:56

URS

Figure 5
As-Built SSVS Site Plan

Former Magic Cleaners
Lake Forest Park, Washington

Exhibit I

DDC System O&M Manual

WASATCH ENVIRONMENTAL, INC.
ENVIRONMENTAL SPECIALISTS

WASATCH GEOTECHNICAL, INC.
SOILS AND FOUNDATION ENGINEERS

Mr. David Raubvogel
URS, Corporation
Century Square1501 4th Avenue, Suite 1400
Seattle, Washington
98101

October 21, 2001
1494-02.O&M

SUBJECT: As-Built Report & Operation and Maintenance Manual
Former Magic Cleaners
Lake Forest Park Town Center Mall
Lake Forest Park, Washington

In accordance with project requirements, Wasatch Environmental, Inc. is providing the attached As-Built Report & Operation and Maintenance Manual for the density driven convection groundwater and soil remediation systems located at the Lake Forest Park Town Center Mall in Lake Forest Park, Washington.

There are two separate systems which have been installed at this site; the first (System #1) is located immediately south of a Rite Aid drug store and the second (System #2) is adjacent to the Bank of America building. There are four DDC wells associated with System #1 and three DDC wells associated with System #2. The remediation equipment enclosures for System #1 and #2 are located along the south exterior wall of Rite Aid and immediately west of Bank of America, respectively.

This As-Built Report and Operation and Maintenance Manual consists primarily of figures which document the system components, construction photographs, vender equipment information, well logs, and well maintenance instructions. These data have been broken up into 13 Appendixes (A through M). The text of this report discusses the key construction details and then provides guidance on proper maintenance procedures for individual components of the remediation system. Detailed Operation and maintenance instructions as well as warranty information for Kasaer blowers have been included in Appendix B. URS personnel responsible for maintaining the DDC systems, should carefully review details presented in Appendix B. A checklist of the suggested items to monitor during site visits is presented in Appendix M. Only individuals with proper training and experience in forced air remediation, should operate or maintain these systems.

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical and environmental engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied.

Should you have any questions, please do not hesitate to contact us.

Sincerely,

WASATCH ENVIRONMENTAL, INC.

L. Boyd Breeding

L. Boyd Breeding, P.HG., P.E.
Science and Engineering Department Manager

Copies: (1) Addressee

TABLE OF CONTENTS

List of Appendices

AS-BUILT REPORT
OPERATIONS AND MAINTENANCE MANUAL
MAGIC CLEANERS DDC SYSTEM
LAKE FOREST PARK TOWN CENTER
LAKE FOREST PARK, WASHINGTON

Prepared for:

David Raubvogel
URS Corporation
1400 Century Square
1501 4th Avenue
Seattle, Washington

Prepared by:

Wasatch Environmental, Inc.
2410 West California Avenue
Salt Lake City, Utah

AS-BUILT REPORT

Two density driven convection (DDC) groundwater remediation systems were installed at the subject site during August and September of 2001. The remediation systems were installed as proposed in the URS/Wasatch Environmental Subcontractor Agreement (Work Order Number 1) dated July 10, 2001.

A general process flow diagram for the two closed loop DDC systems is presented in Figure 1. The closed loop design results in the stripping of dissolved halogenated volatile organic compounds (HVOCs) from groundwater and then the sorption of the HVOCs onto vapor phase carbon within each equipment enclosure.

The two DDC systems are referenced throughout this report as System #1 and System #2. One system was installed immediately south of the Rite Aid drug store (System #1) and the second adjacent to the Bank of America building (System #2). There are four DDC wells associated with System #1 and three associated with System #2. Layouts for each system are presented in Figures 2 and 3.

SYSTEM #1

The equipment and materials installed for System # 1 consist primarily of buried air supply and vapor return piping, a moisture knockout with an automated sump drain system (KO #1), a positive displacement blower, valves, gages, vapor phase carbon, and a ventilation fan.

The buried pipe consisted of 2-inch steel to deliver the air to each DDC well and 2-inch PVC schedule 40 to return air from the wells to the vapor phase carbon. Construction photographs of the buried air supply and vapor return piping are presented in Appendix A. A 6-inch diameter moisture knockout was placed in the return line to allow for the removal of water which would otherwise collect within the buried vapor return piping. The specifications for the moisture knockout and automated sump pump system are presented in Figure 4, annotated photographs are provided in Appendix A, and vender cut sheets have been included in Appendix B. The sump pump is activated by an electronic float switch. When activated, the sump pump will remain on for approximately 45 seconds in order to remove water which has accumulated within the knockout. An off delay timer is located within the electrical control panel and can be hand adjusted to set the run time for the sump pump. The range over which the off delay switch can be modified extends from 0.6 to 60 seconds.

The blower delivering air to the four DDC wells included in System #1 is a five horse power (HP) positive displacement blower, Kaeser Model Omega 21 (Omega PAK BB53). Electrical service provided to the blower is three phase, 208 volt. The Kaeser Service Manual is provided in Appendix C.

Vender cut sheets, and other pertinent information for the remaining equipment are provided in Appendixes E through I. The specifications, prepared by URS, for the bricked equipment enclosure for System #1 are presented in Appendix I. Work Permits granted by the City of Lake Forest Park are included in Appendix J. DDC well logs for System #1 (DDC wells 1,2,3, and 4) are provided in Appendix K.

SYSTEM #2

The equipment and materials installed for System # 2 consists primarily of buried air supply and vapor return piping, a moisture knockout (KO #2), a moisture knockout with automated sump drain system (KO #3), a positive displacement blower, valves, gages, vapor phase carbon, and a ventilation fan.

The buried pipe consisted of 2-inch CPVC to deliver the air to each DDC well and 2-inch PVC schedule 40 to return air from the wells to the vapor phase carbon. Construction photographs of the buried air supply and vapor return piping are presented in Appendix A. Two 6-inch diameter moisture knockouts were placed in the return line to allow for manual (KO #2) and automated (KO #3) removal of water from the buried vapor return piping. The locations for these two knockouts are shown on Figure 3, specifications for the automated sump drain and sump pump system are presented in Figure 4, and vender cut sheets have been included in Appendix B. The sump pump is activated by an electronic float

switch. When activated, the sump pump will remain on for approximately 45 seconds in order to remove water accumulated within the knockout. An off delay timer is located within the electrical control panel that can be hand adjusted to modify the run time for the sump pump. The range over which the timer can be set, extends from 0.6 to 60 seconds.

The blower delivering air to the three DDC wells included in System #1 is a 5 HP positive displacement blower, Kaeser Model Omega 21 (Omega PAK BB53). Electrical service provided to the blower is three phase, 208 volt. The Kaeser Service Manual is provided in Appendix C.

Vender cut sheets, and other pertinent information for the remaining equipment are provided in Appendixes E through I. Well logs for System #2 (DDC wells 5,6 and 7) are provided in Appendix K. The enclosure supplied to house the System # 2 equipment was manufactured by Tuff Shed, Inc. Replacement keys (key number BT02) and touch up paint (Forest Green) are available through the Seattle branch of Tuff Shed, Inc.

OPERATION AND MAINTENANCE MANUAL

OPERATION

The air injection rate to each remediation well can be regulated by adjusting a gate valve located inside the steel manways. The steel manways are painted black and surround each DDC well. Access to the manways is obtained by removing the bolts which ring the top of each steel lid. The rate of vapor return from each well can also be regulated using a PVC ball valve located within each manway. The air injection rate should be slowly adjusted to prevent either the over flow of water from the manway or a sudden drop in well head pressure. If the air injection pressure drops too low (the valve is tightened too much) air will stop flowing to the well.

The air injection drop pipe is the 1.5-inch PVC schedule 80 pipe which has been inserted into the 6-inch DDC well. The length of the drop pipe is approximately 15 feet. The end of the drop pipe varies slightly from well to well but the average depth of the drop pipe below ground surface is 12 feet. The depth of submergence of the drop pipe will vary as water levels change, however immediately prior to startup, the depth of submergence varied among the seven DDC wells from approximately 8 to 10 feet.

Adjustments to the air injection rates would be required if the height to which water is lifted in DDC wells becomes out of balance or if air supply to one or more wells stops. Air flow would stop if the well head pressure no longer exceeds the pressure of the column of fluids above the bottom of the drop pipe. Since air is supplied to all wells within each system via a single main conduit, restoring air flow to a well would require one to slowly tighten the gate valve in one or more wells within the system. The process is intuitive and should readily be mastered by field personnel. When finished adjusting the DDC well head valves, replace the steel manway lids, adjust the gasketed seals to line up with the holes drilled in the manway flanges, and bolt down the lids. Secure the bolts only as tight as needed to form an air tight seal between the lid and the manway flange.

Measurement of system discharge pressure, return vacuum, temperature, and overall air injection rate, can be obtained using the supplied gages and tapped ports provided in each equipment enclosure. Operators should familiarize themselves with the location of the gages and valved ports for each system. The flow rate produced by the blowers is determined by measuring the pressure differential indicated on the magnahelic gages mounted on the wall of each equipment enclosure.

Appendix F contains a graph which allows for the conversion of the observed pressure differential readings to a flow rate. Use the curve for ACFM (actual cubic feet per minute) to estimate the flow rate of air passing through the flow meter. Use the SCFM (standard cubic feet per minute) to estimate the overall flow returning from the wells. The difference between these two flow rates represents the change in volume due to compression and then expansion of the air within the piping manifold. Further refinements of the flow rate are possible using the equations provided in Appendix F. These refinements are not ordinally required. Use the Monitoring Log in Appendix M to record your observations during site visits.

Operators should use the valved ports to sample air emissions from the DDC systems. Valved sampling ports exist before and after the carbon for both systems. Summa canisters are recommended for the collection of air samples submitted for laboratory analyses. Tedlar bags and a sample pump capable of overcoming the line vacuum may be preferable for on site screening with a photoionization detector (PID).

Use the nested piezometers installed in DDC well # 2 (System #1) and DDC Well #6 (System #2) to evaluate the well bore gradient and to monitor for stripping efficiency. Water elevation measurements and groundwater samples should generally be collected with the system in operation. It may be desirable, on some occasions, to turn off the DDC system and monitor for static water levels in the deep piezometers. When monitoring for static conditions, make sure to allow enough time for water levels to stabilize. Comparison of static water levels to the water levels measured while the system is in operation allows one to estimate groundwater flow rates through the well. The flow estimate is based primarily on

the draw down observed in the deep DDC piezometer and the hydraulic conductivity of the aquifer.

Under typical monitoring conditions the DDC system would remain on. The following procedures describe a typical groundwater sampling event designed to evaluate the DDC well stripping efficiency. Prior to sampling, purge approximately three well bore volumes from the deep piezometer. This removes stagnant water from the casing prior to sample collection. Purge approximately one gallon from the shallow piezometer as it is screened across the static water level elevation and will not have significant stagnant water present. Following purging, collect groundwater samples from the piezometers by simultaneously lowering bailers into the shallow and deep piezometers. Analyses of groundwater samples collected in this manor allows for comparison of inlet and outlet HVOC concentrations. These data may then be used to evaluate the DDC well stripping efficiency. An air emissions sample (prior to the carbon) should also be collected from approximately the same time interval. This allows for the comparison of mass removal estimates based on stripping efficiency in the DDC well to the mass removal estimates based on air sample analyses.

MAINTENANCE

Kaeser Blower Maintenance

The Kaeser Service Manual for the System #2 blower is provided in Appendix C. The Service Manual for the System #1 blower was left with URS personnel during startup. Please include this manual in Appendix C as it presents technical specifications and lists the serial number for this blower. The blower technical specifications are as presented on page 1-1 of each Service Manual. The recommended blower lubricant and maintenance schedule are presented on Service Manual pages 1-2 and 9-19, respectively. The sheave, belt, and inlet air filter replacement part numbers for each system are included in Appendix D.

DDC Well Maintenance

Biological or chemical precipitate fouling could require system modification or redevelopment of the DDC wells. Evidence of fouling is generally evident on the upper portion of the drop pipe. Evidence of carbonate scale would initially take the form of a paper thin coating on the outside wall of the DDC drop pipe. Even if scaling is not immediately apparent, it may be necessary to pull the drop pipe and examine the lower portions of it. The drop pipe may be removed by disconnection of a union fitting. If precipitate scaling does not occur within the first three months of operations it is unlikely to do so in the future. Based on geochemical analyses performed on groundwater prior to system design, carbonate scaling is unlikely to form at this site.

Iron fouling through biological process (iron bacteria) or chemical precipitation (ferrous hydroxides) may also form within the well. If an unknown form of precipitate or biofouling is observed, either on the drop pipe or within the DDC well, refer to the information provided in Appendix L for assistance in identifying the form and the selecting the appropriate treatment option(s). The information in Appendix L is designed for maintenance of drinking water wells but the methods of identification and treatment may be applicable at your site. Wasatch is available to assist on a time and materials basis, should URS require our services in this area.

Gages

The magnehelic pressure differential gages should be isolated from the valved ports until the operator wants to measure the air supply flow rate. This can be accomplished by closing the valves provided on the DS300 flow sensors.

Protection of Buried Pipe From Excessive Heat

Care should be taken to ensure that the blower discharge temperature for System #2 does not exceed the design temperature (180 ° F) for the buried, CPVC, air supply pipe. A manifold consisting of 0.5-inch copper tubing has been inserted in the air discharge line in order to provide for the removal of heat from the discharge line. The copper pipe manifold has been set in front of the ventilation fan for System #2 to enhance heat transfer.

To control discharge temperature, make sure that the discharge pressure of the blower is at the minimum level required for proper operation of the DDC wells. Unnecessary excess pressure could be generated by over tightening all of the DDC well head gate valves or by over tightening the 2-inch bronze gate valve located within the equipment enclosure. After adjusting any gate valve, observe the blower discharge temperature. Maintain the temperature for System # 2 at 165 ° F or less.

The blower discharge temperature is also dependant on the temperature of the air returning to the blower. Since the DDC systems installed at the Lake Forest Park Town Center are closed loop in design, the inlet temperature should remain relatively constant throughout the year. The temperature of the return air should be within a few degrees of the native groundwater/soil temperatures. Despite this moderating effect on the blower inlet air temperature, inspection of the site should be done on the first hot (>90 ° F) summer day. Also ensure that the hand adjustable thermostat regulating the System #2 ventilation fan is set so that the fan runs continuously if the blower discharge exceeds 140 ° F. It is recommended that the thermostat regulating the System # 2 ventilation fan be set at its minimum setting unless frost forms on the cooper manifolding. The thermostat is located on the south wall of the System #2 shed.

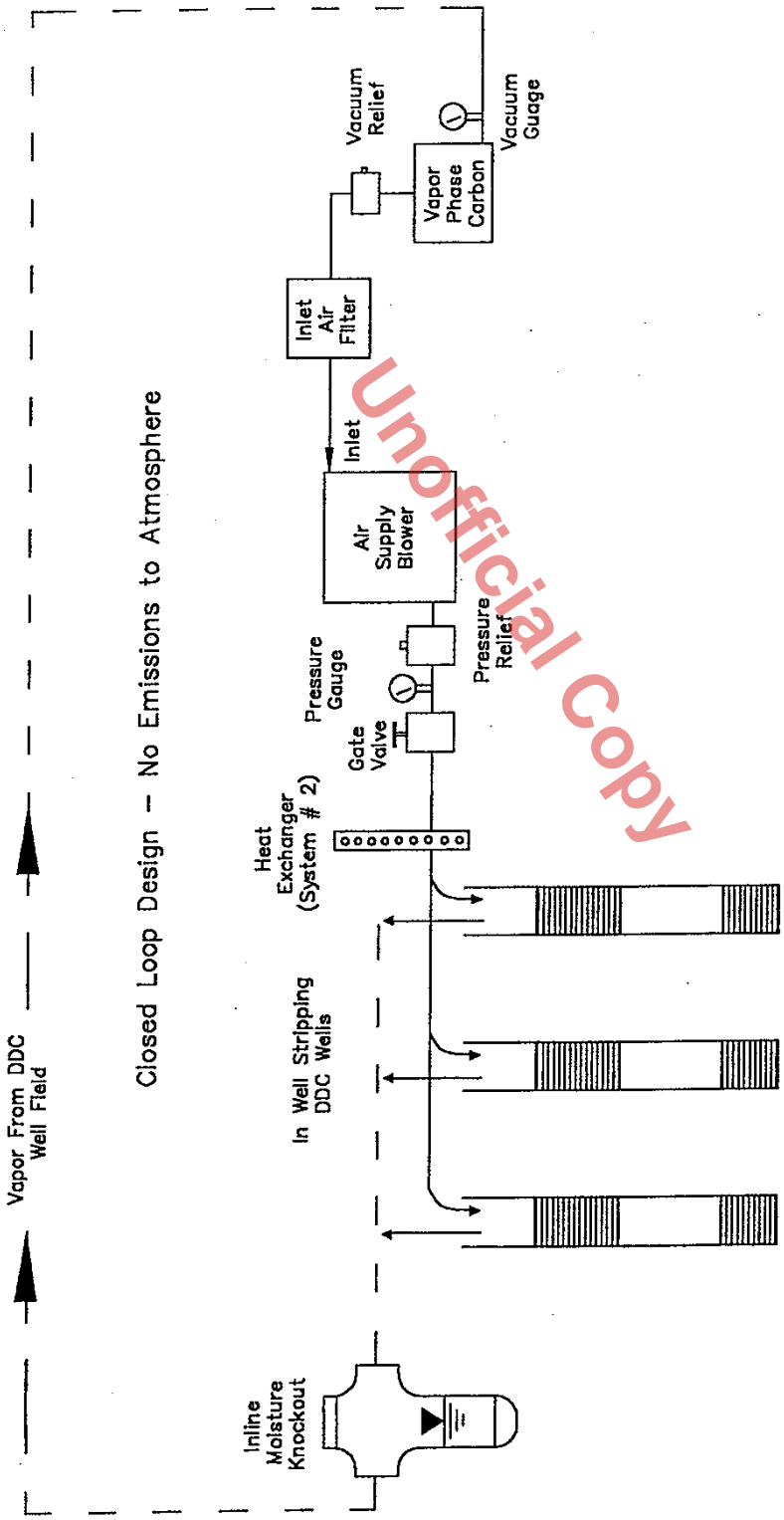
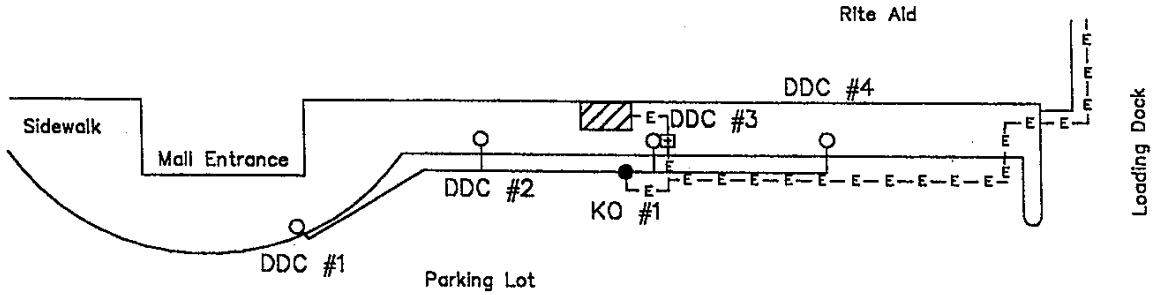


Figure 1: Process Flow Diagram for Systems #1 and #2
WEI MAGIC CLEANERS



LEGEND

- DDC well (4)
- Moisture knockout on vapor return (1)
- Bricked Equipment Enclosure
- Electrical Junction Box
- Buried Electrical Conduit
- Buried 2" Carbon Steel Air Supply and 2" PVC Sch 40 Vapor Return Piping

APPROXIMATE SCALE (ft.)
0 20 40 80

Figure 2: System #1
WEI MAGIC CLEANERS

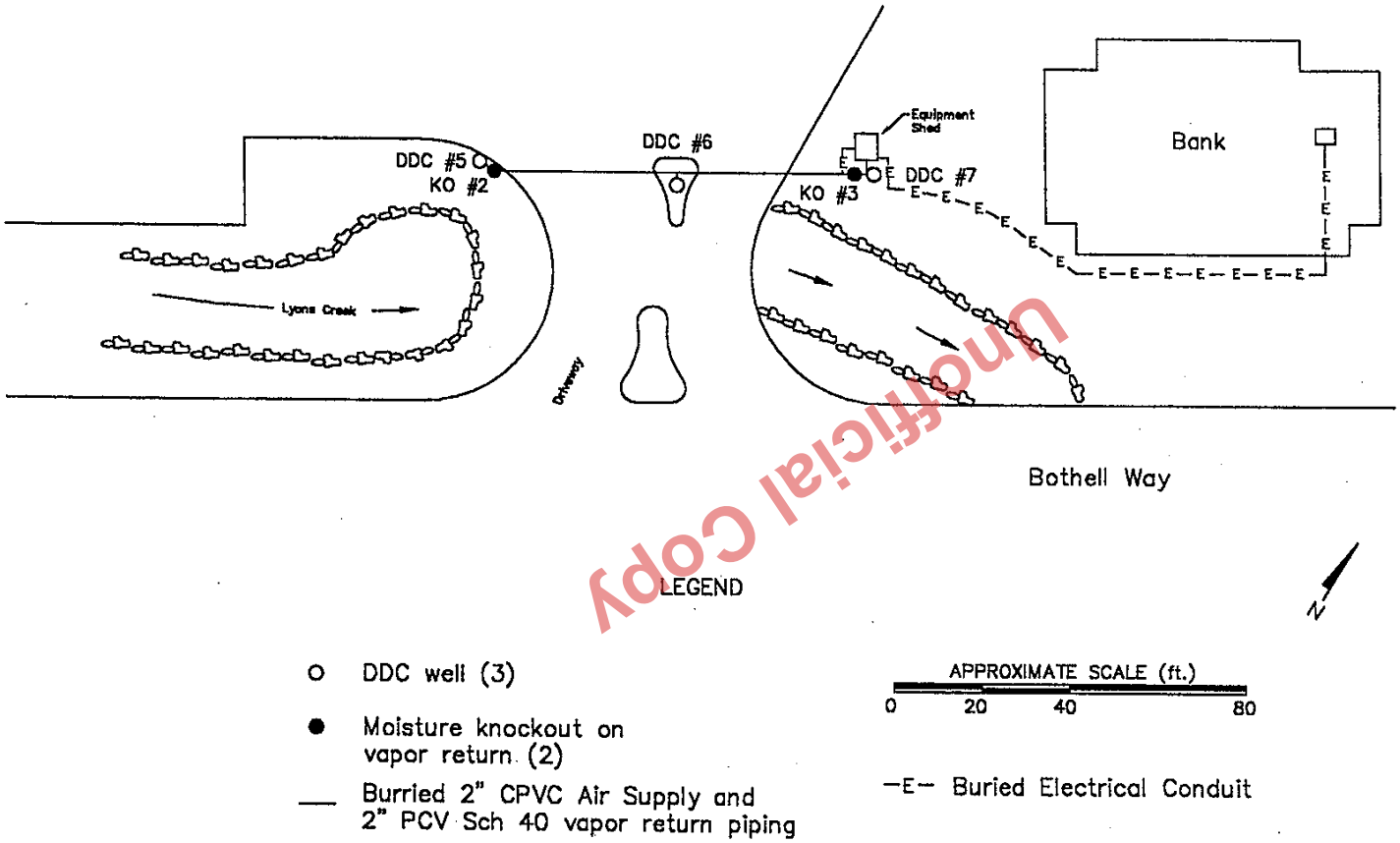


Figure 3: System #2
WEI MAGIC CLEANERS

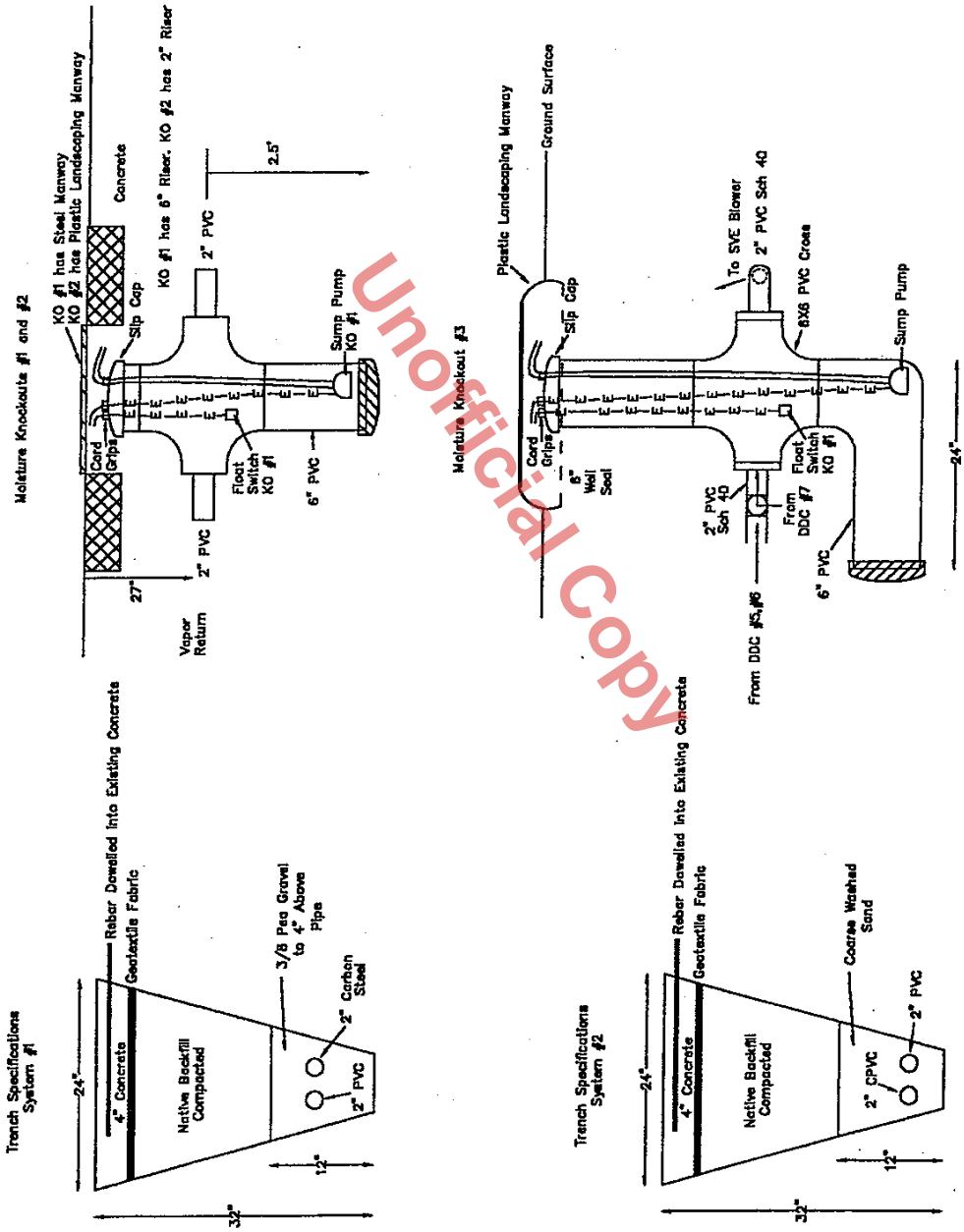
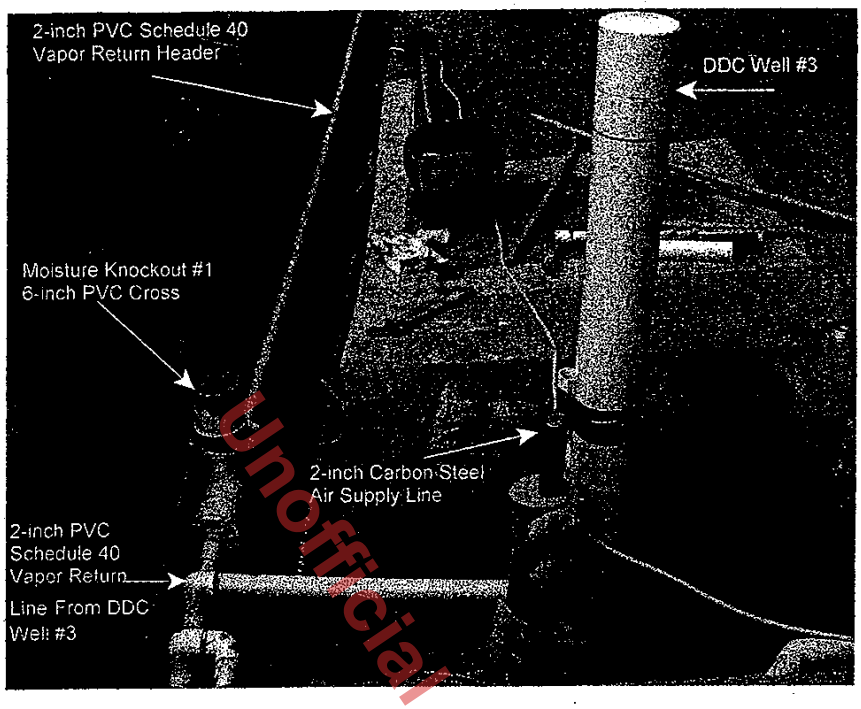
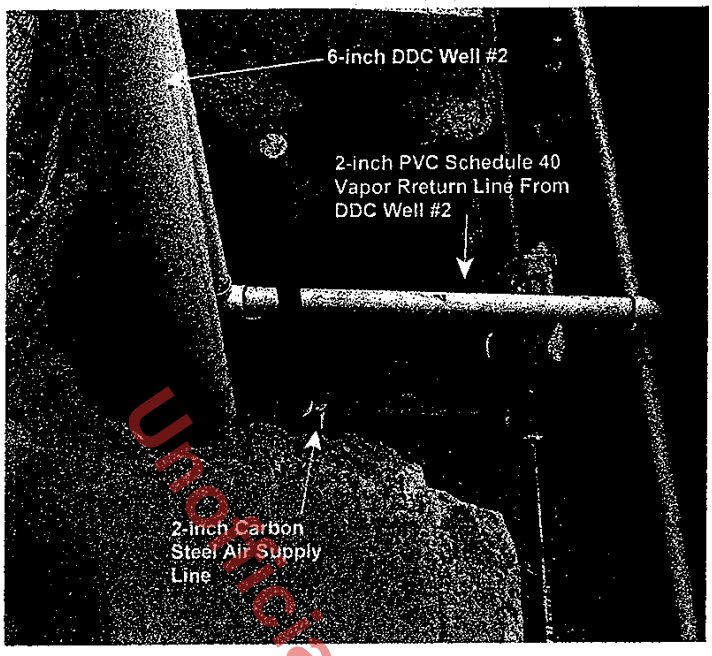


Figure 4: As Built Details For Trenches and Moisture Knockouts
WEI MAGIC CLEANERS



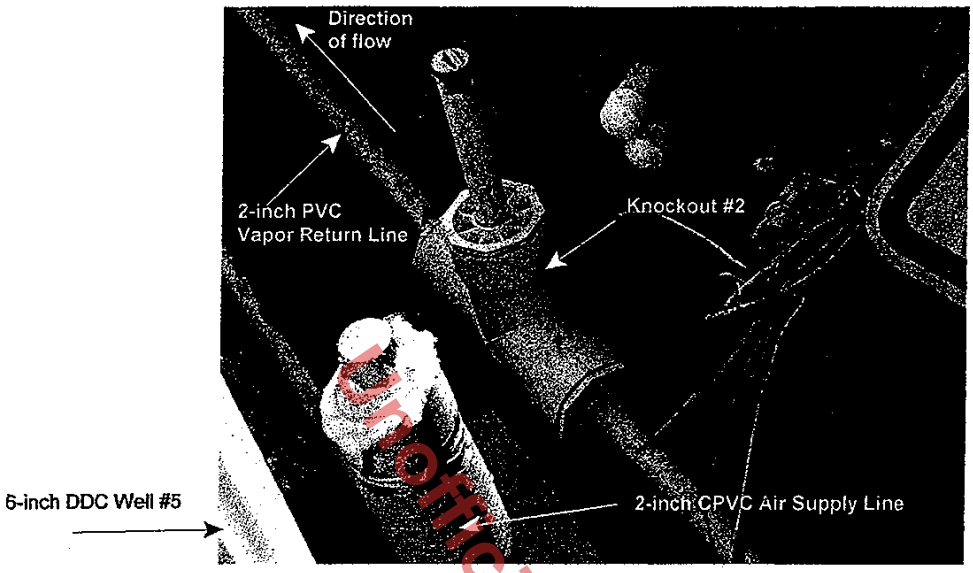
Knockout #1 and DDC Well #3 Piping

2-inch Carbon Steel Air Supply Header For System #1

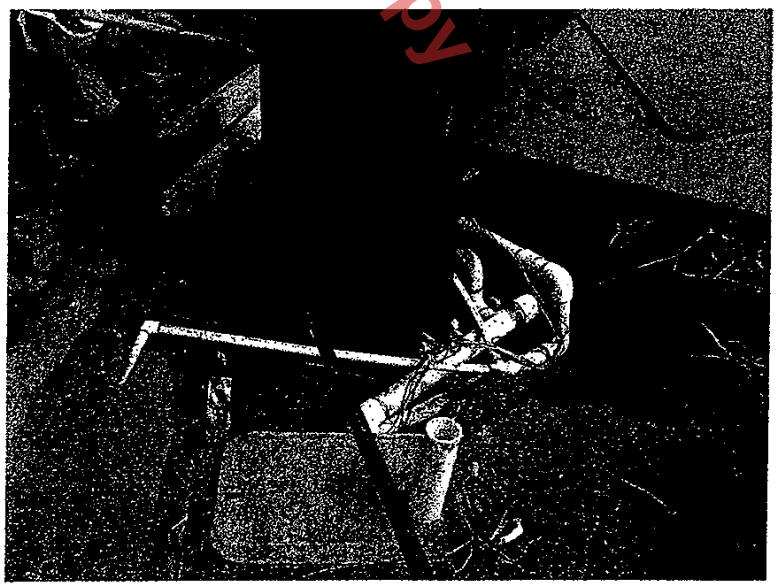


DDC Well #2 Piping

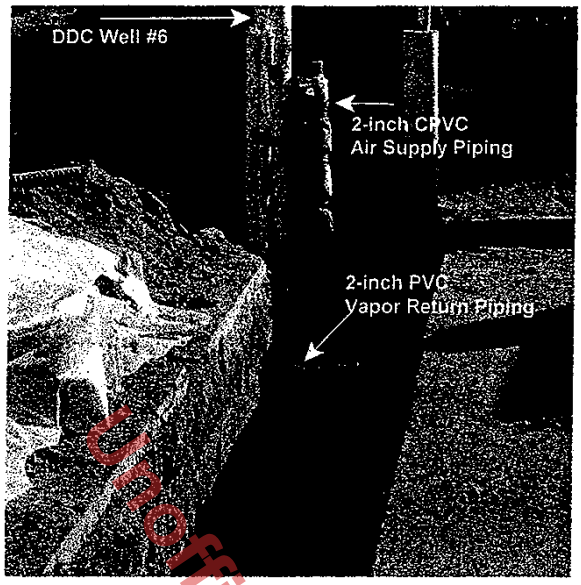
Manway Completion For DDC Well #1



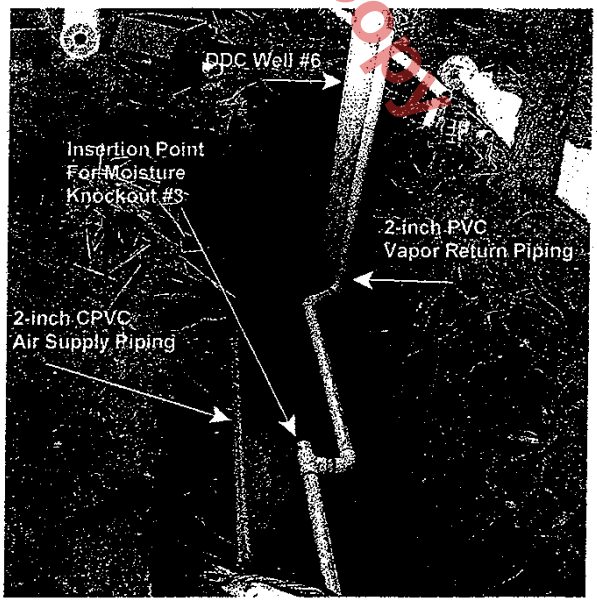
Moisture Knockout #2 and Piping To DDC Well #5



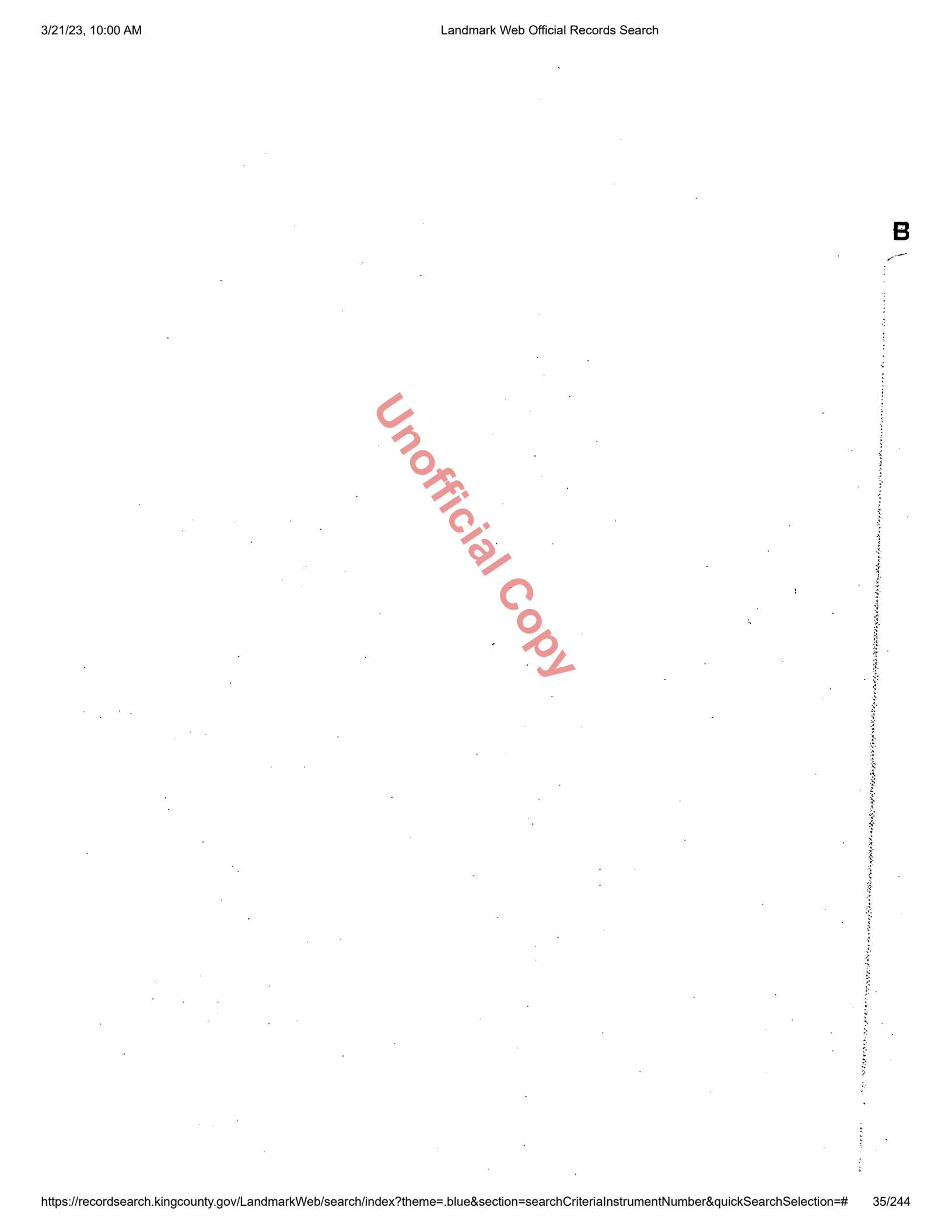
Irrigation Piping and Manway For DDC Well #5



DDC Well #6 Piping



DDC Well #7 Piping and Knockout #3 Location


B
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NEW STUFF!

Pumps
Submersible/Centrifugal

Order today! phone | fax | visit | www.grainger.com

Little GIANT Pump Company

New


No. 4RK92


No. 2P495

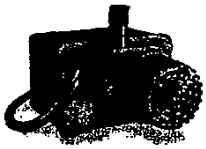

No. 1P553


No. 1P939


No. 4RK93


No. 1P321


No. 3P733


No. 4RK94


No. 1P372


No. 1P322

Compact Submersible Centrifugal Pumps

Ideal for fountains, water gardens, coolant systems, evaporative coolers, masonry wet saws, and other liquid moving applications. Low-pressure and high-volume. Nos. 1P372, 2P495, 3P734, and 1P323 can be run submerged or in open air. All are UL Listed except Nos. 1P553, 4XK38, and 4XK39.

Nos. 2P495, 1P553, 1P939, 1P321, 3P733, 1P372, 4XK38, 1P323, 4XK39, and 1P322 are oil-filled and have epoxy-coated die cast aluminum motor housings (except No. 2P495, which has nylon housing). Nos. 4RK92, 3P734, 4RK93, and 4RK94 have epoxy-encapsulated motors and polyester cases. Pumps have 6 ft., 3-conductor cords (except No. 1P553, which has 3 ft. cord). Pumps have removable inlet screens and volutes for easy cleaning. Nos. 4RK92 and 3P734 have polypropylene impellers, volutes, and screens. Nos. 4RK93, 3P733, 1P321, 1P372, 1P323, and 1P322 have nylon impellers and volutes, and polypropylene screens (no screen included with 3P733). Nos. 1P553 and 1P939 have polypropylene impellers and volutes, and polyethylene screens. No. 2P495 has nylon impeller, volute, and screen. All pumps are 115V, 60 Hz, except Nos. 4XK38 and 4XK39 which are 230V, 50/60 Hz.

No. 4RK94 has nylon impeller, polypropylene volute, and polyethylene screen. Nos. 4RK92, 4RK93, 4RK94, 1P323, and 1P922 have Viton shaft seals. Nos. 3P734, 2P495, 1P553, 1P939, 3P733, 1P321, and 1P372 have nitrile shaft seals. Nos. 4XK38 and 4XK39 have 12-foot power cord without plug.

Uses: For use with nonflammable liquids, ranging from 30 to 120°F, which are compatible with pump component materials.

Inlet FPT (In.)	Outlet MPT (In.)	Delivery in Gallons Per Hour 1 Ft.	3 Ft.	5 Ft.	9 Ft.	11 Ft.	13 Ft.	22 Ft.	Max. Head (Ft.)	Equiv. PSI	Motor HP	Dimensions (In.) Height	Width	Length	Little Giant Model	Stock No.	List	Each	Ship Wt.
PUMP CAPACITIES WITH INLET—OUTLET SIZES											COMPACT SUBMERSIBLE CENTRIFUGAL PUMPS								
Hooded	1/8	80	50	—	—	—	—	—	4.5	2.0	1/250	2¼	3	2¾	PE-A	4RK92	$47.55	$41.40	3
Smooth	1/4	120	70	—	—	—	—	—	4.6	2.0	1/160	3½	3	3¾	P-AAA	2P495	52.68	45.95	3
Smooth	1/4	170	140	100	—	—	—	—	7.0	3.0	1/200	4	3¾	4⅛	1-AA	1P553	55.78	48.23	3
Smooth	1/4	170	140	100	—	—	—	—	7.0	3.0	1/200	4	3¾	4¼	1-A	1P939	58.88	50.72	3
Smooth	1/4	170	140	100	—	—	—	—	7.0	3.0	1/125	3⅝	2¾	3¼	PE-1	3P734	55.21	48.65	2
Hooded	1/4	300	255	205	—	—	—	—	12.2	5.3	1/40	4 15/16	2 13/16	4 13/16	PE-2H	4RK93	68.54	55.89	4
Hooded	1/4	300	255	205	115	115	—	—	11.8	5.1	1/40	4½	3½	5½	2E-N	1P321	77.47	67.38	5
1/4 (1/2" MPT)	1/4	205	168	120	—	—	—	—	7.4	3.2	1/150	4⅝	4½	4½	1-42	3P733	59.91	56.30	3
Smooth	3/8	475	440	395	—	—	—	—	13.4	5.8	1/28	4	4	4½	PE-2.5F	4RK94	94.07	82.80	4
3/8	1/4	300	255	205	115	115	—	—	11.8	5.1	1/40	4½	3½	5½	2E-38N	1P372	80.56	69.66	5
3/8	1/4	300	255	205	115	55	—	—	11.8	5.1	1/40	4¾	3½	5½	2E-38NY	4XK38	96.10	75.56	5
1/2	1/2	500	435	337	255	255	163	—	17.3	7.5	1/15	5½	4½	7	3E-12N	1P323	124.27	108.11	6
1/2	1/2	600	580	517	414	325	290	—	21.0	7.5	1/15	4¾	4½	7	3E-12NRY	4XK39	166.80	137.66	6
3/4	1/2	810	790	745	630	630	475	80	24.5	10.6	1/12	5½	4½	7	4E-34NR	1P322	175.77	152.25	6

Little GIANT Pump Company


No. 2P016

No-Korode Submersible Chemical Pumps

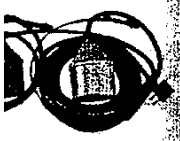
Operate horizontally or vertically, fully submerged in mild acids and alkalis, machine tool coolants up to 100 SSU and other nonflammable liquids compatible with pump component materials. Pumps are highly resistant to corrosion. Motor housing is glass-filled nylon. Impeller, pumping head, and removable screen are nylon. Viton shaft seal. Thermal overload protected motor.

- 1/4" male NPT discharge.
- 115V, 60 Hz motor
- 6 ft., 3-conductor cord set
- Handles pH range from 5 to 9
- 4 9/16H x 5 1/16W x 5½"L

Repair Parts Available
1-800-323-0620

Motor HP	Capacity GPH @ Total Feet of Head 1 Ft.	3 Ft.	5 Ft.	7 Ft.	9 Ft.	Max. Head (Ft.)	Equiv. PSI	Little Giant Model	Stock No.	List	Each	Ship Wt.
1/150	210	180	150	105	50	10.1	4.4	NK-1	2P016	$69.21	$59.05	3.6
1/40	325	300	270	230	185	12.3	5.3	NK-2	2P017	83.68	71.05	4.2

WITCHES



lo. 4RK19

tock No.	List	Each
K04	$28.11	$22.49
K05	40.87	32.70
K06	40.87	32.70
21	75.74	54.10
22	75.74	54.10
15	56.91	40.65
29	44.03	31.45
16	56.84	40.60
7	90.09	64.35
3	96.39	68.85
4	104.58	74.70
8	90.09	64.35
5	96.39	68.85
1	104.65	74.75
	51.12	40.90
	66.00	52.80
	76.31	61.05
	.18	26.55
	46.62	37.30
	63.07	45.05
	48.65	34.75
	142.38	101.70
	142.66	101.90
	145.39	103.85
	145.39	103.85
	84.64	73.60
	84.64	73.60
	100.68	87.55
	100.68	87.55
	45.08	32.20
	97.37	69.55

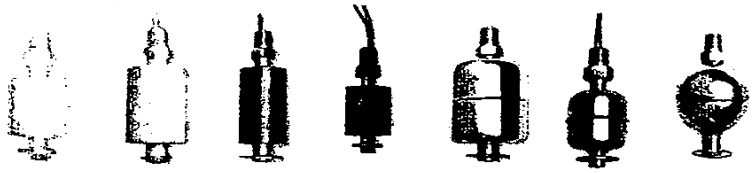
VERTICAL LIQUID LEVEL CONTROLS

Madison

CE NSE

SP. General Purpose LR56150 Explosion Proof LR26414 (No. 2A551 only)

UL General Purpose E54633 Explosion Proof E150881 (No. 2A551 only)



No. 2A554 | No. 2A552 | No. 2A553 | No. 4YM35 | No. 2A551 | No. 4YM31 | No. 4YM33

All Models

- Magnetically actuated dry reed switch
- Used for alarm circuits controlling motor starters, contactors, solenoids, and relays
- Switches have 22 gauge, 24" leads
- User selectable normally open or normally closed switch operation

No. 2A554 and 2A552

- Polypropylene switch for general purpose applications and acidic conditions

No. 2A553

- Seamless formed floats
- FDA approved materials
- Buna N float with brass stem for fuels
- Excellent for low specific gravity fluids
- Use with lubricating/hydraulic oils and solvents

No. 4YM35

- Buna N float and PBT stem for small diameter applications

Nos. 2A551, 4YM31 and 4YM33

- Economical switch for use with lubricating oil, hydraulic oil, gasoline and diesel oil
- 316 SS for high temperature, high pressure and corrosive conditions
- Highly polished for applications such as food processing
- No. 4YM33 specifically designed for high current applications

Float Material	Stem Material	Dimensions (in.) A	B	C	D	E (NPT)	Max. Temp. (°C)	Max. Press. (psi)	Watts (Resistive)	Madison Model	Stock No.	List	Each	Shpg. Wt.
Polypropylene	Polypropylene	2¼	1⅝	1	1	1/8	105	100	30	M8000	2A554	$14.42	$11.09	0.1
Polypropylene	Polypropylene	3⅜	2⅝	2	1½	1/4	105	100	60	M8800	2A552	35.53	35.20	0.2
Buna N	Brass	3⅜	2⅝	2	1½	1/4	105	150*	60	M4300	2A553	27.81	27.55	0.3
Buna N	PBT	2¼	1⅝	1	1	1/8	105	150*	30	M7000	4YM35	16.48	12.67	0.1
316 SS	316 SS	3¼	2⅝	2	2⅛	1/4	200	200	60	M5600	2A551	39.65	39.30	0.3
316 SS	316 SS	2¼	1⅝	1	1⅛	1/8	200	300	30	M5000	4YM31	29.87	26.05	0.3
316 SS	316 SS	3¼	2⅝	2	2	1/4	200	500	360	M5600-PR	4YM33	63.03	54.95	0.3

* NSF approved.

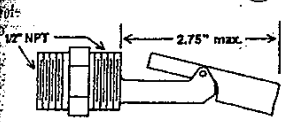
HORIZONTAL LIQUID LEVEL CONTROLS

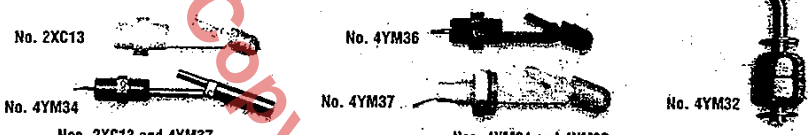
Madison

CE NSE

SP. General Purpose LR56150 Explosion Proof LR26414 (No. 4YM34 only)

UL General Purpose E54633 Explosion Proof E150881 (No. 4YM34 only)





No. 2XC13 | No. 4YM36 | No. 4YM34 | No. 4YM37 | No. 4YM32

All Models

- Magnetically actuated dry reed switch
- Used for alarm circuits controlling motor starters, contractors, solenoids and relays
- Switches have 22 gauge, 24" leads
- User selectable normally open or normally closed switch operation

No. 4YM35

- Polybutylene Terephthalate switch for small diameter fuel and lubricating oil applications
- Mounts inside tank or outside tank

Nos. 2XC13 and 4YM37

- Polypropylene float and stem for general purpose and highly acidic conditions
- No. 2XC13 mounts inside or outside tank; No. 4YM37 mounts outside tank
- FDA approved materials

Nos. 4YM34 and 4YM32

- 316 SS for high temperature, high pressure and corrosive conditions
- 4YM34 for mounting from outside tank with conduit connector or inside tank
- 4YM32 for small diameter applications

Float Material	Stem Material	Max. Temp. (°C)	Max. Press. (psi)	Watts (Resistive)	Madison Model	Stock No.	List	Each	Shpg. Wt.
PBT	PBT	150	100	30	M7700	4YM36*	$22.66	$17.42	0.1
Polypropylene	Polypropylene	105	100	30	M8700	2XC13	19.57	15.05	0.1
Polypropylene	Polypropylene	105	100	30	M8790	4YM37	19.57	15.05	0.1
316 SS	316 SS	200	300	30	M5920	4YM34	108.15	94.25	0.3
316 SS	316 SS	200	300	30	M5010	4YM32	27.81	24.23	0.1

(*) Not NSF approved.

SUBMINIATURE LIQUID LEVEL CONTROLS

No. 4YM29

No. 4YM30

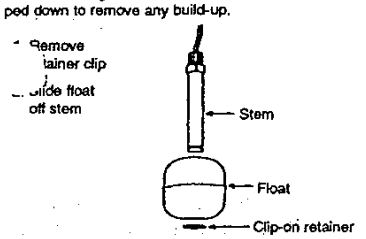
Nos. 4YM29 and 4YM30

- Low-cost polypropylene subminiature switch for applications with severe space constraints; normally closed or normally open (No. 4YM30 normally open.) 22 gauge, 24" leads.

Float and Stem Material	Max. Temp. (°C)	Max. Press. (psi)	Watts (Resistive)	Madison Model	Stock No.	List	Each	Shpg. Wt.
Polypropylene	105	50	15	M3326	4YM29	$18.02	$13.86	0.1
Polypropylene	105	50	15	M3326-NO	4YM30	18.02	13.86	0.1

Maintenance

aintenance should consist of inspection to see that the float is
e to move and not coated with any substance which would
ange its weight or volume significantly. If this occurs, the float
ould be removed for cleaning. This is easily accomplished
thout disturbing the installation. In addition, the stem may be
ped down to remove any build-up.

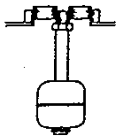


e only repair possible in the field is the replacement of either
float or stem. Dents or nicks on the float are usually of no
nsequence to operation.

Installation

NC Operation:
SS Floats: Witness mark (round circle) down.
Plastic Floats: Magnets up.

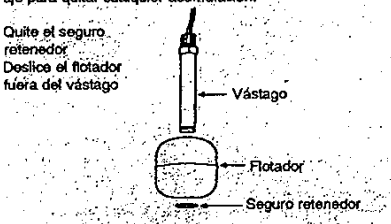
NO Operation:
SS Floats: Witness mark (round circle) up.
Plastic Floats: Magnets down.



Model	Max. Temp.	Max. PSIG	Watt Rating
M5600	200°C	200	60
M5400	200°C	200	60
M5917	250°C	200	60
M8800	105°C	100	60
M8600	105°C	100	60
M8400	105°C	100	60
M7800	105°C	150	60
M4300	105°C	150	60
M4600	105°C	150	60
M9800	105°C	15	60
M5600-PR	200°C	500	360
M8060-PR	105°C	100	360
M8800-PR	105°C	100	360
M7800-PR	105°C	150	360

Mantenimiento

mantenimiento debe consistir en una inspección para verificar
e el flotador tenga libertad de movimiento y que no esté
bierto de ninguna sustancia que pudiese cambiar
nificativamente su peso o volumen. Si esto ocurre, deberá
itar el flotador para limpiarlo. Esto se logra fácilmente sin
ctar la instalación. Además, el vástago puede limpiarse hacia
ajo para quitar cualquier acumulación.

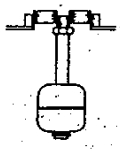


única reparación de campo posible es el reemplazo del
ador o del vástago. Las abolladuras o melladuras del flotador
malmente no tienen consecuencias para su operación.

Instalación

Funcionamiento Normalmente cerrado (NC):
Flotadores de acero inoxidable (SS):
Marca testigo (círculo redondo) abajo.
Flotadores de plástico: Imanes arriba.

Funcionamiento Normalmente abierto (NA):
Flotadores de acero inoxidable (SS):
Marca testigo (círculo redondo) arriba.
Flotadores de plástico: Imanes abajo.



Typical Current & Voltage Ratings

Watts	Voltage	Current Amps (Resistive)
60	220AC	0.4
	110AC	0.5
	120DC	0.2
	24DC	0.5
360	220AC	1.50
	110AC	3.00
	120DC	0.75
	24DC	3.00

Above ratings are for resistive loads only. For inductive loads, maximum life will be achieved if appropriate arc suppression is used.

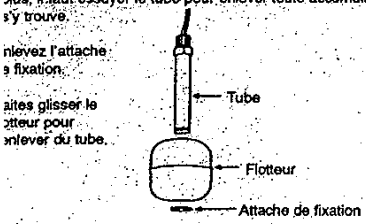
Las clasificaciones de arriba son sólo para cargas resistivas. Para cargas inductivas, se logrará una vida máxima si se usa la supresión de arco apropiada.

Les valeurs nominales ci-dessus sont uniquement pour les charges résistives. Pour les charges inductives, la durée de vie maximale sera atteinte si une suppression d'arc appropriée est utilisée.

Die oben angeführten Werte gelten nur für ohmsche Lasten. Für induktive Lasten muß eine geeignete Lichtbogenunterdrückung angewandt werden, um die maximale Lebensdauer zu erzielen.

Entretien

tretien devrait comporter une inspection pour vérifier que
otteur bouge librement et qu'il n'est pas recouvert d'une
stance quelconque pouvant en modifier le poids ou le volume
nanière importante. Si cela se produit, il faut enlever le flotteur
nettoyer, ce qui se fait facilement sans troubler l'installation.
lus, il faut essuyer le tube pour enlever toute accumulation
s'y trouve.

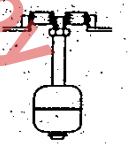


eule réparation possible sur le terrain est le remplacement
du tube soit du flotteur. En général les encoches et
elures sur le flotteur n'ont aucune conséquence sur le
ionnement.

Installation

Fonctionnement NF: Flotteurs en acier inox :
marque de repère (cercle rond) vers le bas.
Flotteurs en plastique: aimants vers le haut.

Fonctionnement NO:
Flotteurs en acier inox: marque de repère (cercle rond) vers le haut.
Flotteurs en plastique: aimants vers le bas.



Approvals

E54633

E150881 M5600
For Hazardous Locations Class I, Groups A, B, C, D; Class II, Groups E, F, G; Class III.

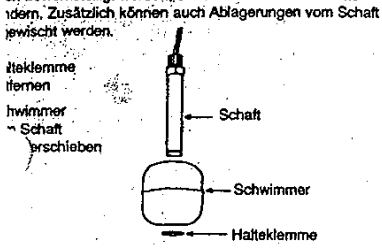
LR56150

LR26414-1 M5600
For Hazardous Locations Class I, Groups A, B, C, D; Class II, Groups E, F, G; Class III.

Models M5600, M5917, M8800, M8600, M9800

Wartung

Wartung sollte darin bestehen, zu sehen, ob die Schwimmer
eweglich und nicht mit Materialien überzogen sind, die ihr
icht oder Volumen wesentlich verändern. Ist dies der Fall,
ien die Schwimmer zur Reinigung entfernt werden. Dies kann
ch bewerkstelligt werden, ohne den Gesamteinbau zu
ndern. Zusätzlich können auch Ablagerungen vom Schaft
ewischt werden.

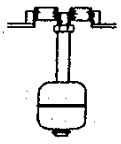


nzigen vor Ort durchführbaren Reparaturen sind der Ersatz
chwimmers oder des Schafts. Dellen oder Kerben am
mmer haben üblicherweise keine Auswirkung auf den Betrieb.

Einbau

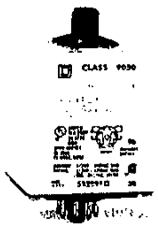
Funktion als Öffner
Edelstahlschwimmer: Markierung (runder Kreis) nach unten.
Plastikschwimmer: Magnete nach oben.

Funktion als Schließer
Edelstahlschwimmer: Markierung (runder Kreis) nach oben.
Plastikschwimmer: Magnete nach unten.



Madison Company
27 Business Park Drive
Branford, CT 06405
(203) 488-4477 • (800) 466-5383
Fax (203) 481-5036
email sales@madisonco.com
http://www.madisonco.com

Elec...cal Controls
Time Delay Relays



No. 5B405

SQUARE D GROUPE SCHNEIDER

LR25490 E42240

- ±1% repeat accuracy (constant voltage and temperature)
- 2VA maximum
- DPDT contacts
- 10 amp contact rating @ 120/240 VAC; rated 1/3 HP @ 120 VAC, 1/2 HP @ 240 VAC
- On Delay, Interval, and Repeat Cycle models have 100 mSec typical reset time; Off Delay and One Shot 40 mSec
- Transient protected (2,000V for 100 microsec.)
- Dimensions: 4.03H x 2.34W x 1.75"D
- See page 520 for sockets

VARIABLE TIME DELAY RELAY SPECIFICATIONS AND ORDERING DATA

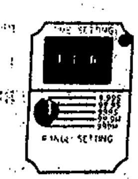
Knob Adjustable Timing Range	Input Voltage	Suggested Socket No.	No. of Pins	Square D Model 9050 . . .	Stock No.	List	Each	Shpg. Wt.
ON DELAY								
0.1-10 Sec.	24VAC/DC	5B586 or 5X852	8	JCK11V14	5B405	$50.00	$50.00	0.4
0.1-10 Sec.	120VAC/110VDC			JCK11V20	5B404	50.00	50.00	0.3
0.3-30 Sec.	120VAC/110VDC			JCK12V20	5B403	50.00	50.00	0.3
0.6-60 Sec. 1.2-120 Sec.	120VAC/110VDC	5B586 or 5X852	8	JCK13V20 JCK14V20	5B402 5B401	50.00 50.00	50.00 50.00	0.3 0.3
1.8-180 Sec.	24VAC/DC 120VAC/110VDC	5B586 or 5X852	8	JCK15V14 JCK15V20	5B400 5B399	50.00 50.00	50.00 50.00	0.3 0.3
0.1-10 Min. 0.3-30 Min. 0.6-60 Min.	120VAC/110VDC	5B586 or 5X852	8	JCK16V20 JCK17V20 JCK18V20	5B398 5B397 5B396	56.00 56.00 56.00	56.00 56.00 56.00	0.3 0.3 0.3
OFF DELAY								
0.1-10 Sec. 0.3-30 Sec. 0.6-60 Sec. 1.8-180 Sec. 0.1-10 Min. 0.3-30 Min.	120VAC/110VDC	5B584, 5B585, or 6X156	11	JCK21V20 JCK22V20 JCK23V20 JCK25V20 JCK26V20 JCK27V20	5B395 5B394 5B393 5B392 5B391 5B390	63.00 63.00 63.00 63.00 69.00 69.00	63.00 63.00 63.00 63.00 69.00 69.00	0.3 0.3 0.3 0.3 0.3 0.3
INTERVAL								
0.1-10 Sec.	120VAC/110VDC	5B586 or 5X852	8	JCK31V20	5B389	50.00	50.00	0.3
ONE SHOT								
0.3-30 Sec.	120VAC/110VDC	5B584, 5B585, or 6X156	11	JCK42V20	5B388	63.00	63.00	0.3
REPEAT CYCLE*								
0.3-30 Sec.	120VAC/110VDC	5B586 or 5X852	8	JCK52V20	5B387	90.00	90.00	0.3

(*) Two dials are provided for independently adjustable repeat cycle timing ranges.

PROGRAMMABLE, MULTI-TIME RANGE RELAYS

SQUARE D GROUPE SCHNEIDER

- 50 mSec max. reset time
- Dimensions: 3.69H x 2.38W x 1.75"D
- ±0.1% repeat accuracy
- Uses socket No. 5B586 or 5X852
- Five programmable timing ranges
- On Delay timer uses five-position rotary switch to select timing range and three pushbutton thumbwheels to select time values



E42240 LR33434

No. 5B386

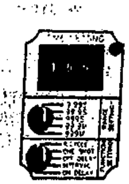
MULTI-TIME RANGE RELAY ORDERING DATA

Timing Mode	Timing Ranges	Input Voltage @ 50/60 Hz	Square D Model 9050 . . .	Stock No.	List	Each	Shpg. Wt.
On Delay	0.05 to 9.99 Sec. 0.1 to 99.9 Sec. 1 to 999 Sec. 0.1 to 99.9 Min.	24VAC 120 240	JCK60V14 JCK60V20 JCK60V24	5B386 5B385 5B384	$100.61 100.61 100.61	$100.60 100.60	0.4 0.4

PROGRAMMABLE, MULTI-FUNCTION RELAYS

SQUARE D GROUPE SCHNEIDER

- 50 mSec max. reset time
- Dimensions: 3.69H x 2.38W x 1.75"D
- ±0.1% repeat accuracy
- Uses socket No. 5B585, 5B584
- Five programmable timing modes and ranges
- Use two, five positon rotary switches to select timing range and mode; three position thumbwheels are used to select time value



E4224... LR3343...

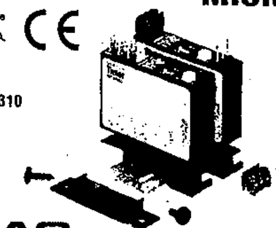
No. 5B383

MULTI-FUNCTION RELAY ORDERING DATA

Timing Mode	Timing Ranges	Input Voltage @ 50/60 Hz	Square D Model 9050 . . .	Stock No.	List	Each	Shpg. Wt.
On Delay Off Delay Interval	0.05 to 9.99 Sec. 0.1 to 99.9 Sec. 1 to 999 Sec.	24VAC	JCK70V14	5B383	$114.11	$114.10	

MICROTIME UNIVERSAL TIM...

Made in U.S.A. CE E57310 ...7310



SSAC inc

17.5mm, knob adjustable package for h... density offers convenient consolidatio... multivoltage, multiple timing modes, a... multiple timing ranges into a single ti... modes of operation and 4 time delay r... can be chosen with 4 top-mounted sel... switches.

Adjustment through the time range is accomplished by an onboard knob. The universal voltage input range is accom... without jumpers or rewiring. The ASQ...

Timing Range	Input Voltage	Termination	Solid State Output Rating	Dimensions
...1S-100M In 4 Ranges	24-240 VAC	0.25" Quick Connect	0.7A Steady 10A Inrush	2.4 x 3.0 x .69 61.2 x 72.8 x 17....

UNIVERSAL ADJUSTABLE ...

...lid state flasher incorporates an onboard ...justable flash rate of 10 to 100 FPM and a ...versal input voltage in one device. Features ...ly encapsulated circuitry and can control ...ds up to 10 amps. Its distinct versatility ...kes it ideal for applications where various ...sh rates and operating voltages are required. ...ust be mounted to metal surface to ensure ...oper heat dissipation.

- Maximum back plate temperature of +8...
- Includes heat sink compound
- Universal replacement part
- Dual mode of operation with steady lamp lamp

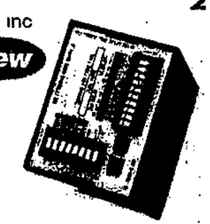
Solid State Output Reading	Operating Voltage	Termination	Dimensions (In.)
10A Steady 100A Inrush	24-240 VAC	1/4" Quick Connects	2 x 2 x 1.51

21 FUNCTION TIME DELA...

SSAC inc

Made in U.S.A. New

LR57415 E57310



Multifunction unit with 21 selectable si... and dual modes of operation. Dual mod... replaces up to 3 timers required to acc... the same timing function. Both the mo... timing range are selectable with switch... located on the face of the unit. Accurat... switch adjustment is used to select the delay.

Timing Ranges	Input Voltage	Contact Rating	Contact Configuration	
...gle Mode: 0.1S - 1705 Hours ...al Mode: 0.1S - 3100 M ...itch Adjustable	120 VAC	10 @ 240 VAC Max. 1/3 HP @ 120/240 VACO	SPDT	TI...

New **What's new?**

About **11,000 things.**

Look for the "New Products" header at the to...

minal
110% of rated voltage. Dropout at 30%
h 2000 VAC, 1 min.
ting bracket
x 1.28W x 2.00"D

E41643 LR31928

gs @ Hz e	Coil Current Rating	Omron Model	Stock No.	List	Each	Shpg. Wt.
	54mA 10.8mA	G4B112T1FDUSRPAC24 G4B112T1FDUSRPAC120	2W935 2W934	$10.88 10.88	$9.58 9.58	0.2 0.2
	54mA 10.8mA	G4B112T1FDCUSRPAC24 G4B112T1FDCUSRPAC120	4A708 4A709	11.56 11.56	10.19 10.19	0.2 0.2

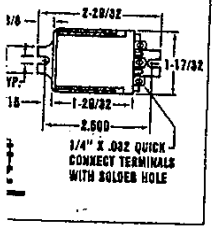
D G7J SERIES

connect .250" spade or screw
4000 VAC, 1 min.
ng bracket

OMRON.

E41643 LR35535

Coil Ratings @ 50/60 Hz Voltage		Coil Current Rating	Omron Model	Stock No.	List	Each	Shpg. Wt.
24 24 120 120	VAC	71mA 71mA 20.4mA 20.4mA	G7L-1A-TUB-J-CB-AC24 G7L-1A-BUB-J-CB-AC24 G7L-1A-TUB-J-CB-AC100120 G7L-1A-BUB-J-CB-AC100120	4A710 2XC21 4A711 2XC22	$12.42 15.57 12.42 15.57	$10.89 13.66 10.89 13.66	0.4 0.3 0.3 0.3
24 24 120 120	VAC	71mA 71mA 20.4mA 20.4mA	G7L-2A-TUB-J-CB-AC24 G7L-2A-BUB-J-CB-AC24 G7L-2A-TUB-J-CB-AC100120 G7L-2A-BUB-J-CB-AC100240	3A354 2XC19 3A355 2XC20	12.88 16.35 12.88 16.35	11.29 14.33 11.29 14.33	0.3 0.3 0.3 0.3
100 200 24	/120VAC /240 VDC	20.4/17mA 8.5/10.2mA 79mA	G7J-2A2B-B-W1AC100120 G7J-2A2B-B-W1AC200240 G7J-2A2B-B-W1DC24	6C913 6C914 6C915	36.91 38.09 33.60	32.60 33.65 29.65	0.5 0.5 0.5
100 200 24	/120VAC /240 VDC	20.4/17mA 8.5/10.2mA 79mA	G7J-3A1B-B-W1AC100120 G7J-3A1B-B-W1AC200240 G7J-3A1B-B-W1DC24	6C985 6C986 6C987	36.91 38.09 33.60	32.60 33.65 29.65	0.5 0.5 0.5
100 200 24	/120VAC /240 VDC	20.4/17mA 8.5/10.2mA 79mA	G7J-4A-B-W1AC100120 G7J-4A-B-W1AC200240 G7J-4A-B-W1DC24	6C988 6C989 6C990	36.92 38.09 33.60	32.60 33.65 29.65	0.4 0.5 0.5

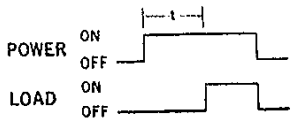


- Suitable for motor loads, HVAC equipment, pumps, and welding equipment
- Enclosed relays designed to switch loads to 20 amps (DPDT); 30 amps (SPDT)
- Pull-in at 85% of nominal voltage for AC coils or 75% for DC coils
- Silver cadmium oxide contacts
- Non-socket mount—use 1/4" quick-connect
- Operating temperature -45° to +50°C (DC); -45° to +45°C (AC)

	Coil Current Rating	Stock No.	List	Each	Shpg. Wt.
	51mA 24mA	2A544 1A489	$13.76 14.92	$11.46 12.43	0.2 0.2
	51mA 115mA 24mA	2A545 1A490 1A491	16.88 18.09 18.09	14.07 15.08 15.08	0.2 0.2 0.2

ON DELAY

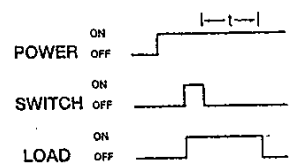
When power is applied to input terminals, the time delay starts. At the end of the preset time delay, the output contacts transfer, either connecting or disconnecting the load. Reset by removing input power.



5X829, 5X830, 6X601, 6A854, 6A855 | H5CR-AB | CD, CH, CL, CNS, CNT

OFF DELAY I

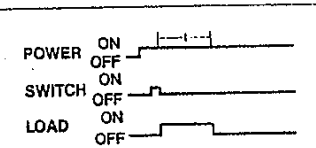
Power is applied at all times. Upon the closure and the normally open switch, the output contacts transfer and remain in this position as long as the switch is kept closed. When the switch opens, timing starts. At the end of the preset time delay, the output contacts transfer back to their original position and the unit is ready for a new cycle. NOTE: Do not ground or apply voltage to the start switch.



6X153, 6X154 6X155, 6X602, 6A855 | H3CA-A, H5CR-B | CD, CH, CNS, CNT

OFF DELAY II

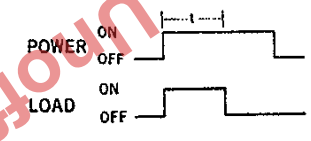
Power is applied at all times. Upon the closure and opening of the normally open switch, the output contacts transfer and timing starts. At the end of the preset time delay, the contacts transfer back to their original position.



— | H3CA-A, H5CR-B | CNT

INTERVAL DELAY

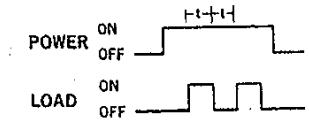
When power is applied to the input terminals, the contacts transfer and the timing cycle starts. At the end of the preset time delay, the output contacts transfer back, either disconnecting or connecting the load. Reset by removing input power.



6X603, 6X604, 6X605, 6A855 | H3CA-A, SYO H5CR-B, H3CR-AB | CNS, CNT

REPEAT CYCLE

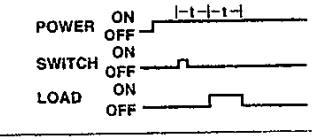
When power is applied to the input terminals, OFF delay is initiated. At the end of the OFF preset time, contacts transfer from OFF to ON position and ON delay starts. At the end of ON preset time, contacts transfer from ON to OFF position and a new cycle begins. The ON and OFF cycles will continue to alternate until power to input terminals is removed.



1A366, 1A367, 1A368, 6A855 | H3CR-F8, H3CA-A, H5CR-B | CR, CNS, CNT

CYCLE ONE-SHOT

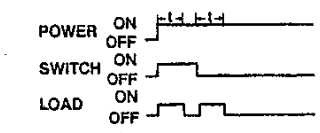
The start terminals are connected. Timing starts when power is applied. The output relay will be OFF for the set time then ON for the set time. The timer is reset when power is disconnected or a reset input is applied.



— | H3CA-A, H5CR-B | CNT

SIGNAL INTERVAL/OFF DELAY

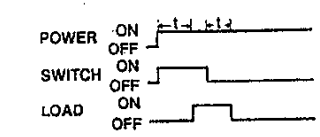
Power is applied at all times. The first timing cycle begins when the input signal is applied. The second timing cycle begins when the input signal is removed. The output relay is energized during both timing cycles.



— | H3CA-A, H5CR-B | CNT

SIGNAL ON DELAY/OFF DELAY

Power is applied at all times. The first timing cycle begins when the input signal is applied, the second when it is removed. The output relay is energized when the lapsed time from the first timing cycle equals the setpoint. It will remain energized until the lapsed time of the second timing cycle equals the setpoint.



— | H3CA-A, H5CR-B | CNT

SERVICE MANUAL

Rotary Blower Package

Model: BB 53 / 5HP

Serial No.: 1063 System # 2

Part No.: 882000.20010

KAESER COMPRESSORS, INC.

P.O. Box 946 · Fredericksburg, VA 22404 · Tel. (540) 898-5500 · Fax (540) 898-5520

KAESER COMPRESSORS

Warranty

Model: _____ **Serial-No.:** _____ **Start-up Date:** _____

Kaeser Compressors, Inc. warrants that the Kaeser rotary lobe blower and Omega-paK package with OMEGA profile manufactured by it and delivered hereunder will be free of defects in material and workmanship for a period ot twelve (12) months from date of start-up not to exceed eighteen (18) months from the date of shipment from KAESER, whichever occurs first. The bare blower is warranted to be free of defects in material and workmanship for a period of twenty-four (24) months from the date of start-up not to exceed thirty (30) months from the date of shipment from KAESER, whichever occurs first. Should any failure to conform to this warranty be reported to KAESER within said period, KAESER shall, upon Purchaser promptly notifying KAESER in writing thereof, correct such nonconformity by suitable repair to such equipment or, at its option, by furnishing a replacement part FOB point of shipment provided the Purchaser has installed, maintained and operated such equipment in accordance with good industry practices and has complied with all procedures outlined in the KAESER Service Manual. Return of equipment to KAESER shall be at Purchaser's risk and expense. Blower accessories furnished by KAESER but manufactured by others shall carry whatever warranty the manufacturer conveyed to KAESER and which can be passed on to the Purchaser. KAESER shall not be liable for any repairs, replacements or adjustments to the equipment or any cost of labor performed by the Purchaser without KAESER's prior written approval. Damage to equipment caused by the use of non-genuine replacement parts is not covered under this warranty.

The effects of corrosion, erosion and normal wear and tear are specifically excluded from the KAESER warranty.

KAESER makes no other warranty or representation of any kind whatsoever, expressed or implied, except that of title, and all implied warranties, including any warranty of merchantability and fitness for a particular purpose, are hereby disclaimed.

Correction by KAESER of nonconformities whether patent or latent, in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of KAESER and it's Distributors for such nonconformities whether based on contract, warranty, negligence, indemnity, strict liability or otherwise with respect to or arising out of such equipment.

P-1501US.3/95

Warranty-Registration-Card

This equipment has been manufactured according to the highest industry standards. In order for Kaeser Compressors, Inc. to properly handle requests regarding warranty or non-warranty, please fill out and mail this form within 30 days after start-up, otherwise warranty is void.

The equipment is installed in accordance with KAESER Service Manual. ☐ Yes ☐ No

The equipment is started and adjusted by authorized distributor technician. ☐ Yes ☐ No

Gentlemen: I have read the attached warranty and limitation of liability statement concerning Kaeser Rotary Lobe Blowers with OMEGA Profile.

COMPANY NAME: _____

STREET ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

MODEL: _____

SERIAL-No.: _____

START-UP DATE: _____

DISTRIBUTOR:

KAESER COMPRESSORS

KAESER COMPRESSORS, INC.

IMPORTANT

Read entire service manual before operating unit or performing any maintenance.

Always shut off power to unit at main disconnect switch before attempting any maintenance. All system pressure should be discharged unless manual instructs otherwise.

Use only **Kaeser Compressors** approved replacement parts.

DANGER

Do not attempt solids flow through blower. Doing so can damage or cause failure of the blower.

This blower is intended for use with non-toxic, inert gases. Please contact **Kaeser Compressors** for use with toxic or flammable gases.

ATTENTION

Kaeser Compressor declines responsibility for any modification made to any **Kaeser Omega Blower** other than those made at the **Kaeser** factory or those made with prior written permission from **Kaeser Compressors.**

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Table of Contents

Technical Specification

KAESER COMPRESSORS

1. Technical Specification

1.1 Rotary Blower Package — BB53 / 5HP, Std TEFC

Air flow capacity, Based on Actual Inlet Conditions	70	ICFM
Air flow capacity, Based on Standard Inlet Conditions	70	SCFM
Rotary blower performance	3.2	BHP
Rotary blower speed	2877	RPM
Inlet pressure	14.7	PSIA
Discharge pressure	21.7	PSIA
Pressure difference	7.0	PSIG
Temperature difference Δt	98	°F
Approximate weight	295	Lbs
Estimated noise level, free field (at one meter, without enclosure)	78	dB(A)

1.2 Motor

Electric motor

Rated power	5	HP
Frame Size	NEMA	184T
Rated speed	3500	RPM
Enclosure	TEFC	
Service factor	1.15	

V-Belts

Description	(Qty of 1) x SPZ x 987 mm	
Tension	3.8 – 4.5	lbf / belt

1.3 Electrical Connection

Power supply	230 / 460V	3 Ph
Frequency	60	Hz
Maximum suggested main disconnect fuses (dual element or time delay)	25 / 10	A*
Supply cable cross-section (CU multicore)	12 / 14	AWG*
Full load rated current I_R	11.2/5.6	A

* see chapters 2.3 and 6.3

1.4 Lubricant Capacities

Drive end	4.5	Oz.
Gear end	5.1	Oz.

1.5 Recommended Lubricants

Use the following lubricants depending on the blower discharge temperature associated with the application.

Application Temperature	Recommended lubricant	ISO Viscosity Grade
Blower discharge up to 250 °F	SHELL Morlina 220 (mineral lubricant)	220
→ Blower discharge up to 250 °F	OMEGA SB-220 (synthetic lubricant)	220
Blower discharge up to 320 °F	OMEGA SB-320 (synthetic lubricant)	320

The rotary blower provided with the blower package is pre-filled at the factory with SHELL Morlina 220 mineral lubricant. The pre-filled lubricant should be drained out of the blower after 200 hours from its initial start-up.

Attention!

We strongly recommend using OMEGA SB synthetic lubricant, specially formulated for use with rotary blowers, when refilling the blower for lubricant changes at the specifed service intervals (See Section 9.2). Select an ISO Viscosity Grade based upon the blower discharge temperature associated with the application. Consult the factory for other grades of lubricant for special applications.

1.6 Designation

The nameplate of the rotary blower package is located on its frame.
(see chapter 10 for nameplate illustration).

1.7 Installation Requirements

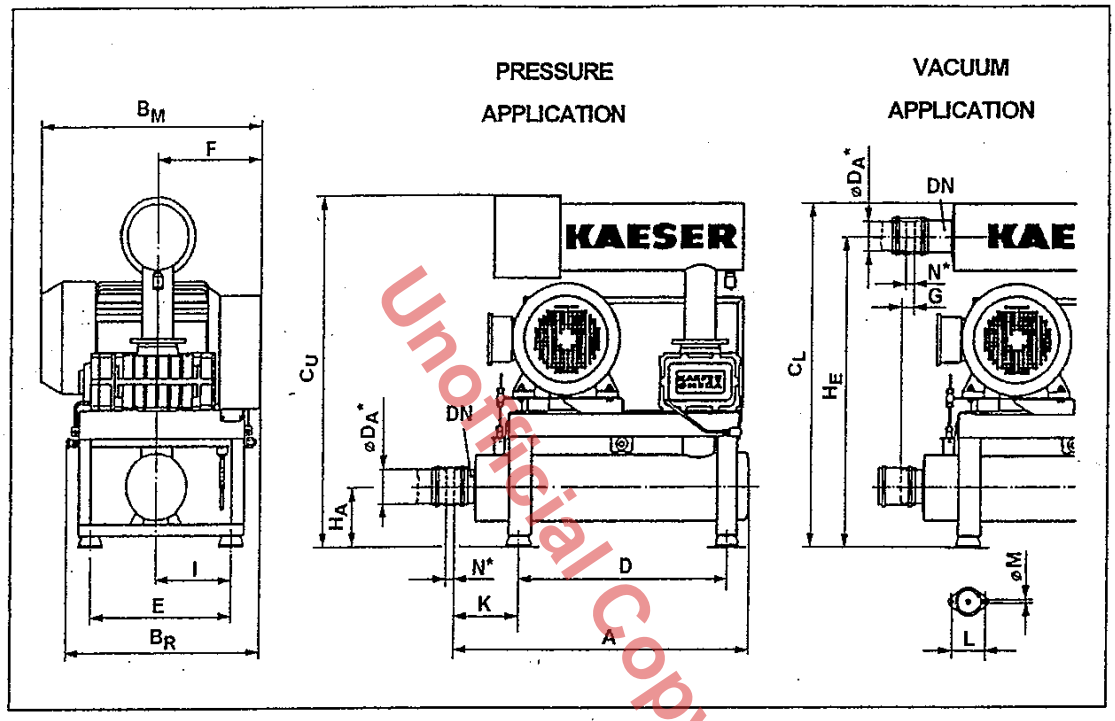
Minimum ambient temperature	40	°F
Maximum ambient temperature	105	°F

Install in a machine space or similar surroundings.

Technical Specification

KAESER COMPRESSORS

1.8 Dimensional Drawing



All dimensions are approximate and given in inches

DN	A	B_M	B_R	C_U	C_L	D	E	F	G	H_A	H_E	I	K	L	M	D_A	N ± 0.4
2	29.9	16.0	17.8	33.9	32.7	20.1	13.8	9.3	0.6	5.7	29.3	7.5	7.1	4.3	0.35	2.3	2

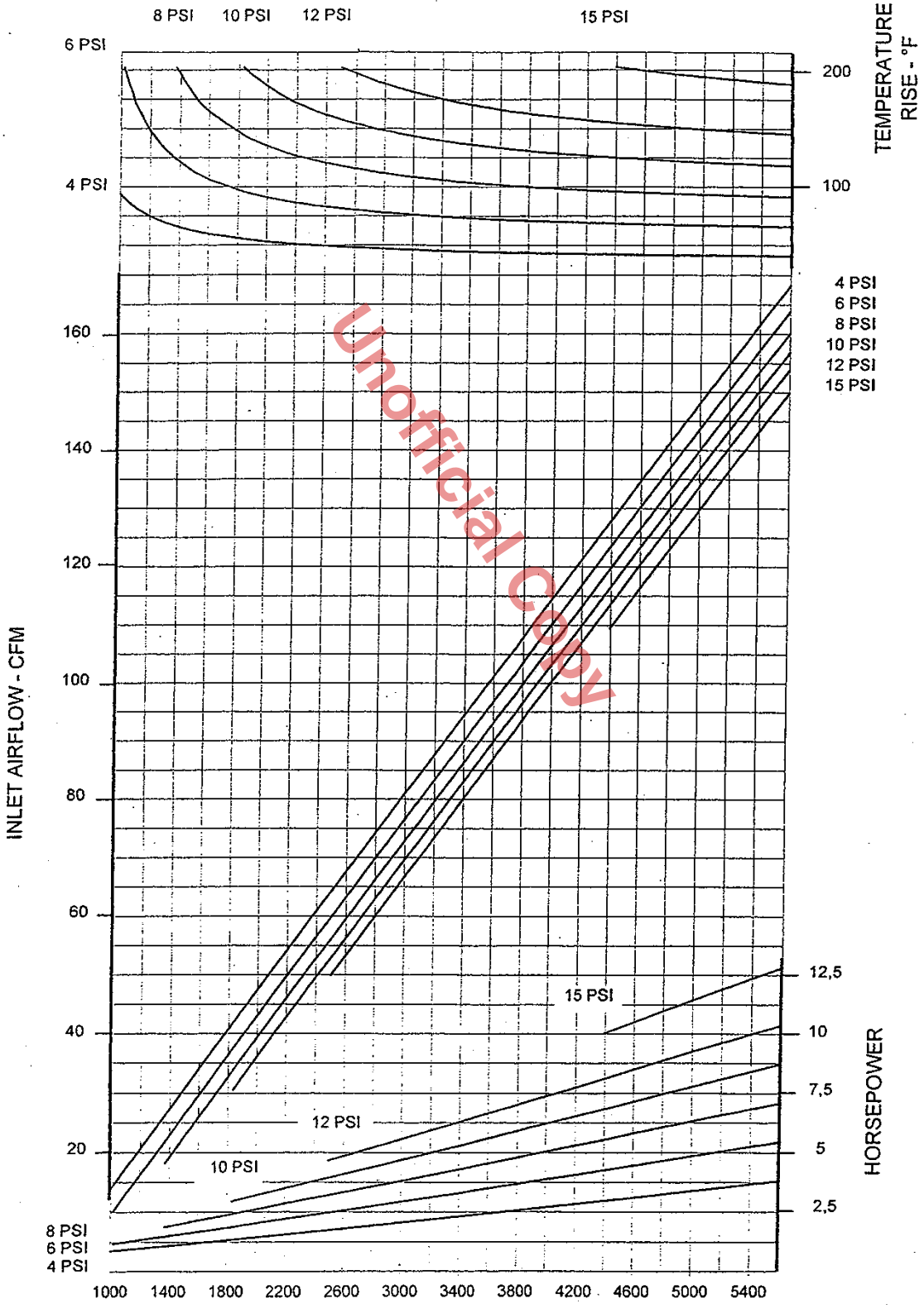
1.9 Performance Curves

KAESER COMPRESSORS

OMEGA 21

Date: 06-02-98
Page: 1 of 1

PRESSURE PERFORMANCE
14,7 PSIA and 68° F



TD.BDS-002.1
Version: 2.0

2. Safety Regulations

Read this service manual carefully and observe all cautionary references before putting the rotary blower package into operation and before carrying out any maintenance

2.1 Explanation of Symbols and References

This symbol is placed before all references to safety where danger to life and limb can occur during work. It is especially important that these instructions are observed and that extreme care is taken.
For their own protection inform all other users of these safety regulations. Observe general safety and accident prevention regulations as well as the safety instructions laid down herein.

Attention!

This symbol is placed at points where considerable attention should be paid to recommendations, instructions, references and correct sequences so that damage or destruction of the blower package and/or other equipment is prevented.

This symbol identifies environmental protection measures.

☞ **This symbol indicates operations to be carried out by the service technician or the operator.**

● **This bullet indicates listings.**

Explanation of the warning notice on the rotary blower:

Warning:
Hot surface, do not touch.

2.2 Precautions

We recommend observation of the following precautions:

- No open flames and flying sparks at the place of installation.
- Ensure that sparks or high temperatures cannot cause fire or explosion during any necessary welding work on the blower package.
- Operating personnel must be instructed on the necessity of wearing ear muffs during operation of the blower package, especially during operation without the acoustic hood.
- Personnel should not linger for long periods in the direct vicinity of blower packages with damaging sound levels.
- Rotary blower packages may not be used for explosive, toxic, corrosive or damaging gases.
- Because of the high temperatures (up to 300 °F) do not touch the air pipes during blower package operation. Wait until the blower has cooled down and pressure has vented before attempting any repairs to the pipework.
- Use only the lubricants recommended by the manufacturer.

2.3 General References

Only trained or specialised personnel may work on power driven systems.

Before work is carried out on electrical systems, carry out the fol lowing precautions in the sequence shown:

Lock the main disconnect in the "OFF" position in accordance with applicable lock out/tag out procedures to ensure the blower package does not restart (as per OSHA CFR 29 §1910.147).

Lock the air discharge valve in the "CLOSED" position and vent all air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures (as per OSHA CFR 29 §1910.147).

Attention! **The warranty is invalid if any modifications are carried out without previous consultation and the consent of KAESER COMPRESSORS.**

2.4 Spare Parts

Safe and reliable operation of the rotary blower package is only guaranteed with KAESER original spare parts.

3. General

Attention! **This Service Manual must always be available at the place of installation of package.**

3.1 Correct Use

The rotary blower package is intended solely for the transport of oil-free air or any inert gas without liquid or solids in conformity with the technical specification (see section 1.1). Any other use is considered incorrect. Do not use this blower package for any combustible gas applications. For special gas applications contact KAESER COMPRESSORS, INC.

The manufacturer cannot accept liability for any damage caused by incorrect use. The user alone is liable for any risks incurred. Correct use also means compliance with installation, removal, commissioning, operational and maintenance instructions laid down by the manufacturer.

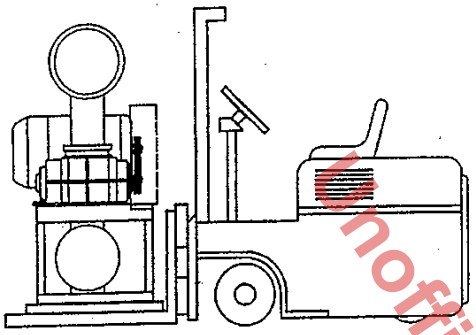
This service manual is intended for operating, maintenance and supervisory personnel use only.

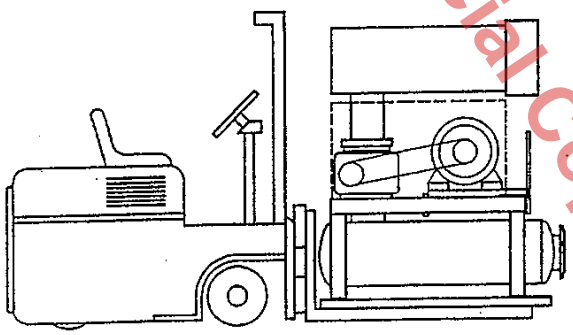
3.2 Copyright

4. Transport

4.1 Transport Instructions

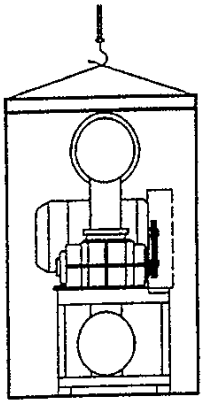
Attention! **To avoid damage to components of the rotary blower package we recommend the use of a fork lift truck, lift truck or a sling for transport.**





Attention! **When transporting the blower package using a crane hook a suitable sisal or steel sling must be used (VBG 9a).**

If lifting the blower package with a sling or rope it should be fastened to the frame and padded if necessary.



No side forces should act upon the blower package when transporting with a sling. Always use a spreader !

Avoid sudden, sharp vertical movements when lifting, lowering and transporting the rotary blower package.

4.2 Packaging

A decisive factor concerning the type of packaging is the transport route.
The packaging conforms to the packaging regulations laid down by the German Federal Association of Wood, Pallet and Export Packaging (HPE) and by the Association of German Mechanical Engineering Institutes (VDMA), if not otherwise contractually agreed.

Packaging should be recycled if possible or disposed of in an environmentally acceptable way.

4.3 Temporary Storage

Attention!

The package must be stored in a dry room at a constant temperature over 0°. Air inlet and air outlet openings should be closed off to prevent ingress of dirt.

When storage is to be longer than a year the block should be treated with a preserving oil.

- ☞ Spray preserving oil onto the flanged ports, drive shaft and air chamber to protect against corrosion.
- ☞ Carry out an oil change annually (see chapter 9.6).

Putting into operation after a long period of temporary storage:

- ☞ Remove the preserving material from the air chamber with a suitable solvent.
- ☞ Carry out the measures detailed for installation and putting into operation.
- ☞ Carry out an oil change (see chapter 9.6).

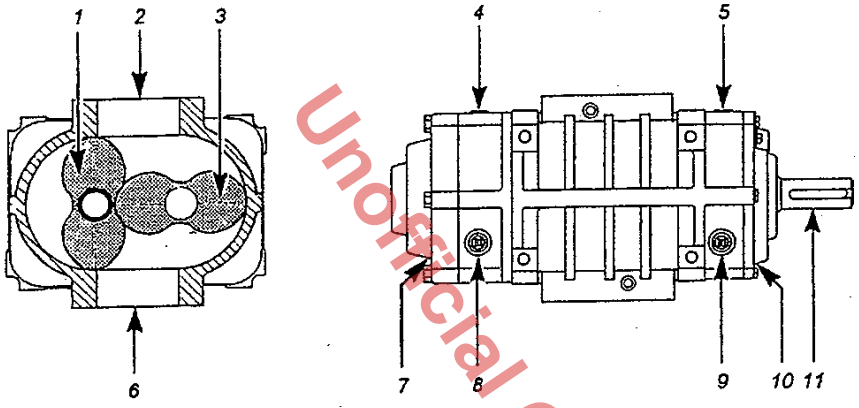
5. Construction and Principles of Operation

5.1 Construction

Kaeser rotary blower packages are delivered with the blower in the "horizontal configuration"

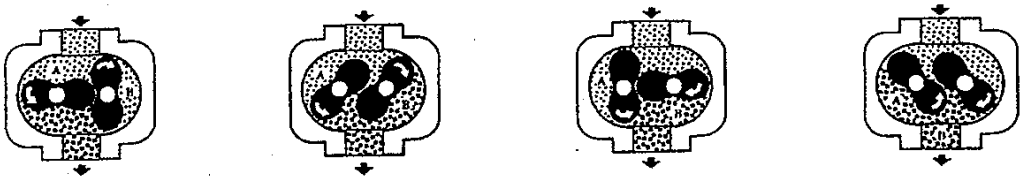
Horizontal configuration

- The drive shaft (11) is located at the left-hand rotor
- The following diagram shows the positions of the oil level sight glasses (8) and (9) and the oil filler plugs (4) and (5)



1 Male rotor
2 Inlet port
3 Female rotor
4 Oil filler plug, gear end
5 Oil filler plug, drive end
6 Discharge port
7 Oil drain, gear end
8 Oil level sight glass, gear end
9 Oil level sight glass, drive end
10 Oil drain, drive end
11 Drive shaft

5.2 Principles of Compression



The KAESER Omega positive displacement rotary blower has two uniquely designed figure-eight shaped rotors that rotate in opposite directions. As the rotor passes the blower inlet, it traps a quantity of air and carries it around the housing to the discharge. The relative position of the rotors is fixed by the use of timing gears which maintain the critical internal clearances essential for high volumetric efficiencies. Rotor lubrication is not necessary since the rotors do not touch thus keeping the discharge air free of oil.

5.2 Principles of Operation

The rotary blower is belt driven from an electric motor.
The electric motor and the blower are mounted on a common base frame.
The flow medium is drawn into the blower via an inlet silencer in which an inlet filter is integrated for pressure applications (an in-line inlet filter is available as an option for vacuum applications).
The air flows in a vertical direction in the discharge silencer.
The compressed air is discharged at the connecting flange of the discharge silencer.

6. Installation

6.1 Installation Requirements

The rotary blower package must be installed in a space of sufficient size allowing free access from all sides for maintenance and repair.

Sufficient air ventilation and exhaust conditions must be provided.

A special foundation or base is not required for installation.

Safe and reliable operation of the blower package is guaranteed only when the temperature limits (see chapter 1. 8) are complied with.

6.2 Compressed Air Connection

The blower package is delivered ready for operation up to and including the compressed air discharge connection.

The discharge connection downstream to the pipework or user should be made via a flexible connecting sleeve, preferably a high temperature resistant rubber sleeve.

It is especially important that necessary safety devices, a check plate and operational measuring and control devices are provided.

If the air flows into a system which remains pressurized after switching off the blower package, an blow-off valve or similar device must be provided.

To ensure safe and reliable operation of the blower package it is recommended that at least the following parameters are monitored and interlocked with the drive:

- Discharge pressure or pressure difference Δp
- Discharge temperature
- Electrical current drawn

6.3 Electrical Connection

⚠

Before servicing the blower package dot the following:

- **with applicable lockout/tagout procedures to ensure the blower does not restart.**
- **Lock the air discharge in the closed position and vent all compressed air trapped between the blower package and air discharge valve in accordance with applicable lockout/tagout procedures.**

For proper sizing of wires and fuses refer to the table in chapter 1.3.

Please note that conductors, fuses and procedure are Kaeser's recommendations and do not supersede any other applicable codes.

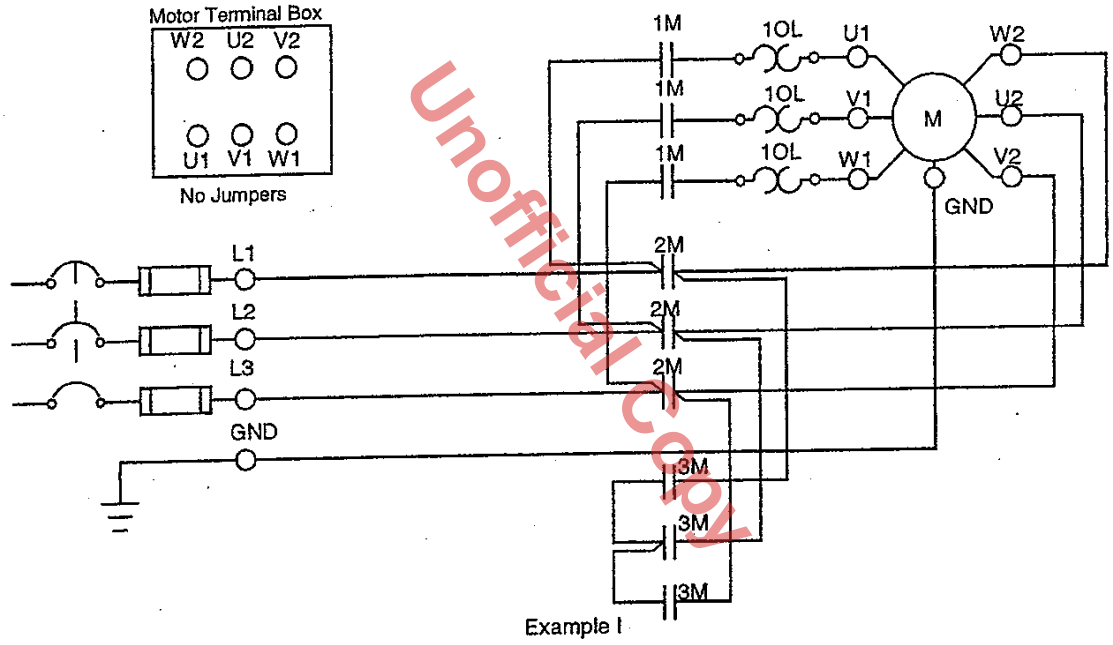
6.4 Lubricant Oil Filling

Attention! **The rotary blower package is delivered with a full charge of lubricating oil.**

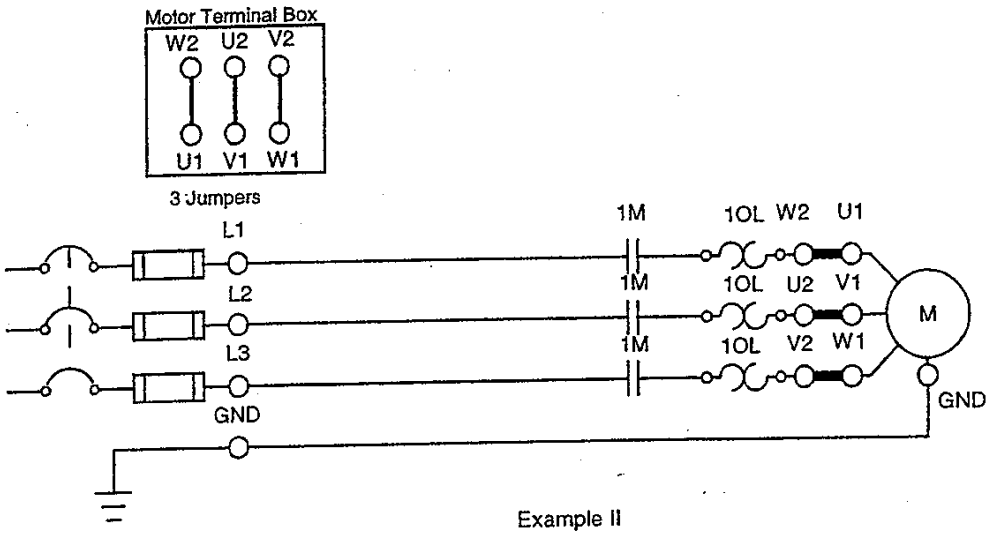
Type of oil used: see chapter 1, sections 4 and 5.

6.5 Motor Wiring Diagrams

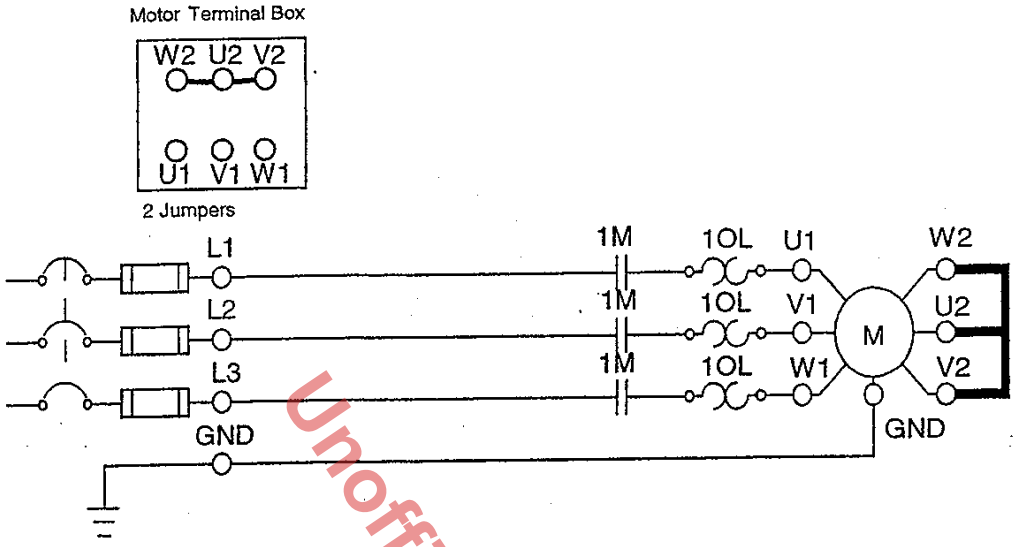
The following are examples of how the motor for the blower package is to be wired. Check the nameplate on the motor in section 6.6 to see which example of wiring should be used.



Example I



Example II



Example III

6.6 Examples of Motor Nameplates

6.6.1 230 V wye delta and 230/460 V direct on line starting

Motor nameplate	
230/460	Δ/Y

Operation	Example wiring
230 V wye delta start	I
230 V DOL (direct on line) start	II
460 V DOL start	III

6.6.2 460 V wye delta and direct on line starting

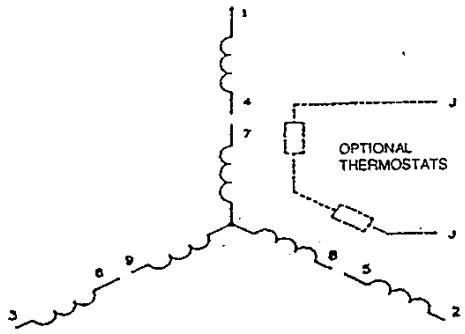
Motor nameplate	
460	Δ

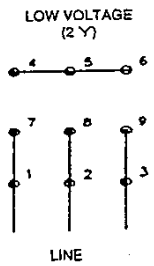
Operation	Example wiring
460 V wye delta start	I
460 V DOL (direct on line) start	II

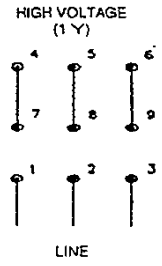
KAESER COMPRESSORS

Installation

3 Phase, 60 Hz, Dual (230/460v) Voltage, Nine (9) Lead Motor, Wye Connection



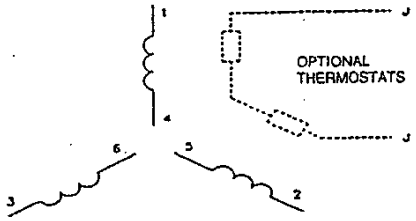


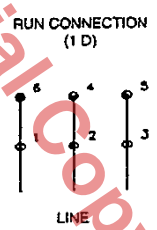


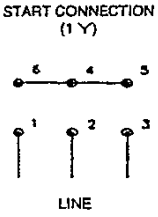
NOTES:

1. INTERCHANCE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.

3 Phase, 60 Hz, Single (460v) Voltage, Six (6) Lead Motor, Wye Start - Delta Run



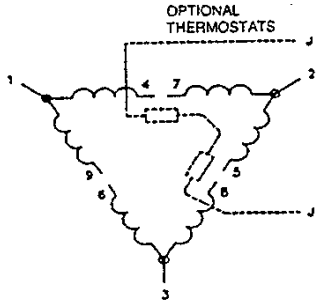


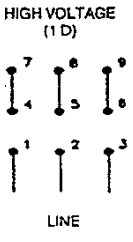


NOTES:

1. INTERCHANCE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.

3 Phase, 60 Hz, Dual (230/460v) Voltage, Nine (9) Lead Motor, Delta Connection





NOTES:

1. INTERCHANCE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.

7. Putting into Operation

7.1 Points to be Observed

Every rotary blower package is given a test run at the factory and carefully checked before shipment. The test run confirms that the blower package conforms to the specification data and runs satisfactorily. However, it is recommended that the blower package is inspected for damage that could have occurred during transport. The blower package should be carefully observed during the first hours of operation to determine any malfunction that could occur.

The user is responsible for the installation of the complete blower package.

- Before putting into operation check the correct sequence of the recommended safety and monitoring devices and the necessary operational measuring and control devices for the processing technology used.
- Check the valves and controls for correct installation.
- Remove the blanking caps fitted during installation.

7.2 Starting Precautions

⚠ **ANY NON-OBSERVANCE OF THESE OR OTHER PRECAUTIONARY REFERENCES (WARNING, ATTENTION) COULD LEAD TO AN ACCIDENT CAUSING PERSONNAL INJURY OR DAMAGE TO EQUIPMENT.**

☞ Remove all packaging materials, tools and transport safety devices from the blower package.

- It is expected that the user employs safe working methods and complies with all valid local operating and safety regulations when operating the blower package.
- It is the responsibility of the user to ensure that the blower package is constantly kept in a state of operational safety.
- Do not operate the blower package in spaces in which high dust pollution, toxic or inflammable vapors and gases can form.
- Do not connect the blower package to a different power supply than that stated on the nameplate.
- Install the blower package in a frost-free space where the ambient temperature conditions are met.

☞ Check the drive shaft of the blower for ease of rotation by turning with the hand.

☞ Check the tension of the belt drive.

☞ Check the oil level and top up if necessary (see chapter 9.5).

⚠ **Before servicing the blower carry out the following:**
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.

Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.

7.3 Direction of Rotation Check

Danger from rotating parts

- The rotary blower must rotate in the correct direction.
- The correct direction of rotation is counter-clockwise when looking at the end of the shaft.
- An arrow indicating the direction of rotation is located on the belt guard and on the blower.

☞ If a KAESER CONTROL is provided check the direction of rotation by turning the control switch to "I" and then immediately back to "O" again and observing the direction of rotation.

☞ If the direction of rotation is incorrect, the phase sequence in the power supply must be changed.

Attention! **If the blower block rotates in the wrong direction a reversal of the direction of flow and an evacuation of the discharge pipework occurs. Always check the direction of rotation with the discharge line disconnected because the blower block could be damaged or destroyed if foreign bodies are sucked in or a high vacuum is generated.**

8. Operation

8.1 Starting and Stopping the Blower Package

⚠ **Observe the safety regulations when putting the blower package into operation.**

The starting and stopping procedure depends largely on the application at hand, together with the control devices fitted.

Always start with the blower stationary. If back pressure is apparent in the pipework system then suitable measures ensuring off-load starting must be taken.

If the blower package is operated via a two-speed motor the changeover from high to low speed must be delayed, i.e. the speed must have reduced to the lower speed or the blower must have stopped rotating before the motor is started again at the lower speed.

The motor can be switched directly to the higher speed.

Attention! **Do not switch the blower package on and off with the mains isolating switch. Always switch the blower package on and off with the control switch.**

8.2 Action to be taken during a Malfunction

Attention! **General safety regulations (see chapter 2) and the corresponding local safety regulations must be observed during trouble-shooting**

Restarting after elimination of a malfunction:

See chapter 7 "Putting into Operation"

Explanation of the symbols used in the following sections:

⊗1 - Have checked by a specialist.

⊗2 - Refer to KAESER customer service.

8.2.1 Abnormal running noises

Possible fault	Remedy
Backlash of the gears too large.	Check the backlash. If it is > 0.004" replace the timing gears; ⊗1 or ⊗2.
Bearing clearance is too large.	Measure the clearance. Replace the bearing if necessary; ⊗1 or ⊗2.
Rotors out of time.	Compare the conditions under use concerning pressure difference and speed with the conditions at delivery on nameplate.

8.2.2 Excessive blower temperature

Possible fault	Remedy
Operation with excessive pressure difference.	Check the pressure difference and correct if necessary.
Contamination of the inlet filter causing degradation of volumetric efficiency.	Clean inlet filter.
Rotor clearance too large.	Measure the clearance between the rotors and check with the manufacturer. Rotor replacement could be necessary.

8.2.3 Oil leaking into the air chamber

Possible fault	Remedy
Oil level too high.	Drain the oil until the level is in the middle of the oil level sight glass. Clean out the air chamber with cleanser.

8.2.4 Low inlet volume flow

Possible fault	Remedy
Excessive rotor clearance caused by wear, especially by heavily contaminated flow medium.	Measure the clearance between the rotors and check with the manufacturer. Rotor replacement could be necessary; ⊗1 or ⊗2.
Inlet flow resistance too high.	Clean the inlet filter.

9. Maintenance

9.1 Precautions to be Observed during all Maintenance and Servicing

Work on power driven equipment may only be carried out by trained or specialized personnel.

Before carrying out any maintenance switch off the blower and lock out the mains isolating switch/electrical disconnect.
Isolate and depressurize the blower package and attached piping to zero psig.

Ensure that no personnel are working on the blower package before restoring power.

9.2 Regular Maintenance

Period	Work to be done	see chapter, section
2 and 24 hours after initial start-up	check the tension of the drive belts	9.3
50 hours after initial start-up	check all electrical connections for tightness and tighten, if necessary	9.1
200 hours after initial start-up	change the lubricating oil	9.6
monthly	check the lubricating oil level	9.6
500 hours	check the tension of the drive belts	9.3
2000 hours or at least annually*	clean or change the air filter	
1500 - 2500 hours*	change the lubricating oil (mineral)	9.6
6000 - 8000 hours*	change the lubricating oil (KAESER Omega synthetic)	9.6
annually	check all electrical connections for tightness and tighten, if necessary	9.1
annually	check the safety valve	

* The maintenance period can vary depending on the cut-in frequency and environmental conditions. The oil should be changed at least once annually, even if the blower was not in operation.

We highly recommend that a record is kept of maintenance work done (see chapter 11, sect. 1)

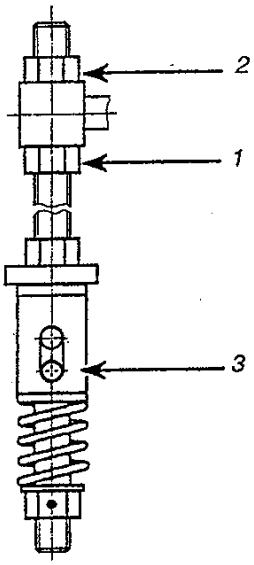
9.3 Checking the Tension of the Drive Belts

☞ Switch off the blower package (see chapter 8, sect. 1).

Before servicing the blower carry out the following:
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.

Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.

Check the tension of the drive belts after the first 2 and 24 hours and then every 500 hours of operation.



1 Hex nut
2 Hex nut
3 Marking pin

The tensioning device automatically adjusts the belt tension over a certain range with the aid of a compression spring.

If the drive belts have stretched to the extent that the marking pin (3) is located at the lower end of the indicating slot the belt tension must be re-adjusted.

Proceed as follows:

☞ Loosen the hex nut (1).

☞ Tighten the belts with the hex nut (2) until the marking pin (3) is located at the top end of the indicating slot again.

☞ Tighten the hex nut (1) again.

9.4 Changing the Drive Belts

☞ Switch off the blower package (see chapter 8.1).

⚠ **Before servicing the blower carry out the following:**
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.

Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.

☞ Remove the belt guard complete.

☞ Turn the hexagonal nut (2, see chapter 9.3) of the tensioning device upwards.

☞ Turn the hexagonal nut (2, see chapter 9.3) of the tensioning device clockwise until the drive belts are loose.

☞ Take off the drive belts.

☞ Lay the new drive belts over the motor and blower pulleys without straining them.

☞ Set the drive belt tension (see chapter 9.3).

☞ Mount the belt guard.

☞ Check the belt tension after two hours and then again after 24 hours of operation as experience shows that the belts stretch mostly during this period.

Attention! **It is essential that the drive belts are of precisely the same length in each set and absolutely impervious to oil. For this reason, we recommend that only original KAESER drive belts are used.**

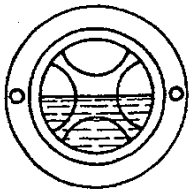
9.5 Lubricating Oil Level Check and Top-Off

Check the lubricating oil level monthly at the gear end and drive end with the blower package switched off. The oil level should never fall below the middle of the oil level sight glass. The oil level at the sight glass changes during operation because of the rotating parts. For this reason the check the oil level only when the blower package is shut down.

Attention! **If the oil level has fallen to 1/8" below the middle of the oil level sight glass, the blower must be topped off according to the instructions in the oil recommendations.**
Never top off the blower above the middle of the oil level sight glass otherwise oil could be forced into the vent chamber.

☞ Switch off the blower package (see chapter 8.1).

Attention! **Before servicing the blower carry out the following:**
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.
Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.



Lubricating oil level at middle of oil level sight glass

☞ Top off with lubricating oil via the "red" oil filler plugs on the gear and drive ends of the block until the middle of the oil level sight glass is reached. (see chapter 1.5).

Attention! **The oil chambers of the gear and drive ends are not connected to each other.**

9.6 Lubricating Oil Change

Attention! **Carry out the first lubricating oil change after the first 200 hours of service.**

See chapter 9.2 for recommended time interval for oil change.

☞ Switch off the blower package (see chapter 8.1).

Attention! **Before servicing the blower carry out the following:**
Lock the main disconnect switch in the "OFF" position in accordance with lockout/tag out procedures to ensure the blower package does not restart.

Lock the air discharge in the "CLOSED" position and vent all compressed air trapped between the blower package and the air discharge valve in accordance with applicable lock out/tag out procedures.

Carry out the oil change with the blower block in a warm state (approximately 131 °F).

Collect the used oil in a suitable container and dispose of according to Federal and local environmental regulations!

☞ Drain the oil drain via the "red" marked oil drain plugs on the gear end drive ends.
Fill up with new lubricating oil to the middle of the oil level sight glass via the "red" marked oil filler plugs on the gear and drive ends. (see chapter 9.5).
Use only the lubricating oil detailed in the oil recommendations (see chapter 1.5).

Attention! **Bleed air from the oil drain lines from the drive end and timing gear end.**

9.7 Cleaning the Blower Package

☞ Regularly clean the surfaces of the blower package and drive motor and keep free of dirt and contamination.

Attention! **Layers of dirt inhibit heat dissipation. Damage may occur through overheating.**

10. Spare Parts and After Sales Service

Nameplate:

KAESER COMPRESSORS	Fredericksburg, VA 22404 Tel. (540) 898-5500	
Model		Part-No.
Year		Serial-No.
psig	cfm	Voltage
Hz/RPM		FLA
Phase	HP	Scheme

Important:

☞ Enter the data from the nameplate found on the frame of the blower package into the nameplate illustrated above.

Please quote the following information for all inquiries and orders for spare parts:

Rotary blower package, model: .....

Part No.: .....

Serial No.: .....

Year of Manufacture: .....

Attention! **Use only KAESER original spare parts.**

11. Appendix

11.1 Maintenance Schedule

Rotary blower package, Model:

Part number: **Serial number:**

Date	Description of work	Service hours	Signature

11.2 Safety information concerning contamination of compressors, blowers, vacuum pumps and components

Application and purpose

Every company is responsible for the health and safety of its employees. This extends to personnel who carry out servicing work at the company's premises or at the site of the user.

The attached declaration is intended to inform the service contractor of any possible contamination to be found in compressors, blowers, vacuum pumps or components sent to him for servicing. Based on this information, the service contractor can instigate the necessary protective measures when carrying out the service work.

Preparation for shipment

Before shipping the item(s), the sender should fill out and sign the attached Declaration of Contamination form (one for each item) and attach a copy to the shipping documents and a copy on the outside of the packaging.

Please note the following shipping regulations:

- drain all operating fluids
- remove filter elements
- make all openings airtight
- pack correctly
- ship in suitable container
- fix a copy of the Declaration of Contamination to the **outside** of the packaging

KOMPRESSOREN

Declaration of Contamination
concerning compressors, blowers, vacuum pumps and components

Repair and/or maintenance work will only be carried out on items for which a Declaration of Contamination form has been filled out and attached. **A completed Declaration is required for each item.** Any item not accompanied by a Declaration is liable to be returned untouched. Items that have been contaminated with microbiological, explosive or radioactive substances will only be accepted when accompanied by confirmation that they have been **fully decontaminated** according to regulation.
This Declaration may only be filled out and signed by the authorized representative of the ordering party (sender of the item).

Sender/dept.: _____
Contact name: _____
Address: _____
_____
Phone / Fax: _____

Reason for sending the item:
_____
_____
_____
_____
_____
_____
(use rear side of form if necessary)

Specification of the item:

Model/type name: _____
Part no..: _____
Serial no..: _____
Oil used: _____

Accessories:
_____
_____
_____

Condition of the item:

	yes	no	not known
- has it been used?	☐	☐	☐
- emptied/vented?	☐	☐	☐
- openings airtight closed?	☐	☐	☐
- cleaned / decontaminated?	☐	☐	☐

Cleaning substance used: _____
Cleaning method: _____

Information on contaminants:

- with what substances has the item been in contact?

	Trade name	Chemical name	Characteristics
a)			
b)			
c)			
d)			

	yes	no	not known
- Are the substances listed above hazardous to health?	☐	☐	☐
- Are any hazardous substances given off by heating?	☐	☐	☐

Which? _____

We declare that the information given in this declaration is true and complete and that the signatory is authorized and in a position to make this declaration. We are aware of our liability for any damages resulting from false or incomplete information given in this declaration and we engage to hold the contractor free of claims from third parties for compensation for damages resulting from such incomplete or false information.

Name of the authorized signatory (please print): _____

_____ Date

_____ Authorized signature

Sender's company seal:

Australia

Australia
KAESER Compressors Australia Pty. Ltd.
Locked Bag 1406
Dandenong South, Vic. 3164
45 Zenith Road
Dandenong, Vic. 3175
Tel.: 0061/3-9791-5999
Fax 0061/3-9791-5733
E-mail: air@kaeser.com.au

Europe

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KAESER Kompressoren Ges.m.b.H.
Niederlassung Österreich
Dallingerstr. 8
PO Box 70
4031 Linz
Tel.: 0043/70-38 60 51-0
Fax 0043/70-38 67 80
E-mail: kaeser.linz@plus.at

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KAESER Kompressoren B.V.B.A.
Koesinglaan 21
2100 Deurne (Antwerpen)
Tel.: 0032/3-326 39 62+63
Fax 0032/3-326 39 73
E-mail: info.belgium@kaeser.com

Croatia
KAESER Kompressoren d.o.o.
Scitarjevska 24
10000 Zagreb
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Fax 00385/1-230 41 28
E-mail: kaeser-kompressoren1@rt.tel.hr

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KAESER Kompressoren, s.r.o.
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148 00 Praha 4 - Chodov
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Fax 0044/1444-24 73 04
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Fax 00372/65 63 045
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01720 Vantaa
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E-mail: info.finland@kaeser.com

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Tel.: 0033/4 72 37 44 10
Fax 0033/4 78 26 49 15

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Fax 0030/1-42 09 517
E-mail: vamviaso@hol.gr

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Fax 0036/1-386 41 60
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Dublin 12
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Tel.: 1850/369400 (National)
Fax 00353/1-456 73 28

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E-mail: info.italy@kaeser.com

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Fax 0031/74-245 22 13
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E-mail: info.norway@kaeser.com

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Millet Cad No. 180-184
34270 Topkapi-Istanbul
Tel.: 0090/212-534 04 10
Fax 0090/212-524 58 46
E-mail: alpzor@topkapigroup.com.tr

D

ubj: **FW: Part Numbers for Drive Components**
ate: 9/26/2001 3:30:20 PM Mountain Daylight Time
rom: johnm@lacotech.com (John Miles)
o: breedingwei@aol.com

oyd,
all me if you have questions.

ohn R. Miles
ACO Technologies

—Original Message—
rom: Jonathan Eubank [mailto:jonathan.eubank@kaeser.com]
ent: Wednesday, September 26, 2001 1:54 PM
o: johnm@lacotech.com
c: sheri.meadows@kaeser.com
ubject: Part Numbers for Drive Components

ear John,

he following units were ordered under the submitted PO numbers. Please
ee the following:

ACO PO# 011490-00:

J 53-5 HP SN 1063 Belt: ANSPZ987 Sheaves: AN455109 & AN455112 System #2

B 53-5 HP SN 1064 Belt: ANSPZ962 Sheaves: AN45110 & AN455110 System # 1

ubj: FILTER ELEMENT REPLACEMENT NUMBERS
: 9/27/2001 10:34:07 AM Mountain Daylight Time
.n: johnm@lacotech.com (John Miles)
): breedingwei@aol.com (Boyd Breeding (E-mail))

oyd,

our PO number1494-02
MEGA PACK BB53 (2") INLET FILTER NUMBER IS SOLBERG 851

all if you have questions.

ohn R Mile
ACO Technologies
36-1004 ext 103

———— Headers ————
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by redhat.inshift.com (8.11.0/8.10.0) with SMTP id f8RGWdF27678
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o: "Boyd Breeding \(E-mail\)" <breedingwei@aol.com>
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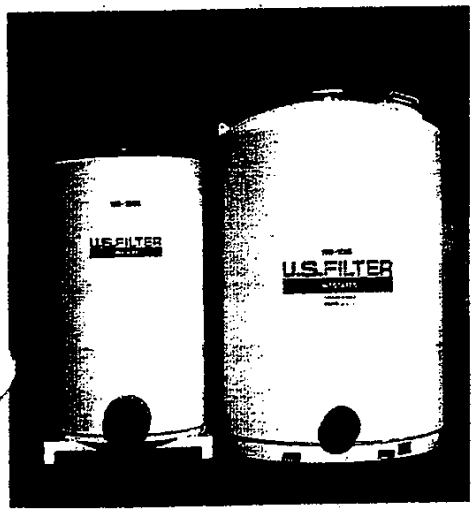
U.S.FILTER
WESTATES



VENT-SCRUB ADSORBERS LOW COST TREATMENT SYSTEMS FOR MALODOROUS AND VOC EMISSIONS

SIMPLE AND ECONOMICAL

Benefits and Features:

•Full service application support from equipment sizing, carbon usage modeling, in-house activated carbon analysis, canister monitoring services to on-site carbon changeout services or adsorber exchange and spent carbon recycling.

•Applications to 3000 SCFM. Higher flows can be handled through operation of units in parallel or by using RB-Series adsorbers.

•The VSC-1200 and VSC-2000 adsorbers have forklift channels for easy handling.

•Ready-to-use systems, simple installation and operation.

•The VSC-200, VSC-400, VSC-1200 and VSC-2000 adsorbers are manufactured to UN specifications and meet requirements as transportation containers for RCRA hazardous spent carbon.

•A wide variety of hose kits and pipe racks are available to simplify installation.

•Low cost operation makes carbon treatment economical.

•Sturdy steel construction.

Our total service package includes on-site carbon changeout by OSHA-trained personnel.

Industry Applications Include:

•API separator vents

•VOC control from soil vapor extraction (SVE) systems and airstrippers

•Wastewater and product storage tank vents

•Process vents

•Refinery and chemical plant process water sewer vents

•Laboratory hood exhausts

The Vent-Scrub™ adsorbers have been proven to be the simplest and most cost effective way to treat malodorous and VOC emission problems. The sturdy steel construction and specially formulated corrosion resistant internal coating ensures long service life and low maintenance. The Vent-Scrub™ adsorbers contain a distribution system that allows for uniform air flow distribution across the carbon bed, assuring full performance from the certified activated carbon.

Spent Carbon Recycling

At the time of purchase or rental of the Vent-Scrubs™, arrangements can be made for on-site service or adsorber exchange and reactivation of the spent carbon. U.S. Filter/Westates will provide instructions on sampling the spent carbon and completion of our spent carbon profile form. Spent carbon acceptance testing can be performed at our certified laboratory located in Vernon, California.

The spent carbon will be reactivated at our RCRA permitted facility where the contaminants are thermally destroyed. When requested, a certificate of reactivation will be issued.

Carbon Bed Life Estimates

U.S. Filter/Westates maintains an extensive organic compound properties database that is used with our proprietary isotherm computer modeling program to estimate carbon usage rates. The isotherm model predicts the effects of relative humidity and temperature to give an improved estimate of the carbon usage rates. Technical support is available to help develop the most cost effective solutions for your applications.

Vent-Scrub™ Safety Considerations

The adsorption of organic contaminants on activated carbon is an exothermic process, i.e. involves the release of heat. The following safety issues should be considered when installing and using activated carbon systems:

•Certain chemical compounds such as ketones, aldehydes, organic acids and organic sulfur compounds may form reactive species on the carbon surface and under certain conditions may lead to a high temperature rise. If you are unaware or unsure of reactions that may occur, appropriate tests should be performed before installing the Vent-Scrubs™.

•At high VOC concentrations of organic compounds the heat of adsorption can lead to an increase in carbon bed temperature. The heat can be controlled by a number of techniques such as dilution of the

A COMPLETE SERVICE PACKAGE

Vessel Specifications	→ VSC-200-2	VSC-400-4	VSC-1200/ VSC-2000	VSC-3000	VSC-8000
Inlet Connection	2" FNPT	4" FNPT	4" FNPT	10" Flange	12" Flange
Outlet Connection	2" MPT	4" FNPT	4" FNPT	10" Flange	12" Flange
Manhole	Top	Top	16" Top	20" Top	20" Top
Internal Distribution**	PVC	PVC	PVC	FRP	FRP
Exterior Top Coating	Enamel	Enamel	Polyester urethane	Polyester urethane	Polyester urethane
Carbon Fill Volume (cu.ft)	7.0	14.0	35/63	108	286
Cross Sectional Area(sq.ft.)	2.8	4.9	11.2	18.0	44.2
Approx. Carbon Weight (lbs.):	200	400	1000/1800	3000	8000
Shipping Weight	250	480	1620/ 2540	4500	4400[1]

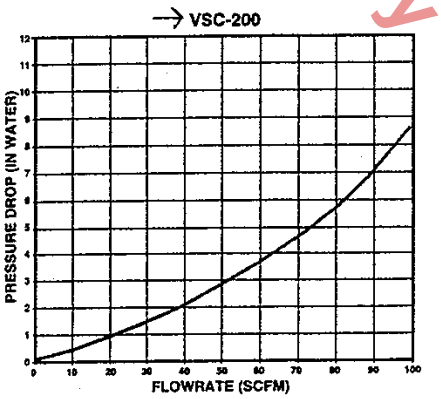
**Carbon steel and stainless steel internals are also available.
[1]The VSC-8000 ships without carbon installed. Operating weight is approx. 12,400 lbs.

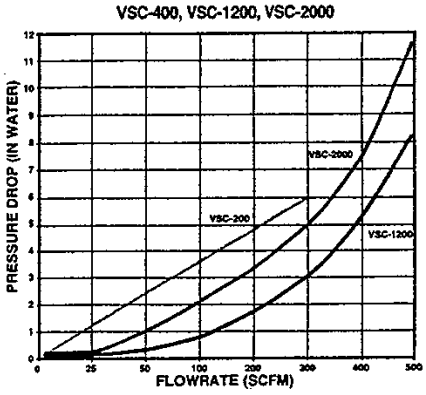
Operating Specifications					
Flow, cfm (max.)	100	300	500	1500	3000
Pressure, psig (max.)	15	6	15	5	5
Vacuum, in. Hg (max.)	18	N/A	12/6[2]	6" w.c.[3]	6" w.c.[3]
Temperature °F. (max.)	140	140	140	140	140

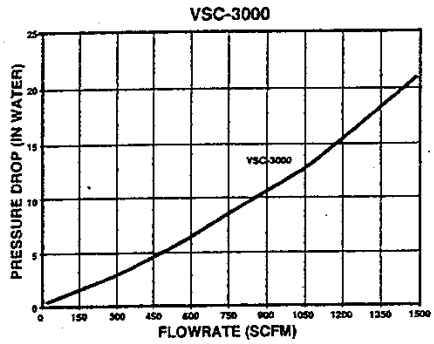
[2]For vacuum greater than 6 in. Hg on VSC-2000, contact your U.S. Filter/Westates representative.
[3]For vacuum service on VSC-3000 and VSC-8000, contact your U.S. Filter/Westates representative.

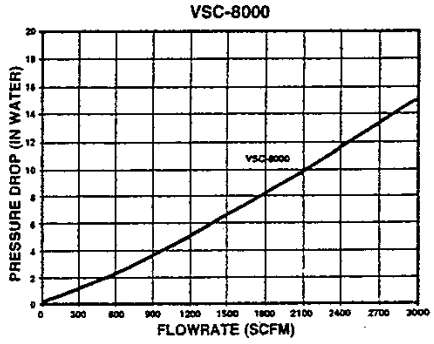
inlet flow, nitrogen blanketing of the carbon system or prewetting the carbon bed.

Please contact your local U.S. Filter/ Westates account representative for technical support concerning the control of carbon bed temperatures.

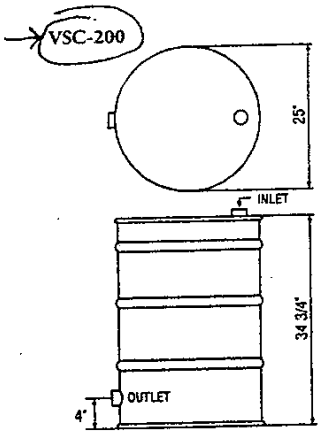


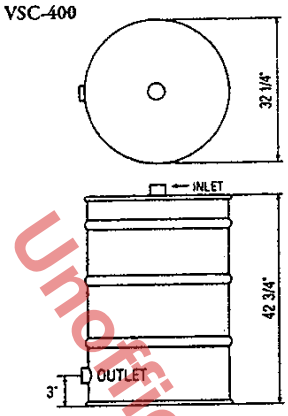


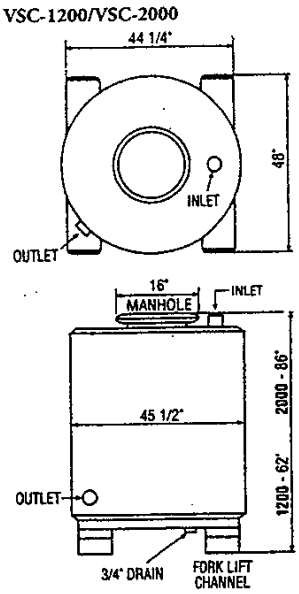


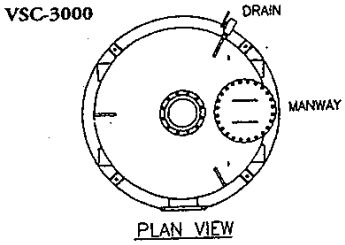


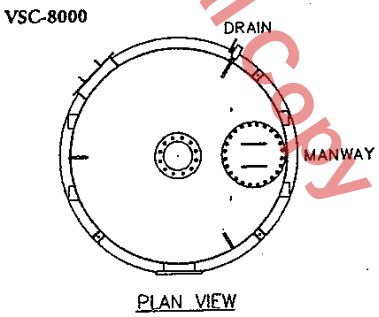
SCHEMATIC DRAWINGS

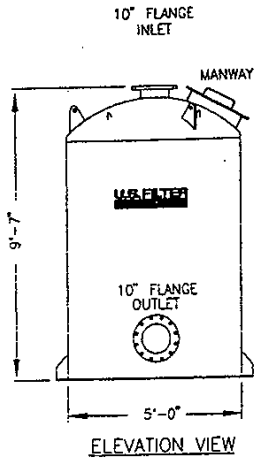


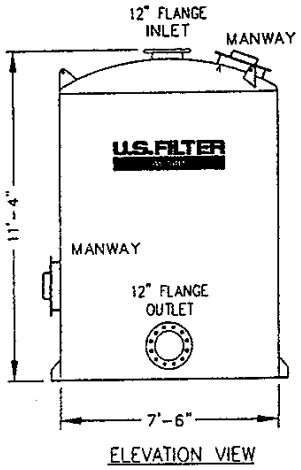












Technical Support

With many years of experience in the applications of activated carbon, combined with our laboratory and computer-modeling capabilities adds up to the kind of technical support required for quickly solving adsorption related problems. The challenge handled by U.S. Filter/Westates is the quick identification, evaluation and implementation of the most cost-effective solution for your air and water treatment applications.

U.S.FILTER
WESTATES

U.S.Filter/Westates
Baytown, TX 800-659-1723
Warren, NJ 800-659-1717
Los Angeles, CA 800-659-1771
Oakland, CA 800-659-1718

USFilter

USFILTER WESTATES
2907 E. Cochise Road
Phoenix, AZ 85028

Telephone 602-923-8552
Facsimile 602-485-5908

August 18, 2000

Boyd Breeding
Wasatch Environmental
2410 West California Avenue
Salt Lake City, Utah 84104

Dear Mr. Breeding:

It has been a pleasure speaking with you. US Filter/Westates Carbon (Westates) is pleased to present our proposal for your activated carbon needs. Westates has over 25 years experience in carbon adsorption technologies and can provide the following benefits:

- **Turn-key Service**. We provide on-site services, vessel exchange service, spent carbon transportation, and off-site reactivation (our own state-of-the-art facility), technical support, full line of quality certified activated carbons.

- **Responsible management of your liabilities**. Westates can provide the stability, resources and experience to address your long term requirements for carbon services.

Based on our conversation and information provided, Westates can provide the following equipment and services:

EQUIPMENT

Vent Scrub 200 disposable carbon adsorption vessel with 2-inch fittings and approximately 200 pounds of granular reactivated carbon.

VSC-200-2-SCC601

UNIT WITH PREPAID DISPOSAL* (As Non-Hazardous Spent GAC):	**$ 400.00/unit**
FREIGHT TO AND FROM SITE (Approximate):	**$ 150.00/unit**
LAB FEE (For Profiling Non-Hazardous Spent GAC):	**$180.00**

*Prepaid disposal includes purchase, transportation to and from site, and reactivation of spent GAC.

An inventory of these units is maintained in our Oakland Regional Service Center. This ensures quick response and often the vessels can be delivered to your site within two days.

SPENT CARBON PROFILE PROCESS

Westates requires that all clients submit information on our Spent Carbon Profile Forms regarding their carbon and process generating it. Wasatch is responsible for any costs associated with profiling and manifesting the spent carbon. Profiling of RCRA spent carbon requires separate sample analysis be performed in compliance with our facility's Waste Analysis Plan. The Spent Carbon Profile fee quoted above is for non-hazardous or non-RCRA spent carbon only; profiling for RCRA spent carbon required separate sample analysis be performed in compliance with our facility's Waste Analysis Plan at an alternate cost of $400.00. Please contact Westates' in Phoenix (602-923-8552) for assistance in completing the profile and manifest forms.

REACTIVATION SERVICES

Built and placed into commercial operation in 1992, Westates provides its state-of-the-art EPA RCRA permitted reactivation plant in Parker, Arizona for reactivating spent carbon classified as non-hazardous or hazardous. This plant is located on a greenfield site without any previous industry or other use of the area that would pose a threat of liability for generators shipping their spent carbons to Parker. Westates customers receive priority service for the Parker Plant.

Many companies like DuPont, Chevron, FMC, Hewlett Packard and many more have successfully audited our facility. We would be pleased to arrange an audit. Let us know how we can assist you.

Westates can provide spent carbon reactivation services in an economical and environmentally safe manner. All reactivation services will be concluded with the issuance of a Certificate of Reactivation that certifies the reactivation, in accordance with Federal regulations, by a thermal process that removed and destroyed volatile and semi-volatile contaminants adsorbed onto the spent carbon.

TECHNICAL SUPPORT

Westates Carbon's Technical Services Group maintains and operates a state certified laboratory for analysis of contaminants on spent carbon, provides spent carbon testing for profile approval process, conducts research and development,

maintains Quality Control and Quality Assurance program for activated carbons used by Westates.

Dr. James Graham, who has over 25 years of experience and is currently the Chairman of the ASTM Committee D-28 for Carbon, heads our Technical Services Group. Dr. Graham and his staff are available to address our clients' technical questions and consult on issues related to carbon as well as other applications.

By using Westates, Wasatch will benefit from higher quality products, efficient service, lower overall costs and proper management of your long-term liabilities.

Should you have any questions regarding any of the above, please do not hesitate to call me.

Sincerely,

Lucien D Tender

Lucien D. Tender
Account Manager

USFilter

Material Safety Data Sheet

SECTION 1 – CHEMICAL PRODUCT AND COMPANY INFORMATION

****

Product Name: ACTIVATED CARBON, *CC SERIES, KG SERIES, KP SERIES, AG SERIES*
Part Number: 100 **Chemical Family**: activated carbon

Manufacturer's Name: U.S. FILTER WESTATES CARBON
Address: 5375 South Boyle Avenue, Los Angeles, CA 90058
Product/Technical Information Phone Number: (323) 277-1500
Medical/Handling Emergency Phone Number: CHEMTREC 1-800-424-9300
Transportation Emergency Phone Number: CHEMTREC 1-800-424-9300

Revision Date/Revision Number: September 18, 2000/#6

SECTION 2 – COMPOSITION INFORMATION

****

Chemical Name	Percent by Weight	CAS#
Activated Carbon	100	7440-44-0

SECTION 3 – HAZARDS IDENTIFICATION

****

Appearance & Odor: black granules without taste or odor
Emergency Overview: Dust that contacts eyes may be irritating or cause mechanical injury. Dust may cause slight skin irritation. Dust may be irritating to the respiratory tract and cause coughing or sneezing. Ingestion of powder may be irritating to the gastrointestinal tract. Warning: Wet activated carbon depletes oxygen from the air and therefore dangerously low levels of oxygen may be encountered. Whenever workers enter a vessel containing activated carbon, the vessel's oxygen content should be determined and work procedures for potentially low oxygen areas should be followed.
Fire &Explosion Hazards: When burned, hazardous products of combustion including carbon oxides can occur. Irritating and/or toxic gases due to decomposition of the product may be generated during a fire. Fight fire from a safe distance from a protected location. Contact with strong oxidizers such as ozone or liquid oxygen may cause rapid combustion.
Primary Route(s) of Exposure: Eye contact, skin contact, ingestion, or inhalation are all possible routes of entry.
Inhalation- Acute Effects: Dust may be irritating to the respiratory tract and cause coughing or sneezing.
Skin Contact-Acute Effects: Dust may cause slight skin irritation.

SECTION 3 – HAZARDS IDENTIFICATION (cont.)

****

Eye Contact- Acute Effects: Dust that contacts eyes may be irritating or cause mechanical injury.
Ingestion- Acute Effects: Ingestion of powder may be irritating to the gastrointestinal tract.

SECTION 4 – FIRST AID MEASURES

****

Inhalation First Aid: Remove affected person from area to fresh air and provide oxygen if breathing is difficult. Give artificial respiration ONLY if breathing has stopped and give CPR ONLY if there is no breathing and no pulse. Obtain medical attention.
Skin Contact First Aid: Wash skin for 5 minutes with flowing water and soap. Clothing should be discarded or washed before reuse. Obtain medical assistance if irritation develops. DO NOT instruct person to neutralize affected skin area.
Eye Contact First Aid: Immediately irrigate eyes with flowing water continuously for 15 minutes while holding eyes open. Contacts should be removed before or during flushing. Seek medical assistance if irritation develops. DO NOT instruct person to neutralize.
Ingestion First Aid: Vomiting may need to be induced if directed by a physician or poison control center. DO NOT have unqualified personnel induce vomiting. Obtain medical attention immediately.
Medical Conditions Aggravated: Respiratory ailments may be aggravated by exposure to this product.
Note to Physician: No specific antidote, treat patient symptomatically.

SECTION 5 – FIRE FIGHTING MEASURES

****

Flash Point/Method: Nonflammable
Auto Ignition Temperature: 840°C (1,710°F)
Upper/Lower Explosion Limits: not applicable

Extinguishing Media: Water spray, carbon dioxide, foam or dry chemical
Fire Fighting Procedures: In the event of a fire, wear full protective clothing and NIOSH approved self-contained breathing apparatus with full face piece, operated in the positive pressure mode.
Fire & Explosion Hazards: When burned, hazardous products of combustion including carbon oxides can occur. Irritating and/or toxic gases due to decomposition of the product may be generated during a fire. Fight fire from a safe distance from a protected location. Contact with strong oxidizers such as ozone or liquid oxygen may cause rapid combustion.
Hazardous Products of Decomposition and /or Combustion: Carbon oxides.

NFPA Ratings:
HEALTH-1 FLAMMABILITY- 0 REACTIVITY-0 OTHER- none

SECTION 6 – ACCIDENTAL RELEASE MEASURES

****

Clean up spills in a manner that does not disperse dust into the air. Handle in accordance with good industrial hygiene and safety practices. These practices include avoiding unnecessary exposure, and removal of material from eyes, skin, and clothing. Dispose of virgin (unused) carbon (waste or spillage) in a facility permitted for non-hazardous wastes. Spent (used) carbon should be disposed of in accordance with applicable laws. Do not reuse empty bags. Dispose of in facility permitted for non-hazardous wastes. DO NOT DUMP INTO ANY SEWERS, ON THE GROUND OR INTO ANY BODY OF WATER. All disposal methods must be in compliance with all Federal, State, Local and Provincial laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator.

SECTION 7 – HANDLING AND STORAGE

****

Handling: Avoid dispersion into air. Keep containers dry and closed. Follow good handling and housekeeping practices to minimize spills, generation of airborne dusts, and accumulation of dusts on exposed surfaces. Use with adequate exhaust ventilation to draw dust away from workers' breathing zones. Prevent or minimize exposures to dusts by using appropriate respirators, gloves, and eye protection. Wash exposed skin areas thoroughly with soap and water. Use caution when pouring, using pneumatic transport, swirling, etc. as this material can become electrostatically charged.

Storage: Avoid breaking bags or spilling media so as to avoid possibly creating residual dust. Store in ambient atmospheric conditions. Product should be stored in a closed dry container. Maintain good housekeeping procedures. Store away from strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc.

General Comments: Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

SECTION 8 –PERSONAL PROTECTION/ EXPOSURE CONTROL

****

Respiratory Protection: Use NIOSH/MSHA approved respiratory protection equipment appropriate to the material and/or its concentration where airborne exposure is likely. If exposures cannot be kept to a minimum with engineering controls, consult manufacturer to determine appropriate type equipment for a given application. Observe respirator use limitations specified by NIOSH/MSHA or the manufacturer.

Skin Protection: Wear appropriate dust resistant clothing and gloves.

Eye Protection: Safety glasses with side shields are recommended for any type of handling. Where eye contact or dusty conditions may be likely, dust tight goggles are recommended.

SECTION 8 –PERSONAL PROTECTION/ EXPOSURE CONTROL (cont.)

Ventilation Protection: Provide ventilation if necessary to minimize exposure. Dilute ventilation acceptable, but local mechanical exhaust ventilation preferred, if practical, at sources of air contamination such as open process equipment. The following publication offers ventilation guidelines and techniques: "INDUSTRIAL VENTILATION, A MANUAL OF RECOMMENDED PRACTICE" available from the ACGIH.
Other Protection: Safety showers, with quick opening valves which stay open, and eye wash fountains, or other means of washing the eyes with a gentle flow of cool to tepid tap water, should be readily available in all areas where this material is handled or stored. Water should be supplied through insulated and heat-traced lines to prevent freeze-ups in cold weather.

Exposure Limits:
OSHA PEL-TWA: 15 mg/m^3 (total), 5 mg/ m^3 (resp)
OSHA PEL-STEL: 10 mg/m^3

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance & Odor: black granules without taste or odor
Vapor Pressure: zero
Vapor Density (Air=1): not applicable
Boiling Point: not applicable
Melting Point: not applicable
Specific Gravity: 0.25 - 0.60 g/cc
Solubility in Water: Insoluble
Volatile Percentage: 0%
pH: not determined
Flash Point/method: Nonflammable
Auto Ignition Temperature: 840°C
Upper/Lower Explosion Limits: not applicable
Other: none

SECTION 10 – STABILITY AND REACTIVITY

Stability: This product is considered stable under the specified conditions of storage, shipment and use.
Incompatibilities: Contact with strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc. may result in rapid combustion. Avoid contact with strong acids.
Polymerization: Hazardous polymerization will not occur.
Decomposition: Hazardous decomposition will produce carbon oxides.
Conditions to avoid: Store away from strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc. Moist air will reduce the operating life.

SECTION 11 – TOXICOLOGICAL INFORMATION

INHALATION – Acute: Inhalation of carbon dust is mildly irritating to the lungs and can immediately give rise to an increased mucociliary transport and airway resistance mediated by the vagus. The inhalation LC50 (Rat) is > 64.4 mg/l.
INHALATION – Chronic: There are no known chronic inhalation effects.
SKIN CONTACT – Acute: Skin contact is expected to be slightly irritating. The primary skin irritation index (rabbit) is 0.

SECTION 11 – TOXICOLOGICAL INFORMATION (cont.)

****

SKIN CONTACT – Chronic: There are no known chronic dermal effects.
EYE CONTACT – Acute: Eye contact can cause conjunctivitis, epithelial hyperplasia of the cornea, as well as eczematous inflammation of the eyelids.
INGESTION – Acute: Carbon is practically nontoxic. The probable oral lethal dose (human) is greater than 15 g/kg; more than one quart (2.2 lbs) for a 70 kg (150 lb) person.
INGESTION – Chronic: There are no known chronic ingestion effects.
CARCINOGENICITY/MUTAGENICITY: There are no known carcinogenic/mutagenic effects.
REPRODUCTIVE EFFECTS: There are no known reproductive effects.
NEUROTOXICITY: There are no known neurotoxic effects.
OTHER EFFECTS: No other toxic effects of carbon are known.
TARGET ORGANS: Target organs include the respiratory system and the cardiovascular system.

SECTION 12 – ECOLOGICAL INFORMATION

****

This material, in its original state, is not harmful to the environment.

SECTION 13 – DISPOSAL CONSIDERATIONS

****

Clean spills in a manner that does not disperse dust into the air, preferably a wet-down procedure or vacuum. If material is not contaminated, spilled media can be rebagged. Material that cannot be used or chemically reprocessed and empty containers should be disposed of in accordance with all applicable regulations. Product containers should be thoroughly emptied before disposal. Generators of waste material are required to evaluate all waste for compliance with RCRA and any local disposal procedures and regulations. NOTE: State and local regulations may be more stringent than federal regulations.

Warning: Wet activated carbon depletes oxygen from the air and therefore dangerously low levels of oxygen may be encountered. Whenever workers enter a vessel containing activated carbon, the vessel's oxygen content should be determined and work procedures for potentially low oxygen areas should be followed.

SECTION 14 – TRANSPORTATION INFORMATION

****

DOT Shipping Description: Not DOT Regulated

SECTION 15 – REGULATORY INFORMATION

****

CERCLA SECTION 103 (40CFR302.4): no RQ: none
SARA SECTION 302 (40CFR355.30): no
SARA SECTION 304 (40CFR355.40): no
SARA SECTION 313 (40CFR372.65): no
SARA HAZARD CATEGORIES, SARA SECTIONS 311/312 (40CFR370.21):
ACUTE: yes CHRONIC: no FIRE: no REACTIVE: no SUDDEN RELEASE: no
OSHA PROCESS SAFETY (29CFR1910.119): no
CALIFORNIA PROPOSITION 65: no

SECTION 16 – OTHER INFORMATION

****

Disclaimer: The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the user thereof. It is the buyer's responsibility to ensure that its activities comply with federal, state, provincial and local laws.

Created by: James R. Graham

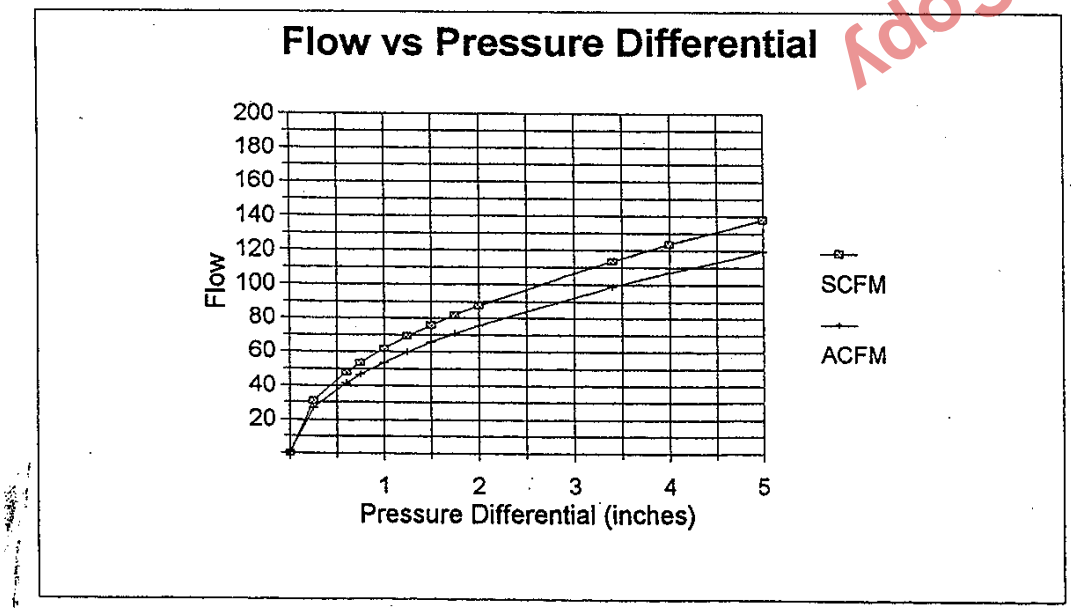
F

Flow Calculations For DS500-2 Flow Sensor

Q SCFM	Q ACFM	Differential Pressure Inches of H_2O
0	0	0
31	27	0.25
48	42	0.60
54	46	0.75
62	54	1.00
69	60	1.25
76	66	1.50
82	71	1.75
87	76	2.00
114	99	3.40
124	107	4.00
138	120	5.00

Input Data

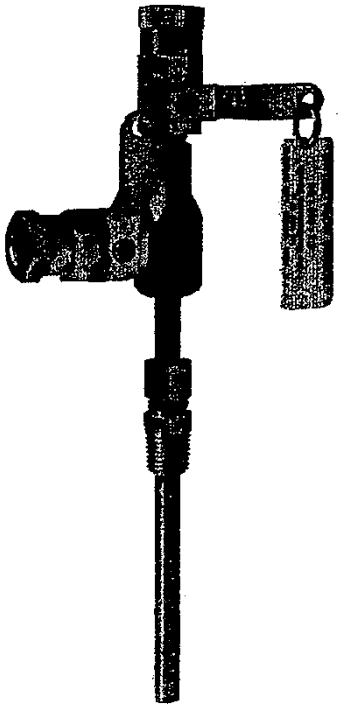
Line Pressure (psig) =	6
Temp F =	175
Assumes atmospheric pressure (psi) =	14.6
Assumes schedule 40 pipe ID (inches) =	2



BULLETIN F-50

SERIES DS-300 FLOW SENSORS

Installation and Operating Instructions, Flow Calculations



INSPECTION

Inspect the sensor upon receipt of shipment to be certain it is as ordered and not damaged. If damaged, contact carrier.

INSTALLATION

General – The sensing ports of the flow sensor must be correctly positioned for measurement accuracy. The instrument connections on the sensor indicate correct positioning. The side connection is for total or high pressure and should be pointed upstream. The top connection is for static or low pressure.

Location – The sensor should be installed in the flowing line with as much straight run of pipe upstream as possible. This will provide a flow profile as ideal as possible. A rule of thumb is to allow 10-15 pipe diameters upstream and 5 down. The table below lists recommended up and down piping:

PRESSURE AND TEMPERATURE

Maximum 200 psig at 200°F.

UPSTREAM AND DOWNSTREAM DIMENSIONS IN TERMS OF INTERNAL DIAMETER OF PIPE

*SEE NOTE #1

UPSTREAM CONDITION	MINIMUM DIAMETER OF STRAIGHT PIPE		
	UPSTREAM		DOWNSTREAM
	IN-PLANE	OUT OF PLANE	
One Elbow or Tee	7	9	5
Two 90° Bends in Same Plane	8	12	5
Two 90° Bends in Different Plane	18	24	5
Reducers or Expanders	8	8	5
All Valves *See Note 2	24	24	5

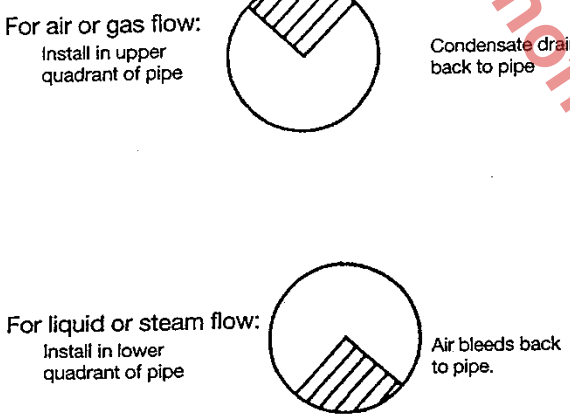
*Note #1: Values shown are recommended spacing, in terms of internal diameter for normal industrial metering requirements. For laboratory or high accuracy work, add 25% to values.

*Note #2: Includes gate, globe, plug and other throttling valves that are only partially opened. If valve is to be fully open, use values for pipe size change. CONTROL VALVES SHOULD BE LOCATED AFTER THE FLOW SENSOR.

POSITION

Be certain there is sufficient clearance between the mounting position and other pipes, walls, structures, etc, so that the sensor can be inserted through the mounting unit once the mounting unit has been installed onto the pipe.

Flow Sensors should be positioned to keep air out of the instrument connecting lines on liquid flows and condensate out of the lines on gas flows. The easiest way to assure this is to install the sensor into the pipe so that air will bleed into, or condensate will drain back to, the pipe.



INSTALLATION

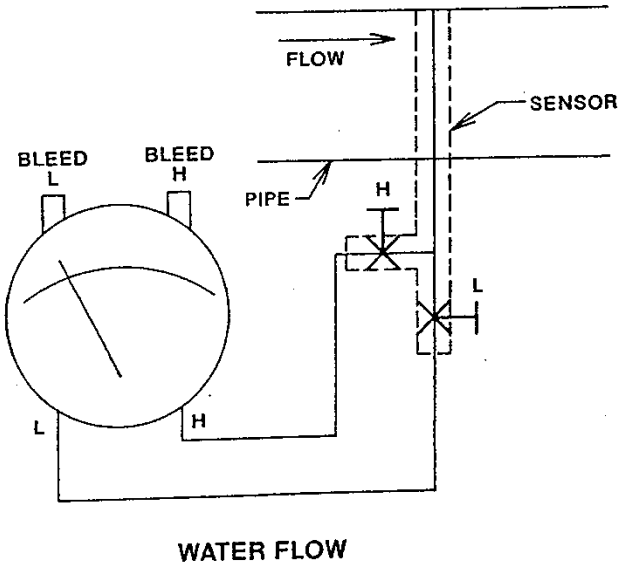
1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4"×3/8") will be needed.
2. Drill through the center of the thred-o-let into the pipe, with a drill that is slightly larger than the flow sensor diameter.
3. Install the packing gland using proper pipe sealant. If the packing gland is disassembled, note that the tapered end of the ferrule goes into the fitting body.
4. Insert the sensor until it bottoms against the opposite wall of the pipe, then withdraw 1/16" to allow for thermal expansion.
5. Tighten packing gland nut finger tight. Then tighten the nut with a wrench an additional 1 1/4 turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

INSTRUMENT CONNECTION

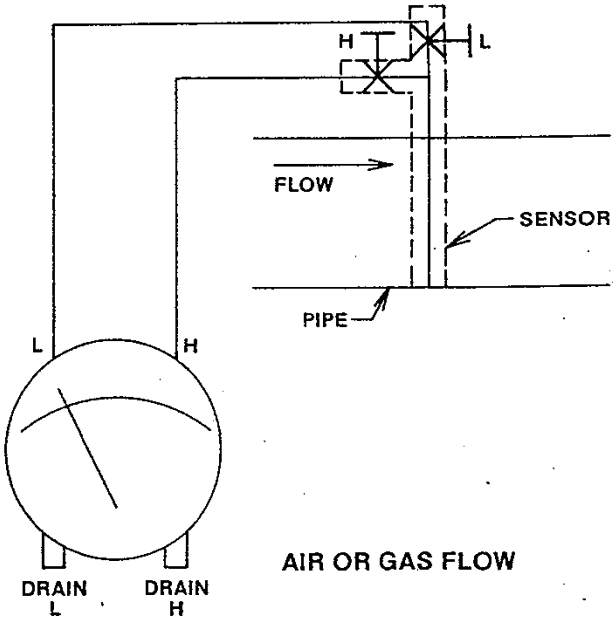
Connect the side pressure tap to the high pressure port of the Magnehelic (air only) or Capsuhelic gage or transmitting instrument and the top connection to the low pressure port. See the connection schematics below.

Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

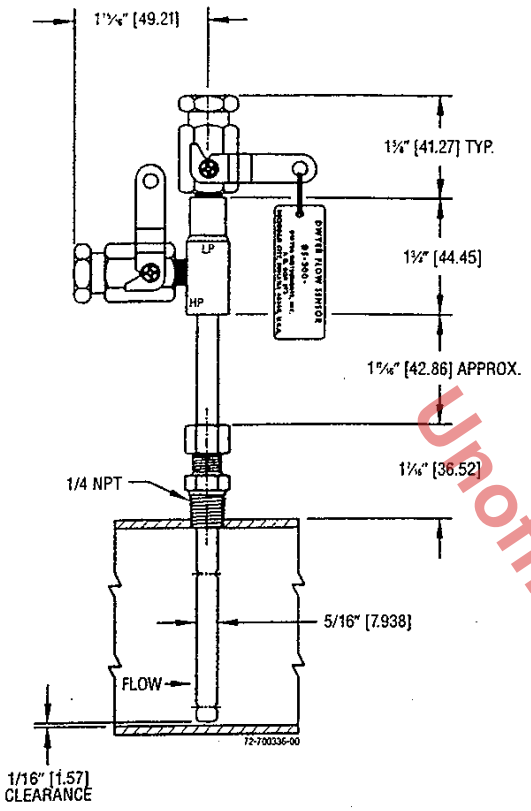


WATER FLOW



AIR OR GAS FLOW

SERIES DS-300 FLOW SENSORS



FLOW CALCULATIONS AND CHARTS

The following information contains tables and equations for determining the differential pressure developed by the DS-300 Flow Sensor for various flow rates of water, steam, air or other gases in different pipe sizes.

This information can be used to prepare conversion charts to translate the differential pressure readings being sensed into the equivalent flow rate. Where direct readout of flow is required, use this information to calculate the full flow differential pressure in order to specify the exact range of Dwyer Magnehelic or Capsuhelic gage required. Special ranges and calculations are available for these gages at minimal extra cost. See bulletins A-30 and F-41 for additional information on Magnehelic and Capsuhelic gages and DS-300 flow sensors.

For additional useful information on making flow calculations, the following reference is recommended: Crane Valve Co. Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings and Pipe." It is available from Crane Valve Co., 104 N. Chicago St., Joliet, IL 60431. Phone 815/727-2600. Price including shipping is $20.00

Using the appropriate differential pressure equation from page 4, calculate the differential pressure generated by the sensor under **normal** operating conditions of the system. Check the chart below to determine if this value is within the recommended operating range for the sensor. Note that the data in this chart is limited to standard conditions of air at 60°F (15.6°C) and 14.7 psia static line pressure or water at 70°F (21.1°C). To determine recommended operating ranges for other gases, liquids and/or operating conditions, consult the factory.

Note the column on the right side of the chart which defines velocity ranges to avoid. Continuous operation within these can result in damage to the flow sensor caused by excess vibration.

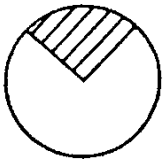
Pipe Size (Schedule 40)	Flow Coefficient "K"	Operating Ranges Air @ 60°F & 14.7 psia (D/P Inches W.C.)	Operating Ranges Water @ 70°F (D/P Inches W.C.)	Velocity Ranges Not Recommended (Feet per Second)
1	0.52	1.10 to 186	4.00 to 675	146 to 220
1¼	0.58	1.15 to 157	4.18 to 568	113 to 170
1½	0.58	0.38 to 115	1.36 to 417	96 to 144
2	0.64	0.75 to 75	2.72 to 271	71 to 108
2½	0.62	1.72 to 53	6.22 to 193	56 to 85
3	0.67	0.39 to 35	1.43 to 127	42 to 64
4	0.67	0.28 to 34	1.02 to 123	28 to 43
6	0.71	0.64 to 11	2.31 to 40	15 to 23
8	0.67	0.10 to 10	0.37 to 37	9.5 to 15
10	0.70	0.17 to 22	0.60 to 79	6.4 to 10

POSITION

Be certain there is sufficient clearance between the mounting position and other pipes, walls, structures, etc, so that the sensor can be inserted through the mounting unit once the mounting unit has been installed onto the pipe.

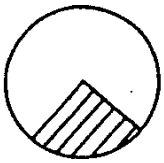
Flow Sensors should be positioned to keep air out of the instrument connecting lines on liquid flows and condensate out of the lines on gas flows. The easiest way to assure this is to install the sensor into the pipe so that air will bleed into, or condensate will drain back to, the pipe.

For air or gas flow:
Install in upper quadrant of pipe



Condensate drains back to pipe

For liquid or steam flow:
Install in lower quadrant of pipe



Air bleeds back to pipe.

INSTALLATION

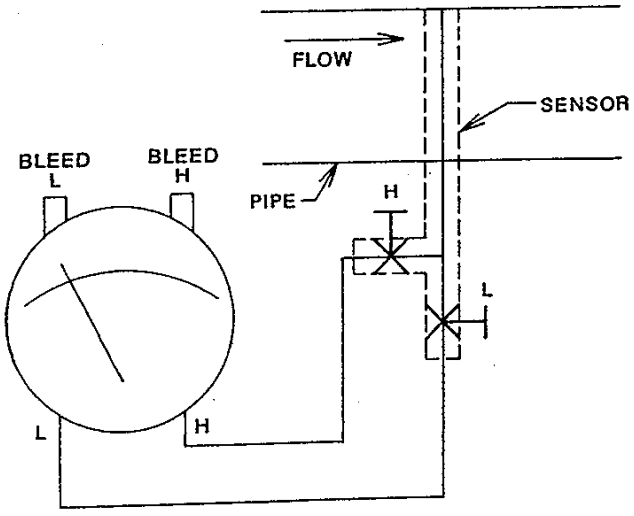
1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4"×3/8") will be needed.
2. Drill through the center of the thred-o-let into the pipe, with a drill that is slightly larger than the flow sensor diameter.
3. Install the packing gland using proper pipe sealant. If the packing gland is disassembled, note that the tapered end of the ferrule goes into the fitting body.
4. Insert the sensor until it bottoms against the opposite wall of the pipe, then withdraw 1/16" to allow for thermal expansion.
5. Tighten packing gland nut finger tight. Then tighten the nut with a wrench an additional 1 1/4 turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

INSTRUMENT CONNECTION

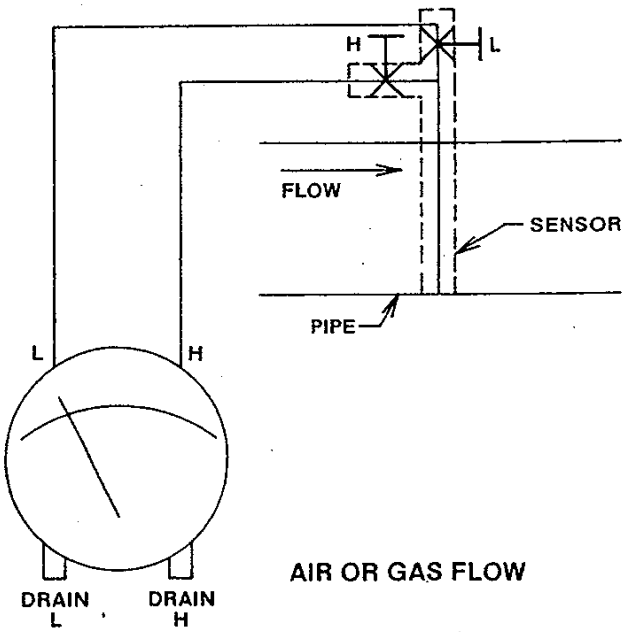
Connect the side pressure tap to the high pressure port of the Magnehelic (air only) or Capsuhelic gage or transmitting instrument and the top connection to the low pressure port. See the connection schematics below.

Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.



WATER FLOW



AIR OR GAS FLOW

FLOW EQUATIONS

1. Any Liquid
$$Q\ (GPM) = 5.668 \times K \times D^2 \times \sqrt{\triangle P/S_f}$$

2. Steam or Any Gas
$$Q\ (lb/Hr) = 359.1 \times K \times D^2 \times \sqrt{p \times \triangle P}$$

3. Any Gas
$$Q\ (SCFM) = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \triangle P}{(T+460) \times S_S}}$$

DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid
$$\triangle P\ (in.\ WC) = \frac{Q^2 \times S_f}{K^2 \times D^4 \times 32.14}$$

2. Steam or Any Gas
$$\triangle P\ (in.\ WC) = \frac{Q^2}{K^2 \times D^4 \times p \times 128{,}900}$$

3. Any Gas
$$\triangle P\ (in.\ WC) = \frac{Q^2 \times S_S \times (T+460)}{K^2 \times D^4 \times P \times 16{,}590}$$

TECHNICAL NOTATIONS

The following notations apply:

$\triangle P$ = Differential pressure expressed in inches of water column.
Q = Flow expressed in GPM, SCFM or PPH as shown in equation.
K = Flow coefficient — See Values Tabulated on page 3.
D = Inside diameter of line size expressed in inches. For square & rectangular ducts use $D = \sqrt{\frac{4 \times Height \times Width}{\pi}}$

P = Static Line pressure (psia)
T = Temperature in degrees Fahrenheit (plus 460=°Rankin)
p = Density of medium in pounds per cubic foot
S_f = Sp Gr at flowing conditions
S_S = Sp Gr at 60°F

SCFM TO ACFM EQUATION

$$SCFM = ACFM \times \left(\frac{14.7 + PSIG}{14.7}\right)\left(\frac{520^*}{460 + °F}\right)$$

$$ACFM = SCFM \times \left(\frac{14.7}{14.7 + PSIG}\right)\left(\frac{460 + °F}{520}\right)$$

$$\text{POUNDS PER CUBIC FOOT STD.} = \text{POUNDS PER CUBIC FOOT ACT.} \times \left(\frac{14.7}{14.7 + PSIG}\right)\left(\frac{460 + °F}{520}\right)$$

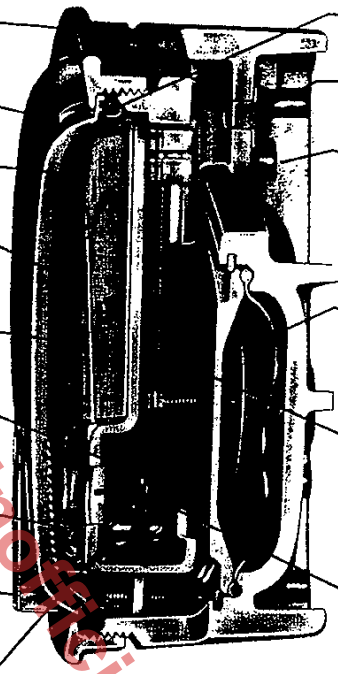
$$\text{POUNDS PER CUBIC FOOT ACT.} = \text{POUNDS PER CUBIC FOOT STD.} \times \left(\frac{14.7 + PSIG}{14.7}\right)\left(\frac{520}{460 + °F}\right)$$

1 CUBIC FOOT OF AIR = 0.076 POUNDS PER CUBIC FOOT AT 60°F AND 14.7 PSIA

*(520 = 460 + 60°) Std. Temp. Rankine

Printed in U.S.A. 6/96 FR 72-440451-01

Quality design and construction features



Bezel provides flange for flush mounting in panel.

Clear plastic face is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

Precision litho-printed scale is accurate and easy to read.

Red tipped pointer of heat treated aluminum tubing is easy to see. It is rigidly mounted on helix shaft.

Pointer stops of molded rubber prevent pointer over-travel without damage.

"Wishbone" assembly provides mounting for helix, helix bearings and pointer shaft.

Jeweled bearings are shock-resistant mounted; provide virtually friction-free motion for helix. Motion damped with high viscosity silicone fluid.

Zero adjustment screw is conveniently located in plastic cover, accessible without removing cover. O-ring seal provides pressure tightness.

Helix is precision milled from an alloy of high magnetic permeability. Mounted in jeweled bearings, it turns freely to align with magnetic field of magnet to transmit pressure indication to pointer.

O-ring seal for cover assures pressure integrity of case.

Blowout plug of silicone rubber protects against overpressure on 15 PSIG rated models. Opens at approximately 25 PSIG.

Die cast aluminum case is precision made. Iridite-dipped to withstand 168 hour salt spray test. Exterior finished in baked dark gray hammerloid. One case size used for all standard pressure ranges, and for both surface and flush mounting.

Silicone rubber diaphragm with integrally molded O-ring is supported by front and rear plates. It is locked and sealed in position with a sealing plate and retaining ring. Diaphragm motion is restricted to prevent damage due to overpressures.

Calibrated range spring is flat spring steel. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length adjustable for calibration.

Samarium Cobalt magnet mounted at one end of range spring rotates helix without mechanical linkages.

SERIES 2000 MAGNEHELIC®— MODELS AND RANGES
STOCKED MODELS in bold

The models below will fulfill most requirements. Page 4 also shows examples of special models built for OEM customers. For special scales furnished in ounces per square inch, inches of mercury, metric units, etc., contact the factory.

Dual Scale English/Metric Models			
Model Number	Range, In. W.C.	Range, Pa or kPa	Price
2000-0D	0-0.5	0-125 Pa	$53.50
2001D	0-1.0	0-250 Pa	53.50
2002D	0-2.0	0-500 Pa	53.50
2003D	0-3.0	0-700 Pa	53.50
2004D	0-4.0	0-1.0 kPa	53.50
2006D	0-6.0	0-1.5 kPa	53.50
2008D	0-8.0	0-2.0 kPa	53.50
2010D	0-10	0-2.5 kPa	53.50

Model Number	Range Inches of Water	Price
2000-00†	0-.25	$59.50
2000-0†	0-.50	53.50
2001	0-1.0	53.50
2002	0-2.0	53.50
2003	0-3.0	53.50
2004	0-4.0	53.50
2005	0-5.0	53.50
2006	0-6.0	53.50
2008	0-8.0	53.50
2010	0-10	53.50
2015	0-15	53.50
2020	0-20	53.50
2025	0-25	53.50
2030	0-30	53.50
2040	0-40	53.50
2050	0-50	53.50
2060	0-60	53.50
2080	0-80	53.50
2100	0-100	53.50
2150	0-150	53.50

Model Number	Range Zero Center Inches of Water	Price
2300	.25-0-.25	$59.00
01† 2301	.5-0-.5	59.00
2302	1-0-1	59.00
2304	2-0-2	59.00
2310	5-0-5	59.00
2320	10-0-10	59.00
2330	15-0-15	59.00

Model Number	Range PSI	Price
2201	0-1	$53.50
2202	0-2	53.50
2203	0-3	53.50
2204	0-4	53.50
2205	0-5	53.50
2210†	0-10	87.00
2215*	0-15	87.00
2220*	0-20	87.00
2230**	0-30	114.00

*MP option standard
**HP option standard

Dual Scale Air Velocity Units		
Model Number	Range in W.C.† Velocity, F.P.M.	Price
2000-0AV	0-.25/300-2000	$59.00
2000-0AV	0-.50/500-2800	53.50
2001AV	0-1.0/500-4000	53.50
2002AV	0-2.0/1000-5600	53.50
2010AV	0-10/2000-12500	53.50

For use with pitot tube.

Model Number	Range MM of Water	Price
2000-6MM†	0-6	$59.00
2000-10MM	0-10	53.50
2000-25MM	0-25	53.50
2000-50MM	0-50	53.50
2000-80MM	0-80	53.50
2000-100MM	0-100	53.50
Zero Center Ranges		
2300-20MM†	10-0-10	$59.00

Model Number	Range, CM of Water	Price
2000-15CM	0-15	$ 53.50
2000-20CM	0-20	53.50
2000-25CM	0-25	53.50
2000-50CM	0-50	53.50
2000-80CM	0-80	53.50
2000-100CM	0-100	53.50
2000-150CM	0-150	53.50
2000-200CM	0-200	53.50
2000-250CM	0-250	53.50
2000-300CM	0-300	53.50
Zero Center Ranges		
2300-4CM	2-0-2	$59.00
2300-10CM	5-0-5	59.00
2300-30CM	15-0-15	59.00

†These ranges calibrated for vertical scale position.

Model Number	Range, Pascals	Price
2000-60 Pa†	0-60	$59.00
2000-125 Pa†	0-125	53.50
2000-250 Pa	0-250	53.50
2000-500 Pa	0-500	53.50
2000-750 Pa	0-700	53.50
Zero Center Ranges		
2300-250 Pa	125-0-125	$59.00
2300-500 Pa	250-0-250	59.00

Model Number	Range, Kilopascals	Price
2000-1 kPa	0-1	$53.50
2000-1.5 kPa	0-1.5	53.50
2000-2 kPa	0-2	53.50
2000-3 kPa	0-3	53.50
2000-4 kPa	0-4	53.50
2000-5 kPa	0-5	53.50
2000-6 kPa	0-8	53.50
2000-10 kPa	0-10	53.50
2000-15 kPa	0-15	53.50
2000-20 kPa	0-20	53.50
2000-25 kPa	0-25	53.50
2000-30 kPa	0-30	53.50
Zero Center Ranges		
2300-1 kPa	.5-0-.5	$59.00
2300-3 kPa	1.5-0-1.5	59.00

Accessories
- **A-310A**, 3-Way Vent Valve.....$8.00
- **A-321**, Safety Relief Valve.....$10.50
- **A-432**, Portable Kit.....$21.50
- **A-605**, Air Filter Kit.....$21.50
- **A-616**, Pipe Mount Kit.....$12.00

Options — To order, add suffix: I.E. 2001-ASF
- ASF (Adjustable Signal Flag).....add $12.00
- HP (High Pressure Option).....add $59.00
- LT (Low Temperatures to -20°F).....$4.00
- MP (Med. Pressure Option).....add $35.00
- SP (Setpoint Indicator).....add $54.00

Scale Overlays — Red, Green, Mirrored or Combination. Specify Locations. Add $8.50 Net.

Special Purpose Ranges

Scale No. 2401	Scale No. 2402
Square Root	Blank Scale
Specify Range	Specify Range

Model 2000-00N, range -.05 to +.20" W.C. For room pressure monitoring.....$59.00

1011R01-0296P

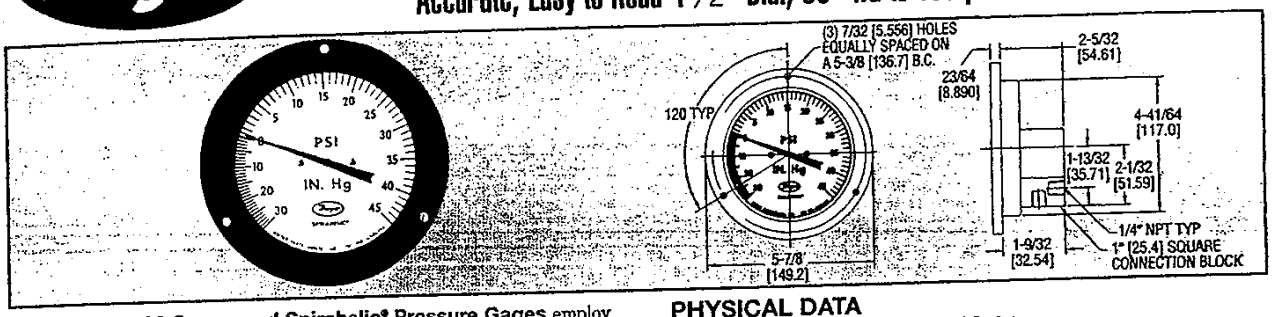
G

Dwyer®

Series 7100

Compound Spirahelic® Pressure Gage

Accurate, Easy-to-Read 4½" Dial, 30" HG to 100 psi



The Series 7100 Compound Spirahelic® Pressure Gages employ a unique triple helix Bourdon tube for precision measurement of compatible gases and liquids. Vacuum pressure readings down to 30" Hg for ASME Grade 2A (½% of full scale) and 1A (1% of full scale) accuracy. Standard and turret mount cases available. Solid brass or 316 stainless steel connection block features convenient dual ¼" NPT female ports. Safety is assured with solid front case design and rear blowout hole. ASME B40.1 design fits existing cutouts for easy replacement.

STOCKED MODELS in bold

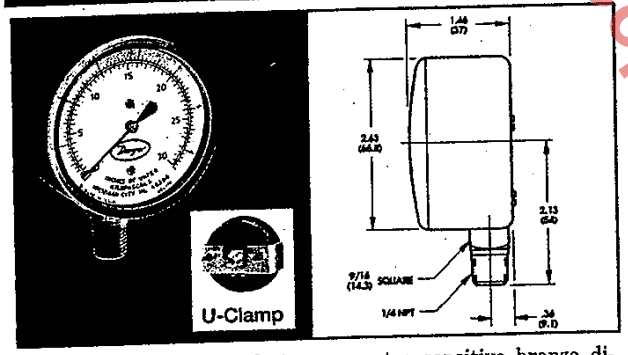
Model Number	Ranges	Case	Model Number	Ranges	Case
7111-G030C	30"Hg-0-30 psi	Standard	7112-G030C	30"Hg-0-30 psi	Standard
7111B-G030C	30"Hg-0-30 psi	Turret Bottom	7112B-G030C	30"Hg-0-30 psi	Turret Bottom
7111C-G030C	30"Hg-0-30 psi	Turret Back	7112C-G030C	30"Hg-0-30 psi	Turret Back
7111-G045C	30"Hg-0-45 psi	Standard	7112-G045C	30"Hg-0-45 psi	Standard
7111B-G045C	30"Hg-0-45 psi	Turret Bottom	7112B-G045C	30"Hg-0-45 psi	Turret Bottom
7111C-G045C	30"Hg-0-45 psi	Turret Back	7112C-G045C	30"Hg-0-45 psi	Turret Back
7111-G060C	30"Hg-0-60 psi	Standard	7112-G060C	30"Hg-0-60 psi	Standard
7111B-G060C	30"Hg-0-60 psi	Turret Bottom	7112B-G060C	30"Hg-0-60 psi	Turret Bottom
7111C-G060C	30"Hg-0-60 psi	Turret Back	7112C-G060C	30"Hg-0-60 psi	Turret Back
7111-G100C	30"Hg-0-100 psi	Standard	7112-G100C	30"Hg-0-100 psi	Standard
7111B-G100C	30"Hg-0-100 psi	Turret Bottom	7112B-G100C	30"Hg-0-100 psi	Turret Bottom
7111C-G100C	30"Hg-0-100 psi	Turret Back	7112C-G100C	30"Hg-0-100 psi	Turret Back

PHYSICAL DATA

Size: 4½" – Design conforms to ASME B40.1.
Accuracy: Model 7112-ASME Grade 2A (½% of full scale); Model 7111-ASME Grade 1A (1% of full scale).
Pressure Connection: ¼" NPT female, duplicated back and bottom.
ASME Specifications: Conforms to ASME B40.1.
Wetted Parts: Beryllium copper Bourdon tube, nickle plated brass connection block; Inconel® X-750 Bourdon tube, 316 Stainless Steel connection block.
Housing: Black polycarbonate case and clear acrylic cover.
Movement: Direct drive of pointer.
Overpressure: 150% of full scale. Normal operation should be between 25% and 75% of full scale.
Calibration: Vertical mounting standard.
Temperature Limits: -65° to 180°F (-54° to 82.2°C).
Weight: 1 lb., 11 oz. (766 g).

STOCKED MODELS

Model 7111 – ASME Grade 1A ..... **$ 91.00**
Model 7112 – ASME Grade 2A **101.00**
Standard Accessory: (1) ¼" NPT stainless steel plug
Optional Accessory:
No. A-341 Brass adapter, ¼" NPT × G2A. **12.50**



Series 61000 gages feature an extra sensitive bronze diaphragm for ASME Grade A accuracy in ranges to 100 inches w.c. The Series 62000 employs a bronze Bourdon tube for ranges to 300 psig with Grade B accuracy. Both measure pressures of air, natural gas and other compatible gases and liquids.

Dwyer®

Series 61000 62000

Pressure Gages

Exceptional Value in a 2½" Gage

PHYSICAL DATA

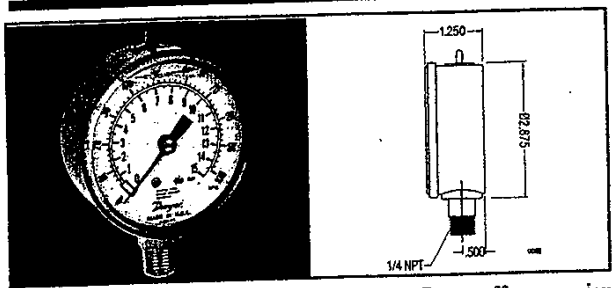
Dial/Pointer: Aluminum
Housing: Steel with black baked enamel finish
Diaphragm/Bourdon Tube: Phosphor bronze
Connection: ¼" NPT bottom-std. ¼" NPT back 61000U, 62000U
Operating Mechanism: Polycarbonate and brass
Accuracy: 61000, ASME Grade A — 1% middle half of scale, 2% remainder 61015 only — 1% middle half of scale, 3% remainder 62000, ASME Grade B — 2% middle half of scale, 3% remainder
Temperature Range: -40 to 160°F (-40 to 71°C)

®Items subject to Schedule B discounts.

STOCKED MODELS

Model Number	Range In. W.C.	Range kPa	Price
61015	0-15	0-4	$38.50®
61030	0-30	0-7.5	30.50®
61060	0-60	0-15	30.50®
61100	0-100	0-25	30.50®
Model Number	**Range PSIG**	**Range kPa**	**Price**
62030	0-30	0-210	$10.00
62060	0-60	0-400	10.00
62100	0-100	0-700	10.00
62160	0-160	0-1100	10.00
62200	0-200	0-1400	10.00
62300	0-300	0-2100	10.00

Options — Add options as a suffix. U-U-clamp (panel mount)-61000-add $7.00; 62000-add $6.50



The Series 63000 Liquid-Filled Pressure Gages offer superior performance in applications where vibration, pulsation, mechanical shock, and pressure spikes are common.

Series 63000 ..... **$18.50**

Dwyer®

Series 63000

Liquid-Filled Gages

2½" Dual Scale Dial, ASME Grade B

PHYSICAL DATA

Accuracy: ASME Grade B, ±3-2-3%.
Media: Clean, noncorrosive liquids or gases.
Bourdon Tube: Phosphor bronze.
Dial/Pointer: Aluminum.
Housing: ABS plastic.
Connection: 14" NPT(M), brass bottom.
Fill Solution: Glycerine.
Weight: 1 lb (0.5 kg).

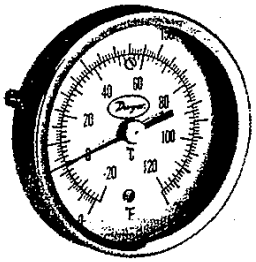
STOCKED MODELS

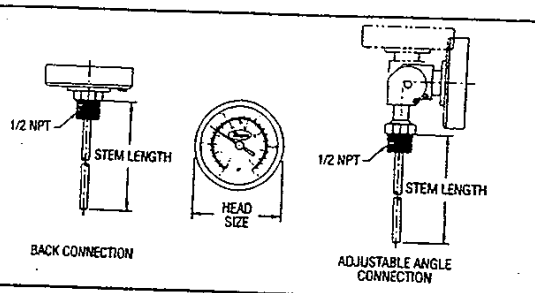
MODEL NUMBER	RANGE	MODEL NUMBER	RANGE
63030V	0 to 30"Hg (vac) (0 to -100 kPa)	63060	0 to 60 psi (0 to 400 kPa)
63015	0 to 15 psi (0 to 100 kPa)	63100	0 to 100 psi (0 to 700 kPa)
63030	0 to 30 psi (0 to 200 kPa)	63200	0 to 200 psi (0 to 1400 kPa)
		63300	0 to 300 psi (0 to 2000 kPa)

Series BT

Bimetal Thermometers

2", 3" or 5" Dial, Dual Scale, ±1% FS Accuracy, External Reset.





Series BT Bimetal Thermometers offer accurate, reliable service even in the toughest environments. These corrosion resistant units are constructed from stainless steel and hermetically sealed to prevent crystal fogging. The bimetal element directly drives pointer, eliminating gears and linkage. An external reset screw allows field calibration and easy-to-read aluminum dial minimizes parallax error. Choose back connection or adjustable angle for easy viewing and installation. Adjustable models can be rotated a full 360° and tilted over a 180° arc. NOTE: When using in pressurized applications, use a suitable thermowell.

STOCKED MODELS

Model Number	Dial Size, Stem Length	Temperature Range, °F(°C)	Degree Div., °F(°C)	Price
Back Connection				
BTB2405D	2", 4"	0/250(-20/120)	2(2)	$36.90
BTB2409D	2", 4"	200/1000(100/550)	10(5)	38.90
BTB3255D	3", 2½"	0/250(-20/120)	2(2)	39.95Ⓑ
BTB3405D	3", 4"	0/250(-20/120)	2(2)	39.95Ⓑ
BTB3605D	3", 6"	0/250(-20/120)	2(2)	39.95Ⓑ
BTB3407D	3", 4"	50/500(10/260)	5(5)	39.95Ⓑ
Adjustable Angle Connection				
BTA5405D	5", 4"	0/250(-20/120)	2(2)	92.00Ⓑ
BTA5605D	5", 6"	0/250(-20/120)	2(2)	92.00Ⓑ

Ⓑ Items subject to schedule B discounts

PHYSICAL DATA

Accuracy: ±1% full scale.
Response Time: ≤ 40 seconds.
Maximum Head Temperature: 200°F (93°C).
Maximum Stem Temperature: not to exceed 50% over-range or 1000°F (538°C) or 800°F (427°C) continuously.
Immersion Depth: minimum 2" in liquids, 4" in gas.
Stem Diameter: ¼" O.D.
Materials of Construction: 304 stainless steel stem, glass crystal, anodized aluminum dial, Series 300 stainless steel head, bezel, and mounting bushing.
Process Connection: ¼" NPT on 2" dial size.

APPLICATIONS

Temperature measurement in boilers, burners, ducts, air conditioning systems, furnaces, manifolds, stacks, steam generators, ventilation systems, refrigeration systems, piping, grain elevators, tanks, or any process application.

Suggested Specifications:

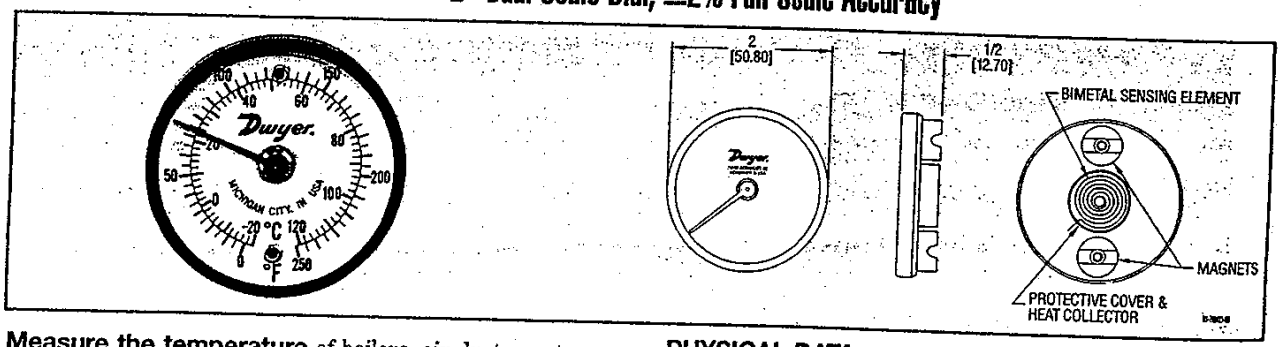
Bimetal thermometer shall have a direct driven pointer, dual scale dial and ± 1% full scale accuracy. Thermometer shall be hermetically sealed with an external reset. Stem shall be constructed of 304 Stainless Steel. Thermometer shall be Dwyer Model No.BT____ .

Temperature

Model ST250

Surface Mount Thermometer

2" Dual Scale Dial, ±2% Full Scale Accuracy



Measure the temperature of boilers, air ducts, motors, bearings, furnaces or other surfaces with Model ST250 Surface Mount Thermometer. Dual magnet design allows easy mounting on any ferrous surface. Bi-metallic thermal sensing coil provides quick temperature measurement with ±2% full scale accuracy.

Model ST250 Surface Mount Thermometer **$28.50**

PHYSICAL DATA

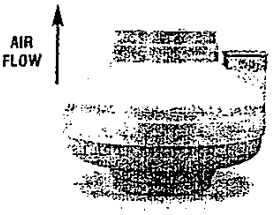
Temperature Range: 0 to 250°F (–20 to 120°C).
Accuracy: ±2% full scale.
Sensing Element: Bimetal coil.
Response Time: approximately one minute.
Head Size: 2" (5.08 cm).
Mounting: Two Alnico magnets on back.
Height: 2" (1.27 cm).
Case: Aluminum with optically clear crystal.
Weight: 2 oz (56.7 g).

APPLICATIONS

Manifolds, platens, boilers, air ducts, furnaces, engines, motors, bearings, enclosures, cabinets, drums, plumbing, piping, refridgerators, and other ferrous surfaces.

System #1

PLASTIC CENTRIFUGAL IN-LINE DUCT FANS



No. 5C515

Fantech

E128817

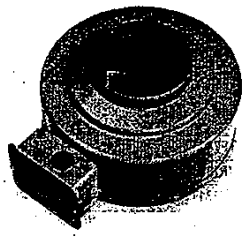
5-YEAR FANTECH LIMITED WARRANTY

Text of warranty available on request. See "Manufacturers' Warranties" on page opposite inside back cover.

- For use in commercial and residential outdoor and wet location applications such as spa and hot tub venting
- Fans are caulked at motor screws, wiring cables, and along seams; suitable for radon gas mitigation
- Remote mounted fans have lower sound levels than comparable surface mounted fans
- UL Listed (E128817) for outdoor use/wet locations and in conditioned airstreams of up to 140°F
- Housing manufactured of Engineered Thermoplastic. UL Recognized and UV protected
- Totally enclosed, 115V, 60 Hz, ball bearing motor
- Mounting bracket and duct clamps included; vertical or horizontal mounting
- External wiring box with waterproof gasket keeps wiring compartment dry
- 100% Speed Controllable; see No. 5C203 speed control listed below
- Fans not for use in corrosive environments

Duct Dia. (In.)	CFM Air Delivery @ RPM Shown 0.0" SP	0.20" SP	0.40" SP	0.60" SP	0.80" SP	1.0" SP	1.5" SP	2.0" SP	2.5" SP	Motor Data Max. RPM	Max. Watts	Overall Dimensions, (In.) Inlet/ Outlet	Dia.	Width Less Flange	Flange	Fantech Model	Stock No.	List	Each	Shpg. Wt.
4	108	90	72	54	19	—	—	—	—	2865	42	3⅜	9½	5¼	7/8	FR100	5C516	$278.89	$172.85	6.0
6	243	220	196	170	142	114	18	—	—	2411	90	5⅜	11¾	5¼	3/4	FR150	5C517	298.93	185.27	7.0
8	429	400	366	332	297	260	168	—	—	2964	144	7⅜	13¼	6¼	1½	FR225	5C518	490.98	304.29	10.0
10	563	530	493	456	419	381	294	—	—	2817	230	9¾	13¼	6¼	1½	FR250	5C519	592.85	367.43	11.0

CENTRIFUGAL IN-LINE DUCT FANS



No. 4YM43

Fantech

E77545

5-YEAR FANTECH LIMITED WARRANTY

Text of warranty available on request. See "Manufacturers' Warranties" on page opposite inside back cover.

Fantech certifies that the in-line duct fans shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

- Externally mounted terminal box, 1¾" deep
- Direct-drive in-line fans for industrial, commercial or residential use for heating, ventilating and cooling applications
- Galvanized steel housing with powder coated, baked enamel finish
- Totally enclosed, 115V, 60 Hz, ball bearing, class B motor
- Maximum operating temperature: 140°F
- Prewired fans include mounting bracket
- Remote mounted fans have lower sound levels than comparable surface mounted fans
- Speed control available, see column below
- Horizontal or vertical mounting
- UL Listed for residential range hoods

Duct Dia. (In.)	CFM @ Static Pressure Shown* 0.0" SP	0.125" SP	0.250" SP	0.375" SP	0.500" SP	0.750" SP	1.00" SP	1.50" SP	Sones @ .5 SP*	Motor Data Max. RPM	Max. Watts	Overall Dimensions (In.) Inlet/ Outlet	Dia.	Width	Fantech Model	Stock No.	Speed Control	Each	Shpg. Wt.
4	117	101	86	72	58	—	—	—	3.8	2950	44	3⅛	8	5	FX4	4YM43	5C203	$186.04	6.1
→ 6	257	241	221	197	178	143	99	—	6.3	2680	84	5⅛	11½	6	FX6	4YM44	5C203	201.31	10.0
8	521	496	469	440	411	345	282	180	9.7	2930	152	7⅛	13¼	6¼	FX8-XL	4YM45	5C203	290.06	12.0
10	590	565	541	519	496	442	394	290	11.6	2460	242	9⅛	13¼	5¼	FX10-XL	4YM41	5C203	353.45	14.0
12	801	783	765	747	729	692	655	566	21.0	3250	384	4⅛	16	8¼	FX12-XL	4YM42	5C205	445.83	21.0
12	2016	1920	1832	1746	1649	1423	1066	—	21.0	1700	500	12	17⅛	18¼	FKD12XL	4YM40	5C204	774.70	40.0

(*) The sound ratings shown are loudness values in fan sones at 5 ft. from test inlet duct per AMCA Standard 301.

ACCESSORIES FOR IN-LINE DUCT FANS

[A] Adjustable Plastic Grille. For exhaust or supply. White.

Dia. (In.)	Fantech Model	Stock No.	List	Each	Shpg. Wt.
4	HG4	5C520	$20.04	$11.80	1.0
6	HG6	5C521	26.72	15.73	1.5
8	TD8	5C522	48.43	30.02	2.2

[B] Back-draft Damper. Spring tension. Galvanized sheet metal.

Dia. (In.)	Fantech Model	Stock No.	List	Each	Shpg. Wt.
4	RSK4	5C523	$31.73	$18.68	0.5
6	RSK6	5C524	43.42	25.56	0.9
8	RSK8	5C525	60.12	37.26	1.3
10	RSK10	5C526	68.47	42.44	1.5

No. 5C520

[A] Grille

No. 5C523

[B] Damper

[C] Variable Speed Control

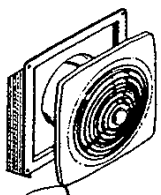
[C] Variable Speed Control. 3.0 Amps. For use on duct fans listed above which are rated less than 300 watts.

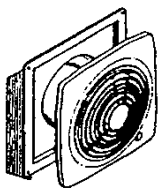
No. 5C203. Shpg. wt. 0.3 lbs. List $31.06.
Each.....$21.42

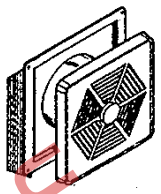
System #2

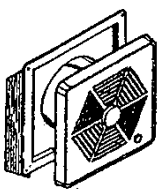
MODELS 508, 508MG, 509, 509MG, 509S & 509SMG AUTOMATIC WALL FANS

BROAN®


508, 509


509S


508MG, 509MG


509SMG

READ AND SAVE THESE INSTRUCTIONS

WARNING

TO REDUCE THE RISK OF FIRE, ELECTRIC SHOCK, OR INJURY TO PERSONS, OBSERVE THE FOLLOWING:

1. Use this unit only in the manner intended by the manufacturer. If you have questions, contact the manufacturer at the address or telephone number listed in the warranty.
2. Before servicing or cleaning unit, switch power off at service panel and lock the service disconnecting means to prevent power from being switched on accidentally. When the service disconnecting means cannot be locked, securely fasten a prominent warning device, such as a tag, to the service panel.
3. Installation work and electrical wiring must be done by a qualified person(s) in accordance with all applicable codes and standards, including fire-rated construction codes and standards.
4. Sufficient air is needed for proper combustion and exhausting of gases through the flue (chimney) of fuel burning equipment to prevent backdrafting. Follow the heating equipment manufacturer's guideline and safey standards such as those published by the National Fire Protection Association (NFPA), and the American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), and the local code authorities.
5. When cutting or drilling into wall or ceiling, do not damage electrical wiring and other hidden utilities.
6. Ducted fans must always be vented to the outdoors.
7. If this unit is to be installed over a tub or shower, it must be marked as appropriate for the application.
8. Never place a switch where it can be reached from a tub or shower.
9. This unit must be grounded.

TO REDUCE THE RISK OF A RANGE TOP GREASE FIRE:

1. Never leave surface units unattended at high settings. Boilovers cause smoking and greasy spillovers that may ignite. Heat oils slowly on low or medium settings.
2. Always turn hood ON when cooking at high heat or when cooking flaming foods.
3. Clean ventilating fans frequently. Grease should not be allowed to accumulate on fan or filter.
4. Use proper pan size. Always use cookware appropriate for the size of the surface element.

TO REDUCE THE RISK OF INJURY TO PERSONS IN THE EVENT OF A RANGE TOP GREASE FIRE, OBSERVE THE FOLLOWING:*

1. SMOTHER FLAMES with a close-fitting lid, cookie sheet, or metal tray, then turn off the burner. BE CAREFUL TO PREVENT BURNS. If the flames do not go out immediately, EVACUATE AND CALL THE FIRE DEPARTMENT.
2. NEVER PICK UP A FLAMING PAN - You may be burned.
3. DO NOT USE WATER, including wet dishcloths or towels - a violent steam explosion will result.
4. Use an extinguisher ONLY if:

A. You know you have a Class ABC extinguisher and you already know how to operate it.
B. The fire is small and contained in the area where it started.
C. The fire department is being called.
D. You can fight the fire with your back to an exit.

*Based on "Kitchen Firesafety Tips" published by NFPA.

CAUTION

1. For general ventilating use only. Do not use to exhaust hazardous or explosive materials and vapors.
2. To avoid motor bearing damage and noisy and/or unbalanced impellers, keep drywall spray, construction dust, etc. off power unit.
3. Please read specification label on product for further information and requirements.

TOOLS AND MATERIALS REQUIRED

- ☐ Straight blade screwdriver
- ☐ Drill, electric or ratchet drive
- ☐ Hammer
- ☐ Pliers
- ☐ 1–1/4" Spade bit
- ☐ Circular saw
- ☐ Saber saw
- ☐ Tape measure or ruler and pencil
- ☐ Electrical supplies of type needed to comply with local codes
- ☐ 4–1/2' of 1x2 for framing installation opening
- ☐ High quality caulking compound

MODELOS 508, 508MG, 509, 509MG, 509S y 509SMG VENTILADORES AUTOMATICOS DE PARED

LEA Y CONSERVE ESTAS INSTRUCCIONES

ADVERTENCIA

PARA REDUCIR EL RIESGO DE INCENDIO, DESCARGA ELECTRICA, O LESIONES PERSONALES, CUMPLA CON LOS SIGUIENTES PUNTOS:

1. Solamente use esta unidad de la manera propuesta por el fabricante. Si tiene alguna pregunta, póngase en contacto con el fabricante en la dirección o teléfono anotados en la garantía.
2. Antes de limpiar o de poner en servicio la unidad, apague el interruptor en el panel de servicio, y asegure el panel de servicio para evitar que se encienda accidentalmente. Cuando el dispositivo para desconectar el servicio eléctrico no puede ser cerrado con algún tipo de traba, sujete fuertemente al panel de servicio, una etiqueta de advertencia prominente.
3. El trabajo de instalación y el alambrado eléctrico deben de llevarse a cabo por personal calificado de acuerdo con todos los códigos y las normas aplicables, incluyendo los códigos y normas de construcción contra incendios.
4. Se requiere una cantidad de aire suficiente para la combustion y escape de gases por la chimenea del equipo que quema combustible para prevenir la retrogresión de la llama. Siga las especificaciones y estándares de seguridad para equipos de calefacción del fabricante, tales como los publicados por la Asociación Nacional de Protección Contra Incendios (NFPA por sus siglas en inglés), y la Sociedad Americana de Ingenieros de Calefacción, Refrigeración y Aire Acondicionado (ASHRAE), y los códigos de las autoridades locales.
5. Cuando corte o taladre en una pared o cielo raso, no dañe los cables eléctricos ú otras instalaciones no visibles.
6. Los ventiladores con conductos deben ser siempre ventilados hacia el exterior.
7. Si esta unidad va a ser instalada sobre una bañera o ducha,debe ser marcada como apropiada para dicha aplicación.
8. Nunca coloque un interruptor donde pueda ser alcanzado desde la bañera o la ducha.
9. Esta unidad debe ser conectada a tierra.

PARA REDUCIR EL RIESGO DE INCENDIO DEBIDO A GRASA ACUMULADA EN LAS HORNILLAS:

1. Nunca deje sin atender las unidades de superficie cuando tengan ajustes altos. Los reboses pueden provocar humo y derrames grasosos que se pueden incendiar. Caliente lentamente el aceite en un ajuste bajo o medio.
2. Siempre ENCIENDA la campana cuando cocine con alta temperatura o cuando cocine alimentos que se puedan incendiar.
3. Limpie con frecuencia los ventiladores. No debe permitirse que la grasa se acumule en el ventilador ni en el filtro.
4. Utilice un sartén de tamaño adecuado. Siempre utilice el utensilio adecuado al tamaño del elemento de superficie.

PARA REDUCIR EL RIESGO DE LESION A PERSONAS RESULTADO DE UN INCENDIO DEBIDO A GRASA ACUMULADA EN LAS HORNILLAS, PROCURE LO SIGUIENTE:*

1. AHOGUE LAS LLAMAS con una tapa ajustada o charola de metal, después apague la hornilla. TENGA CUIDADO A FIN DE EVITAR QUEMADURAS. Si las llamas no se apagan de inmediato, EVACUE Y AVISE A LOS BOMBEROS.
2. NO LEVANTE NUNCA UNA SARTEN QUE ESTE EN LLAMAS - Usted se podrá quemar.
3. NO UTILICE AGUA, incluyendo toallas de cocina mojadas - puede resultar una explosión de vapor violenta.
4. Utilice un extinguidor SOLAMENTE si:

A. Usted sabe que tiene un extinguidor de clas ABC y lo sabe utilizar.
B. El incendio es pequeño y contenido dentro del área donde se inició.
C. Los bomberos han sido avisados.
D. Usted puede combatir el incendio con una salida a su espalda.

* Basado en las recomendaciones para "Seguridad en la Cocina" publicadas por la NFPA de los EEUU.

PRECAUCION

1. Solamente para uso de ventilación general. No se use para extraer materiales o vapores peligrosos o explosivos.
2. Para evitar daños al cojinete del motor y/o impulsores ruidosos o desequilibrados, mantenga la fuente de potencia lejos de rocíos de yeso, de polvo de construcción, etc.
3. Lea la etiqueta de especificaciones del producto para más información y requisitos.

HERRAMIENTAS Y MATERIALES NECESARIOS

- ☐ Destornillador de hoja ancha
- ☐ Taladro o perforador
- ☐ Martillo
- ☐ Alicates
- ☐ Broca de espada de 3,18 cm (1–1/4" plg.).
- ☐ Sierra circular
- ☐ Sierra saber
- ☐ Cinta métrica o regla y lápiz
- ☐ Accesorios eléctricos del tipo necesario para cumplir con los códigos locales.
- ☐ Madera: 1,38 m de 2,54 cm x 5,08 cm (4–1/2 pies de 1x2 pulg.) para la abertura de la instalación del marco
- ☐ Masilla de sellar de alta calidad

INSTALLER: Leave This Manual With The Homeowner. HOMEOWNER: Use and Care Information on Page 4.
INSTALADOR: Deje este manual con el dueño de casa. DUEÑO DE CASA: Información del uso y mantenimiento en la página 4.

TYPICAL INSTALLATION

This unit mounts between walls 4-1/2" to 9-1/2" thick. Outside housing flange is fastened to casing strips ('1 x 2's). See Fig. 1. If sheathing behind siding is not ood, provide extra supports between walls (nailed or crewed to siding).

PREPARE FAN

1. Remove motor assembly by loosening mounting screws, rotating assembly and lifting motor assembly out of inner housing. (FIG. 2)
2. Use care when handling motor bracket assembly to prevent damage to blade. Do not set down assembly with weight of motor resting on the blade.
3. Pull inner housing out of outer housing.
4. Remove wiring knockout from bottom of wiring box (provided in plastic parts bag). (FIG. 2)

NOTE

Remove bottom knockout ONLY!

INSTALL FAN

1. Choose location on inside wall. Make sure that wall stud does not run through opening. Lay out hole on wall. (FIG. 3) **NOTE:** If fan is installed above a cooking surface, grille center must be located at least 58" above floor or at least 22" above heat source.
2. **509S ONLY.** Lay out smaller hole for rotary switch as shown in Figure 3.
3. Transfer center of hole to outside wall.
4. Cut out hole on inside wall.
5. Lay out 14-1/2" square around center location transferred from inside room. (FIG. 4)
6. Cut square hole in **SIDING ONLY!** DO NOT CUT SHEATHING (FIG. 5)! Nail down all siding ends.
7. Cut round hole for fan housing in sheathing. (FIG. 6)
8. Nail or screw 1x2 casing strips inside square opening. (FIG. 7)
9. Put a large bead of caulk on the inside of flange on outer housing. (FIG. 8)
10. If wall is less than 8" thick, remove one or more knockouts on outer sleeve. (FIG. 8) Use inner sleeve for test fit.

FIG. 2

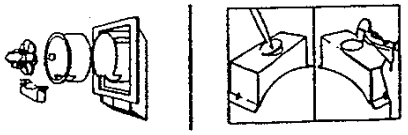
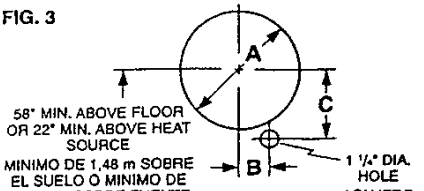


FIG. 3



	508	509	509S
A	10-1/4" 26 cm	8-1/4" 21 cm	8-1/4" 21 cm
B*	—	—	2-1/8" 5,4 cm
C*	—	—	4-7/8" 12,4 cm

*509S ONLY!
SOLAMENTE PARA EL 509S

FIG. 4

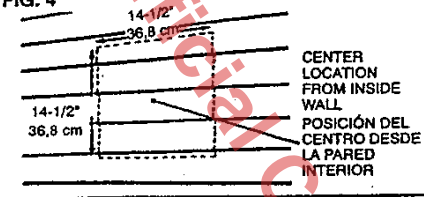


FIG. 5

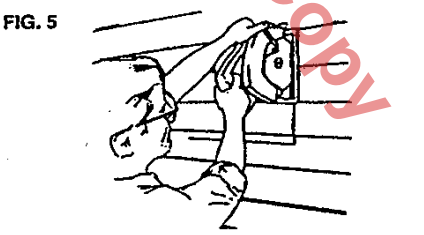
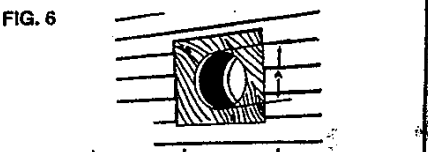


FIG. 6



	508	509	509S
A	10-1/4" 26 cm	8-1/4" 21 cm	8-1/4" 21 cm

FIG. 7

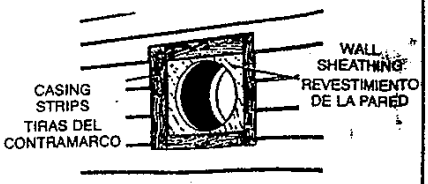
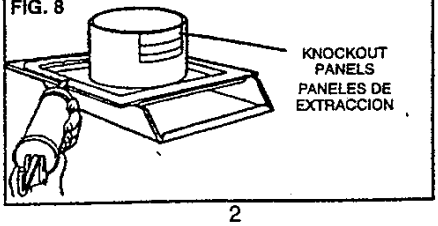


FIG. 8



INSTALACION TIPICA

Esta unidad se monta entre paredes de un grosor entre 11,43 cm y 24,13 cm (4-1/2 plg. y 9-1/2 plg.) El borde exterior de la caja se sujeta a las tiras del contramarco de 2,54 cm x 5,08 cm (de 1 x 2 pulg.).

Vea la figura 1. Si el revestimiento de detrás del entablado no es de madera, proporcione soportes extra entre las paredes (clavadas o atornilladas al entablado).

PREPARACION DEL VENTILADOR

1. Saque el conjunto del motor aflojando los tornillos de montaje, girando el conjunto y levantando el conjunto del motor hacia afuera de la caja interior. (FIG 2)
2. Use especial cuidado al manejar el conjunto del motor prevenir daño a la hélice del ventilador. No establezca al conjunto con el peso del motor que se reclina sobre la hélice del ventilador.
3. Saque la caja interior de la caja exterior.
4. Saque el disco removible para el cable del fondo de la caja de cables (suministrada en la bolsa de piezas de plástico). (FIG. 2)

NOTA

Saque SOLAMENTE el disco removible del fondo.

INSTALACION DEL VENTILADOR

1. Elija una posición en la pared interior. Compruebe que la abertura no quede donde hay una viga de la pared. Dibuje el agujero en la pared. (FIG. 3) **NOTA:** Si el ventilador se instala sobre una superficie donde se va a cocinar, el centro de la rejilla debe estar situado por lo menos a 1,48 m (58 plg.) del suelo o por lo menos a 55,88 cm (22 plg.) de la fuente de calor.
2. **SOLAMENTE PARA EL MODELO 509S.** Dibuje un agujero más pequeño para el interruptor giratorio como se muestra en la figura 3.
3. Transfiera el centro del agujero a la pared exterior.
4. Recorte el agujero en la pared interior.
5. Dibuje un cuadrado de 36,83 cm (14-1/2" plg.) de lado alrededor del centro que se transfirió del interior del cuarto. (FIG. 4)
6. Corte un agujero cuadrado **SOLAMENTE EN EL ENTABLADO.** NO CORTE EL REVESTIMIENTO. (FIG. 5) Clave todos los extremos del entablado.
7. Corte un agujero redondo para la caja del ventilador en el revestimiento. (FIG. 6)
8. Clave o atornille las tiras del contramarco de 2,54 cm x 5,08 cm (1x2 pulg.) dentro de la abertura cuadrada. (FIG. 7)
9. Aplique una capa de masilla de sellar en el interior del borde de la caja exterior. (FIG. 8)
10. Si la pared tiene menos de 20,32 cm (8 plg.) de grosor, saque uno o más discos removibles de la cubierta exterior. (FIG. 8) Use la cubierta interior para comprobar el ajuste.

11. Insert outer housing through hole on outside wall and nail or screw housing to casing strips. Caulk all around filler strips and flange. (FIG. 9)
12. Run wiring to fan location. Pull wire through both sleeves. (FIG. 10) Insert inner sleeve into opening and fasten sleeves together with three black sheet metal screws provided in plastic bag.
13. Attach wiring to wiring box with proper connector for type of wire being used. Drop box into opening in housing.
14. **509S ONLY!** Insert switch into wiring box and fasten with nut provided. (FIG. 11)
15. Make electrical connections as shown in Figures 12 and 12A. Make sure unit is grounded using green ground screw.
16. Install wiring box cover. Use two screws provided in plastic bag.
17. Reinstall motor assembly and plug in motor.
18. Fasten grille to motor bracket with knob and stud from parts bag. **509S ONLY:** Attach knob to rotary switch. (FIG. 13)

FIG. 9

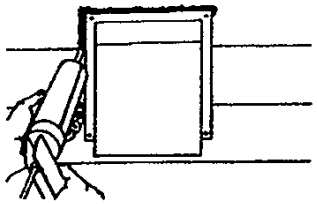


FIG. 10

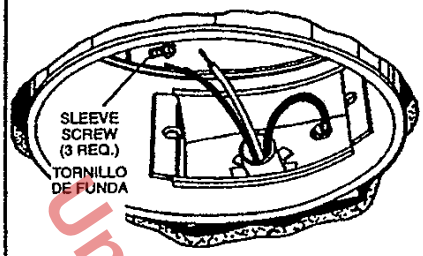


FIG. 11

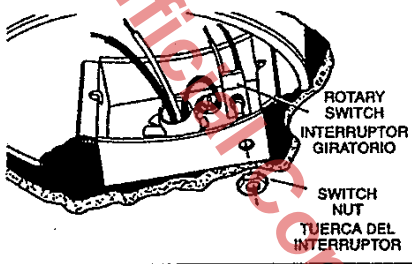


FIG. 12

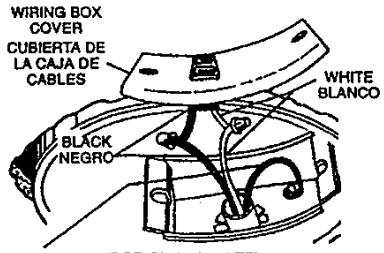


FIG. 12A

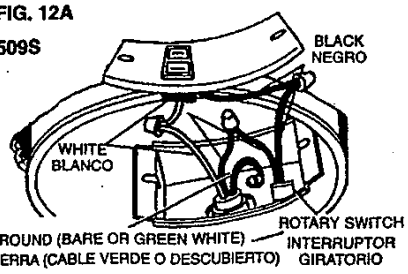
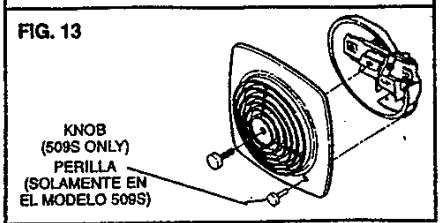


FIG. 13



11. Meta la caja exterior a través del agujero en la pared exterior y clave o atornille la caja a las tiras del contramarco. Selle con masilla de sellar alrededor de las tiras de llenado y el borde. (FIG. 9)
12. Lleve el cableado adonde se instala el ventilador. Tire del cable a través de las dos cubiertas. (FIG. 10) Meta la cubierta interior en la abertura y fije las dos cubiertas con tres tornillos de lámina de metal negros que se incluyen en la bolsa de plástico.
13. Fije el cableado a la caja de cables con el conector apropiado para el tipo de cable que se está usando. Coloque la caja de cables dentro de la caja principal.
14. **SOLAMENTE PARA EL MODELO 509S:** Meta el interruptor en la caja de cables y fíjelo con la tuerca que se suministra. (FIG. 11)
15. Haga las conexiones eléctricas tal como se muestra en las figuras 12 y 12A. Asegúrese de que la unidad está conectada a tierra con el tornillo verde de tierra.
16. Instale la cubierta de la caja de cables. Utilice los dos tornillos que se suministran en la bolsa de plástico.
17. Vuelva a instalar el conjunto del motor y conecte el motor.
18. Sujete la rejilla al soporte del motor con perilla y tornillo de la rejilla en la bolsa de piezas. **SOLAMENTE PARA EL MODELO 509S:** Fije la perilla al interruptor giratorio. (FIG. 13)

USE AND CARE

DISCONNECT ELECTRICAL POWER SUPPLY BEFORE SERVICING FAN.

Always unplug the fan motor before servicing the fan. The motor is permanently lubricated and will never need oiling.

Clean the grill in warm, soapy water. Use a mild detergent, such as a dishwashing liquid. DO NOT USE ABRASIVE CLOTHS, STEEL WOOL OR SCOURING POWDERS.

Clean the fan blade and motor every six months by removing the grille, unplugging the motor, and gently vacuuming the fan blade and motor.

BROAN-NUTONE ONE YEAR LIMITED WARRANTY

Broan-NuTone warrants to the original consumer purchaser of its products that such products will be free from defects in materials or workmanship for a period of one year from the date of original purchase. THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

During this one-year period, Broan-NuTone will, at its option, repair or replace, without charge, any product or part which is found to be defective under normal use and service.

THIS WARRANTY DOES NOT EXTEND TO FLUORESCENT LAMP STARTERS AND TUBES. This warranty does not cover (a) normal maintenance and service or (b) any products or parts which have been subject to misuse, negligence, accident, improper maintenance or repair (other than by Broan-NuTone), faulty installation or installation contrary to recommended installation instructions.

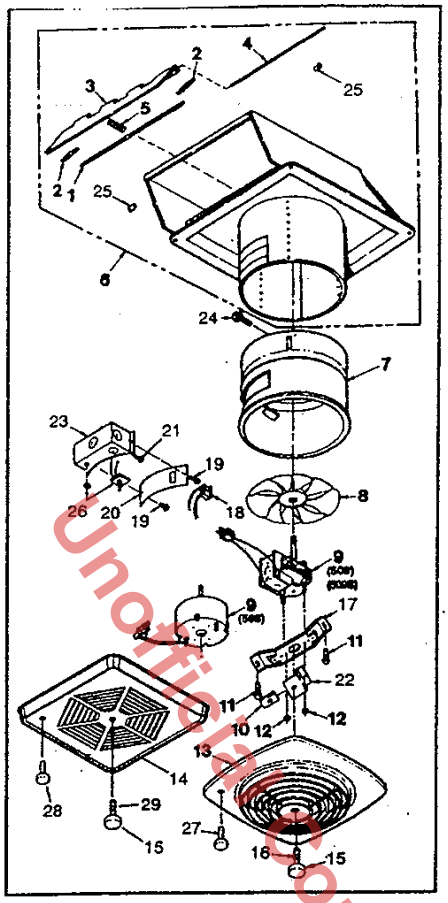
The duration of an implied warranty is limited to the one-year period as specified for the express warranty. Some states do not allow limitation on how long an implied warranty lasts, so the above limitation may not apply to you.

BROAN-NUTONE'S OBLIGATION TO REPAIR OR REPLACE, AT BROAN-NUTONE'S OPTION, SHALL BE THE PURCHASER'S SOLE AND EXCLUSIVE REMEDY UNDER THIS WARRANTY. BROAN-NUTONE SHALL NOT BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH PRODUCT USE OR PERFORMANCE. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights, which vary from state to state. This warranty supersedes all prior warranties.

To qualify for warranty service, you must (a) notify Broan-NuTone at the address stated below or telephone: 1-800-637-1453, (b) give the model number and part identification and (c) describe the nature of any defect in the product or part. At the time of requesting warranty service, you must present evidence of the original purchase date.

BROAN-NUTONE LLC
926 West State Street,
Hartford, WI 53027



USO Y MANTENIMIENTO

DESCONECTE LA CORRIENTE ELECTRICA ANTES DE DAR SERVICIO AL VENTILADOR.

Desconecte siempre el motor del ventilador antes de dar servicio al ventilador. El motor esta lubricado permanentemente y nunca necesitarán lubricación.

Limpie la rejilla en agua caliente enjabonada. Use un detergente suave, tal como líquido lavavajillas. NO USE TELAS ÁSPERAS, ESPONJILLAS DE LANA DE ACERO O POLVOS ÁSPEROS.

Limpie el motor y la hélice cada seis meses quitando la rejilla, desconectando el motor, y limpiando el motor y la hélice cuidadosamente con una aspiradora.

GARANTIA BROAN-NUTONE LIMITADA POR UN AÑO

Broan-NuTone garantiza al consumidor comprador original de sus productos que dichos productos carecerán de defectos en materiales o en mano de obra por un período de un año a partir de la fecha original de compra. NO EXISTEN OTRAS GARANTIAS, EXPLICITAS O IMPLICITAS, INCLUYENDO, PERO NO LIMITADAS A, GARANTIAS IMPLICITAS DE COMERCIALIZACION O APTITUD PARA UN PROPOSITO PARTICULAR.

Durante el período de un año, y a su propio criterio, Broan-NuTone reparará o reemplazará, sin costo alguno cualquier producto o pieza que se encuentre defectuosa bajo condiciones normales de servicio y uso.

ESTA GARANTIA NO SE APLICA A TUBOS Y ARRANCADORES DE LAMPARAS FLUORESCENTES. Esta garantía no cubre (a) mantenimiento y servicio normales o (b) cualquier producto o piezas que hayan sido utilizadas de forma errónea, negligente, que hayan causado un accidente, o que hayan sido reparadas o mantenidas inapropiadamente (por otras compañías que no sean Broan-NuTone), instalación defectuosa, o instalación contraria a las instrucciones de instalación recomendadas.

La duración de cualquier garantía implícita se limita a un período de un año como se especifica en la garantía expresa. Algunos estados no permiten limitaciones en cuanto al tiempo de expiración de una garantía implícita, por lo que la limitación antes mencionada puede no aplicarse a usted.

LA OBLIGACION DE BROAN-NUTONE DE REPARAR O REEMPLAZAR, SIGUIENDO EL CRITERIO DE BROAN-NUTONE, DEBERA SER EL UNICO Y EXCLUSIVO RECURSO LEGAL DEL COMPRADOR BAJO ESTA GARANTIA. BROAN-NUTONE NO SERA RESPONSABLE POR DAÑOS INCIDENTALES, CONSIGUIENTES, O POR DAÑOS ESPECIALES QUE SURJAN A RAIZ DEL USO O DESEMPEÑO DEL PRODUCTO.

Algunos estados no permiten la exclusión o limitación de daños incidentales o consiguientes, por lo que la limitación antes mencionada puede no aplicarse a usted. Esta garantía le proporciona derechos legales específicos, y usted puede también tener otros derechos, los cuales varían de estado a estado. Esta garantía reemplaza todas las garantías anteriores.

Para calificar en la garantía de servicio, usted debe (a) notificar a Broan-NuTone al domicilio que se menciona abajo o al teléfono:1-800-637-1453, (b) dar el número del modelo y la identificación de la pieza, y (c) describir la naturaleza de cualquier defecto en el producto o pieza. En el momento de solicitar servicio cubierto por la garantía, usted debe de presentar evidencia de la fecha original de compra.

BROAN-NUTONE LLC
926 West State Street,
Hartford, WI 53027 EE. UU.

SERVICE PARTS

MODELS 508, 508MG, 509, 509MG, 509S & 509SMG

PIEZAS DE SERVICIO

MODELOS 508, 508MG, 509, 509MG, 509S y 509SMG

KEY NO.	508, 508MG	509, 509MG	509S, 509SMG	DESCRIPTION	DESCRIPCION
1	99100489	99100489	99100489	Foam – Long (2 Req.)	Espuma – larga (se necesitan 2)
2	99100490	99100490	99100490	Foam – Short (2 Req.)	Espuma – corta (se necesitan 2)
3	98006086	98006086	98006086	Damper Flap	Aletas del amortiguador
4	98006048	98006048	98006048	Damper Rod	Eje del amortiguador
5	99140145	99140145	99140145	Damper Spring	Muelle del amortiguador
6	97011241	97011240	97011240	Outer Housing Assembly (Includes Key Nos. 1, 2, 3, 4, 5, 24)	Conjunto de la caja exterior (Incluye códigos 1, 2, 3, 4, 5, 24)
7	97013672	97007085	97007085	Inner Housing	Caja interior
8	99020271	99020165	99020165	Fan Blade	Hélice del ventilador
9	99080460	99080180	99080180	Motor	Motor
10	99260434	99260434	99260434	¼-20 U-Type Sheet Metal Nut	Tornillo de hoja de metal ¼-20 Tipo U
11	99150479	99150479	99150479	#8-32 x ½ Hex Hd. Self Tapping Screws (2 Req.)*	Tornillos autoenroscables de cabeza hexagonal #8-32 x ½ (se necesitan 2)*
12	99260425	99260428	99260428	Motor Nuts (2 Req.)*	Tuercas del motor (se necesitan 2)*
13	97011851	97011919	97011727	Grille (Polymeric) (includes knob)	Rejilla (Plástico) (incluye perilla de la rejilla)
14	98008922	98008921	98008923	Grille (Metal)	Rejilla (Metálica)
15	97011918	97011918	97011918	Grille Knob	Perilla de la rejilla
16	—	99420586	99420586	Grille Stud – 2-5/8" long	Tornillo de la rejilla
17	98006066	98007820	98007820	Motor Bracket	Soporte del motor
18	99270982	99270982	99270982	Receptacle	Receptáculo
19	99170245	99170245	99170245	#8B x 3/8 Hex Hd. Self Tapping Screws (2 Req.)*	Tornillos autoenroscables de cabeza hexagonal #8-32 x 3/8 (se necesitan 2)*
20	98006047	98006047	98006047	Wiring Box Cover	Cubierta de la caja de cables
21	99150471	99150471	99150471	#10-32 x ½ Hex Hd. Self Tapping Screw*	Tornillo autoenroscable de cabeza hexagonal #10-32 x ½*
22	98008494	98007819	98007819	Grille Bracket	Soporte de rejilla
23	98006046	98006046	98008491	Wiring Box	Caja de cables
24	99150417	99150417	99150417	#8A x ¼ Hex Hd. Sheet Metal Screws (3 Req.)*	Tornillos de hoja de metal de cabeza hexagonal #8A x ¼ (se necesitan 3)*
25	99100379	99100379	99100379	Plug, Closed End (2 Req.)	Enchufe, extremo cerrado (se necesitan 2)
26	—	—	97005328	Rotary Switch (Includes Nut)	Interruptor giratorio (incluye tuerca)
27	—	—	99360218	Rotary Switch Knob (for polymeric grille)	Perilla de interruptor giratorio (para rejilla plástico)
28	—	—	99360230	Rotary Switch Knob (for metal grille)	Perilla de interruptor giratorio (para rejilla metálica)
29	99420612	—	—	Grille Stud – 3½" long	Tornillo de la rejilla

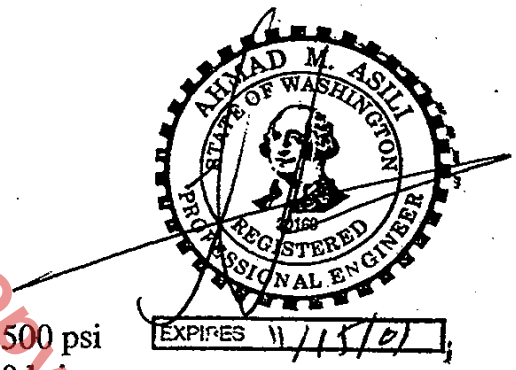
* Standard Hardware. May be purchased locally
* Material estándar Puede ser adquirido localmente.

DDC Groundwater Remedial Action
Lake Forest Park Town Center
Lake Forest Park, WA

Blower Enclosure

Clearcreek Contractors

Structural Plans and Details



S1	Foundation and Roof Framing Plans
S2	Typical Section
S3	End Wall Section

Materials Specifications:

Concrete	2500 psi
Steel Rebar	40 ksi
CMU	1500 psi
Lumber	DF/HF #2 or better
A307 Bolts, Common Nails	

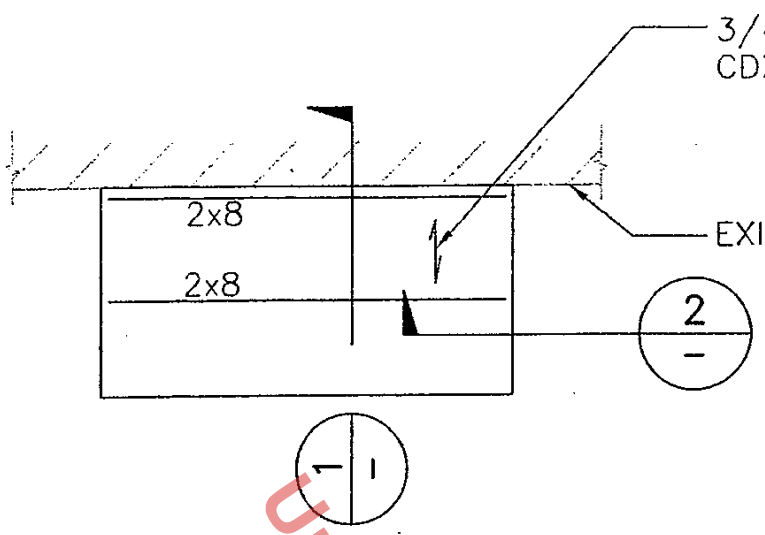
All work to meet the 1997 UBC as adopted and amended by the City of Lake Forest Park. Use Conventional Construction provisions for info not called out. All colors and flashing to match existing, and to be approved by Owner.

Prepared by:

URS
1501 - 4th Avenue Suite 1400
Seattle, WA 98101

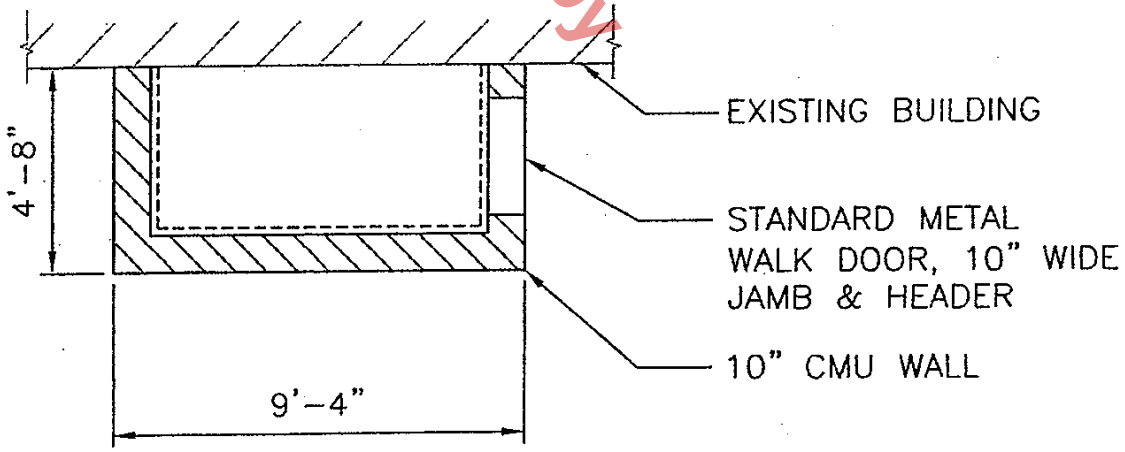
WP 100927

08/22/01



ROOF PLAN

SCALE: 1/4"=1'-0"



FOUNDATION PLAN

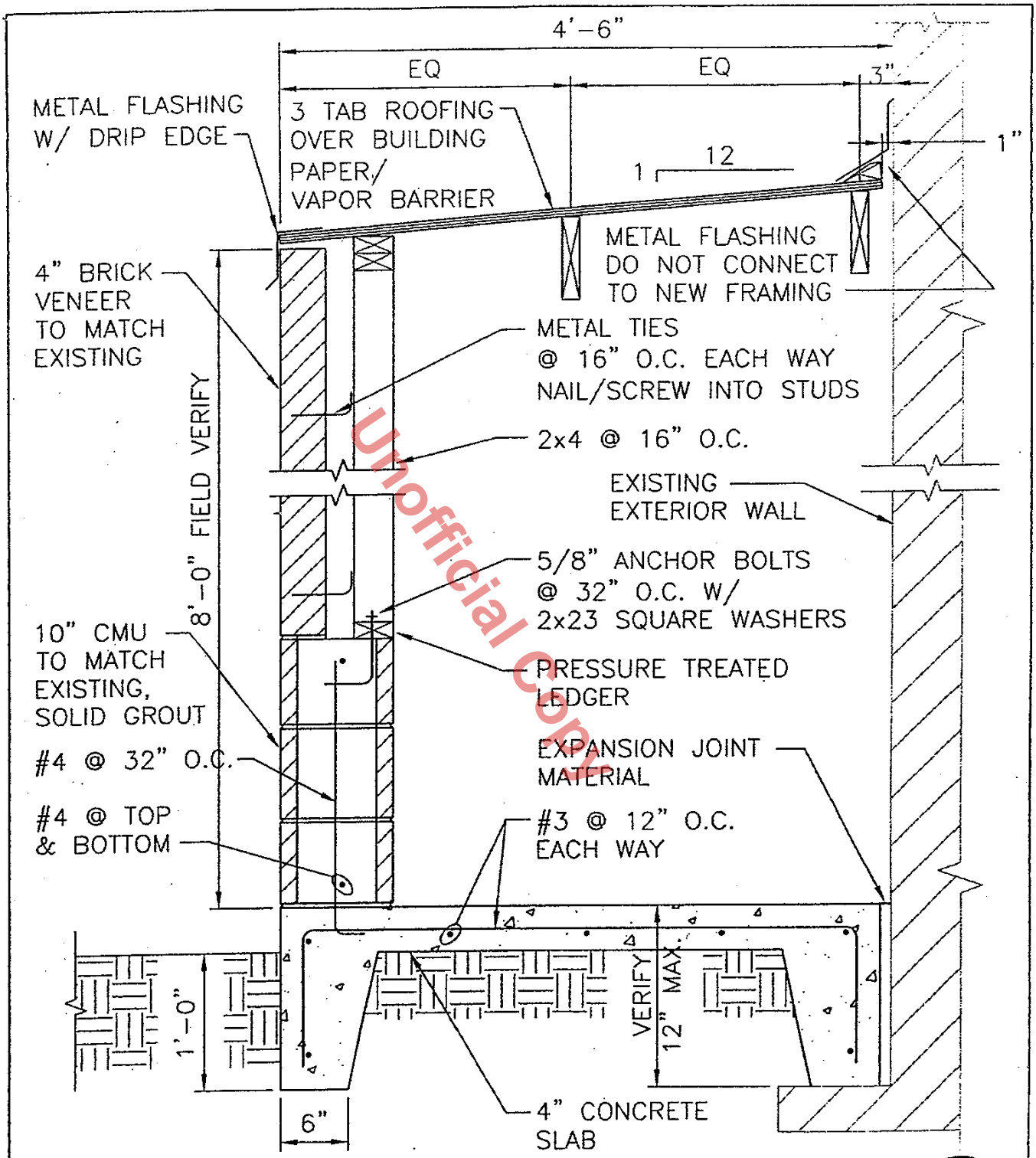
SCALE: 1/4"=1'-0"

URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Lake Forest Park Town Center

DDC GROUNDWATER
REMEDIAL ACTION
BLOWER FAN ENCLOSURE

Dwg. No.
S-1



CMU WALL SECTION

1
–

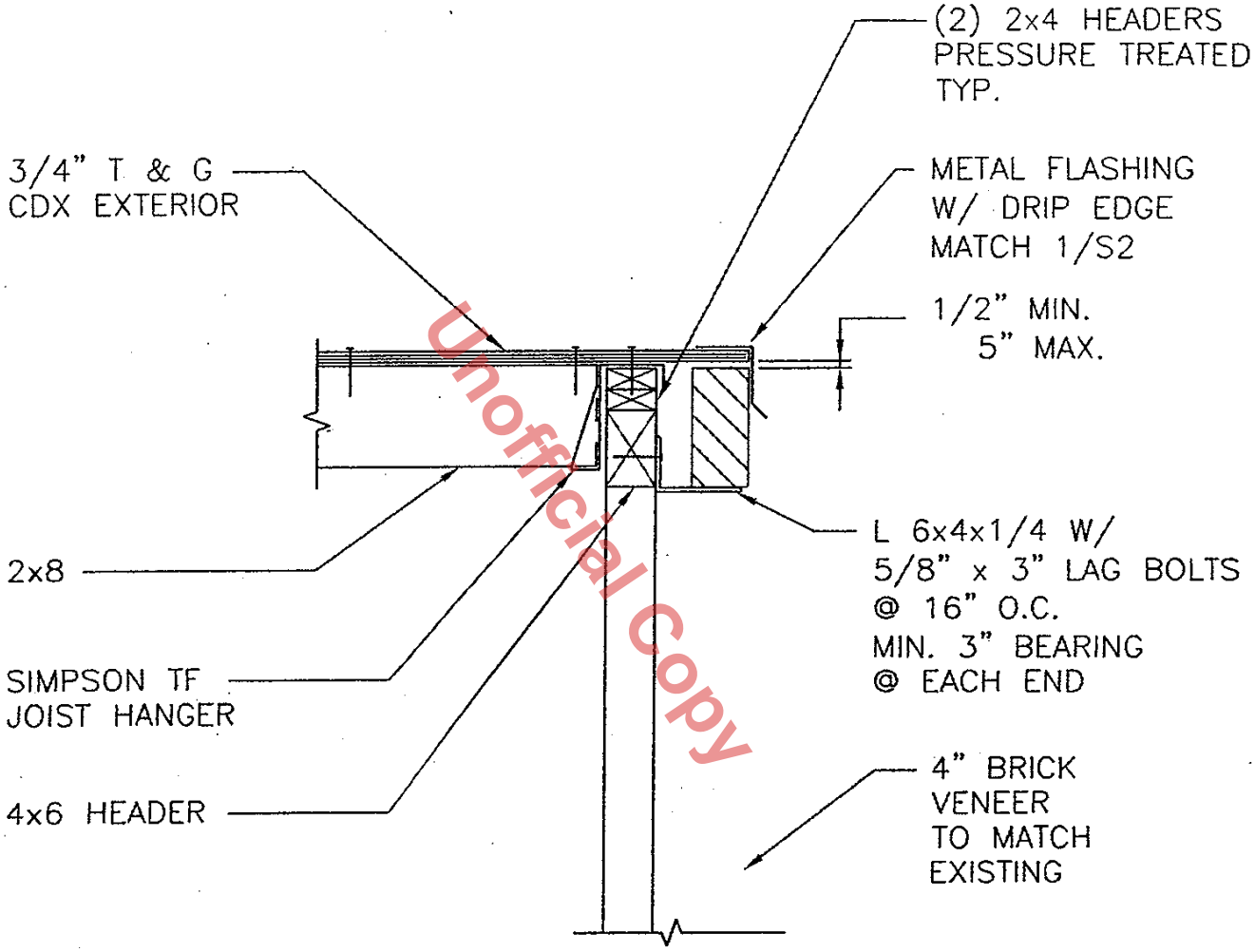
SCALE: 1"=1'-0"

URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Lake Forest Park Town Center Aug 22, 2001

DDC GROUNDWATER
REMEDIAL ACTION
–

Dwg. No.
S-2



2
–

URS
CENTURY SQUARE
1501 4TH AVENUE, SUITE 1400
SEATTLE, WA 98101
PHONE: (206) 438-2700
FAX: (206) 438-2699

Lake Forest Park Town Center Aug 22, 2001

DDC GROUNDWATER
REMEDIAL ACTION
–

Dwg. No.
S-3

City of Lake Forest Park
20150 45th Avenue NE
Lake Forest Park, WA 98155
(206) 368-5440

Sensitive Areas Work Permit

Permit Number: SA01-193

Page: 1
Printed: 8/15/01
Approved: 8/15/01

Applicant: WASATCH ENVIRONMENTAL
2410 W CALIFORNIA AVE
SALT LAKE CITY, UT 84104

Parcel Number: 4019301655
17171 BOTHELL WAY NE
LAKE FOREST PARK, WA 98155

Zoning: TC
Addition: LAKE FOREST PARK ADD
Block: 14 **Lot(s):** 1 THRU 15
Section: 10
Township: 26
Range: 04
Area: 140000

Legal Description:

Owner LAKE FOREST PARK ASSOCIATES
17171 BOTHELL WAY NE
LAKE FOREST PARK, WA 98155

Day: 206.367.6617
Fax:

/GROUNDWATER WASATCH ENVIRONMENTAL
2410 W CALIFORNIA AVE
SALT LAKE CITY, UT 84104

Voice: 801.972.8400
Fax:

Local License:

State License:

Conditions:

1. Daily sweeping with a vacuum type sweeper is required on all paved areas, water flushing is not allowed.
2. No discharge of sediment laden waters is allowed into the Creek or storm drain system without a Department of Fish and Wildlife Hydraulic Permit. Discharge into the sanitary sewer system is also not allowed.
3. To reduce erosion, all revegetated areas must be stabilized with sod, bark or other stable landscaping material.

EROSION CONTROL MEASURES MUST BE INSTALLED PRIOR TO COMMENCEMENT OF EARTHWORK WITHIN 25 FEET OF THE STREAM AND MUST BE MAINTAINED AT ALL TIMES. A FINAL INSPECTION OF THE REVEGETATED AREAS IS REQUIRED. SEE ALSO LC01-3596.

Fees and Receipts:

Number	Description	Amount
	Sensitive Areas Work Permit-Minor	$50.00
	Fees Total:	**$50.00**
37661		$50.00
	Receipts Total:	**$50.00**

Project Description INSTALL TWO REMEDIATION SYSTEMS FOR CHEMICAL CLEANUP

Please call the City Planning/Building Department for inspections 24 hours in advance, 206/368-5440.

City of Lake Forest Park
20150 45th Avenue NE
Lake Forest Park, WA 98155
(206) 368-5440

Sensitive Areas Work Permit

Permit Number: SA01-193

Page: 2
Printed: 8/15/01
Approved: 8/15/01

This permit signifies that the project as described in the application and other documents submitted to the City complies with City ordinances and regulations. The permit does not signify that the project complies with State or Federal laws and regulations, including the Endangered Species Act; and the City has made no representations with respect to this project's compliance with such laws and regulations. The permit holder is responsible for complying with such other laws and regulations.

8/15/01
Date

Alicia Sherman
Responsible Official

THIS PERMIT MUST BE POSTED AT THE ENTRANCE OF THE SITE/PROPERTY UNTIL FINAL APPROVAL HAS BEEN GRANTED.

THIS PERMIT IS NOT VALID UNTIL SIGNED AND DATED BY THE RESPONSIBLE OFFICIAL.

City of Lake Forest Park
20150 45th Avenue NE
Lake Forest Park, WA 98155
(206) 368-5440

Land Clearing and Grading Permit

Permit Number: LC01-3596

Page: 1
Printed: 8/15/01
Approved: 8/15/01

Applicant: WASATCH ENVIRONMENTAL
2410 W CALIFORNIA AVE
SALT LAKE CITY, UT 84104

Parcel Number: 4019301655
17171 BOTHELL WAY NE
LAKE FOREST PARK, WA 98155

Zoning: TC
Addition: LAKE FOREST PARK ADD
Block: 14 **Lot(s):** 1 THRU 15
Section: 10
Township: 26
Range: 04
Area: 140000

Legal Description:

Owner LAKE FOREST PARK ASSOCIATES
17171 BOTHELL WAY NE
LAKE FOREST PARK, WA 98155

Day: 206.367.6617
Fax:

GROUNDWATER WASATCH ENVIRONMENTAL
2410 W CALIFORNIA AVE
SALT LAKE CITY, UT 84104

Voice: 801.972.8400
Fax:

Local License:

State License:

Conditions:

1. Daily sweeping with a vacuum type sweeper is required on all paved areas, water flushing is not allowed.
2. No discharge of sediment laden waters is allowed into the Creek or storm drain system without a Department of Fish and Wildlife Hydraulic Permit. Discharge into the sanitary sewer system is also not allowed.
3. To reduce erosion, all revegetated areas must be stabilized with sod, bark or other stable landscaping material.

EROSION CONTROL MEASURES MUST BE INSTALLED PRIOR TO COMMENCEMENT OF EARTHWORK WITHIN 25 FEET OF THE STREAM AND MUST BE MAINTAINED AT ALL TIMES. A FINAL INSPECTION OF THE REVEGETATED AREAS IS REQUIRED. SEE ALSO SA01-193.

Fees and Receipts:

Number	Description	Amount
	Land Clearing/Grading/Excavating/Filling-Regular	$250.00
	Fees Total:	**$250.00**
37661		$250.00
	Receipts Total:	**$250.00**

Purpose:
Quantity of Work:
Start:
End:

City of Lake Forest Park
20150 45th Avenue NE
Lake Forest Park, WA 98155
(206) 368-5440

Land Clearing and Grading Permit

Permit Number: LC01-3596

Printed: 8/15/01
Approved: 8/15/01

Project Description: INSTALL TWO REMEDIATION SYSTEMS TO CLEANUP CHEMICAL WASTE

Please call the City Planning/Building Department for inspections 24 hours in advance, 206/368-5440.

This permit signifies that the project as described in the application and other documents submitted to the City complies with City ordinances and regulations. The permit does not signify that the project complies with State or Federal laws and regulations, including the Endangered Species Act; and the City has made no representations with respect to this project's compliance with such laws and regulations. The permit holder is responsible for complying with such other laws and regulations.

8/15/01
Date

Alicia Sherman
Responsible Official

THIS PERMIT MUST BE POSTED AT THE ENTRANCE OF THE PROPERTY UNTIL FINAL APPROVAL IS GRANTED.

THIS PERMIT IS NOT VALID UNTIL SIGNED AND DATED BY THE RESPONSIBLE OFFICIAL.

K

DATE DRILLED:	8/14/01
LOGGED BY:	LBB
REFERENCE ELEVATION:	
DRILL RIG:	CME 75
BORING DIAMETER:	15" 10.25" ID HSA
DEPTH TO GROUNDWATER:	⌯ 3' Below Ground Surface

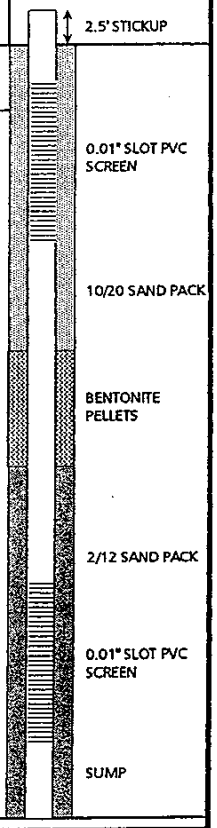
DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE
Concrete 3"			
SAND, fine to coarse with minor silt, minor Gravel, moist	Brown		Fill
SAND, fine to medium, minor Gravel, wet, high % is fine Sand, wet	Brown		SP

DEPTH (FEET)	SAMPLER	BLOWS/FOOT	OVM (ppm)
2	*		NT
4			
6	*		NT
8			
10	*		1.7
12			
14			2
16	*		
18			
20	*		1
22			
24	*		0

WATER LEVEL

PIEZOMETER CONSTRUCTION



BOTTOM OF WELL @ 25'

* Indicates Grab Sample

WASATCH ENVIRONMENTAL, INC.

WELL LOG

MAGIC CLEANERS
LAKE FORREST PARK, WASHINGTON

PROJECT NO.: 1494-02 | WELL NO.: DDC 1

S:\1404.drw

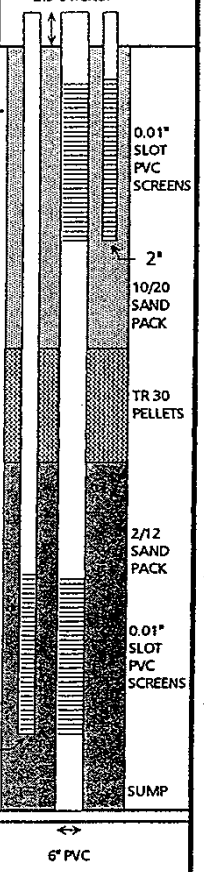
DATE DRILLED:	8/14/01
LOGGED BY:	LBB
REFERENCE ELEVATION:	
DRILL RIG:	CME 75
BORING DIAMETER:	15" 10.25" ID HSA; Pilot with 4.25" HSA and 2" Spoons
DEPTH TO GROUNDWATER:	≅ 3' Below Ground Surface

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	OVM (ppm)
Concrete 6"				2			
SAND, with Silt, Gravel, moist to wet	Brown		Fill				
SAND, fine to medium with minor Gravel, wet, high % is fine Sand	Brown	Medium Dense	SP	4		6	
				6		6	0
						7	
				8			
		Very Dense		10		20	
						30+	0
				12		-	
				14			
				16		24	
						30+	0
				18		-	
slighly higher % medium grained Sand than above				20		19	
						30+	0
				22		-	
SAND, fine to coarse with Gravel, wet	Dark Brown	Very Dense	SW	24		11	
						30+	0
						-	

WATER LEVEL: 2"

PIEZOMETER CONSTRUCTION



BOTTOM OF WELL @ 25'

Indicates split-spoon sampler

WASATCH ENVIRONMENTAL, INC.

WELL LOG

MAGIC CLEANERS
LAKE FORREST PARK, WASHINGTON

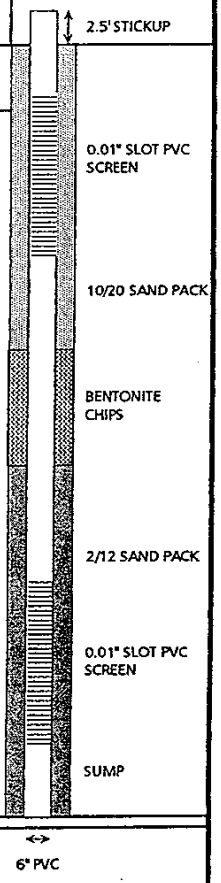
PROJECT NO.: 1494-02 WELL NO.: DDC 2

S:\1404.drw

DATE DRILLED:	8/13/01
LOGGED BY:	LBB
REFERENCE ELEVATION:	
DRILL RIG:	CME 75
BORING DIAMETER:	15" 10.25" ID HSA
DEPTH TO GROUNDWATER:	≅ 3' Below Ground Surface

DESCRIPTION AND CLASSIFICATION DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE	DEPTH (FEET)	SAMPLER	BLOWS/FOOT	OVM (ppm)	WATER LEVEL
Concrete 6"				2				
SAND, fine to coarse with Gravel, moist to wet	Brown		Fill	4	*		0	
SAND, fine to medium, with Gravel and minor % silt, wet, large % is fine Sand	Brown		SP	6				
				8	*		1.2	
				10				
				12				
				14	*		1.8	
				16				
				18				
				20				
				22	*		0	
Clayey SILT, wet, observed on bottom 2' of lead auger	Dark Brown		ML	24				

PIEZOMETER CONSTRUCTION



BOTTOM OF WELL @ 25'

* Indicates Grab Sample

Some heaving when pulling augers from 25-20 feet

WASATCH ENVIRONMENTAL, INC.

WELL LOG

MAGIC CLEANERS
LAKE FORREST PARK, WASHINGTON

PROJECT NO.: 1494-02 | WELL NO.: DDC 3

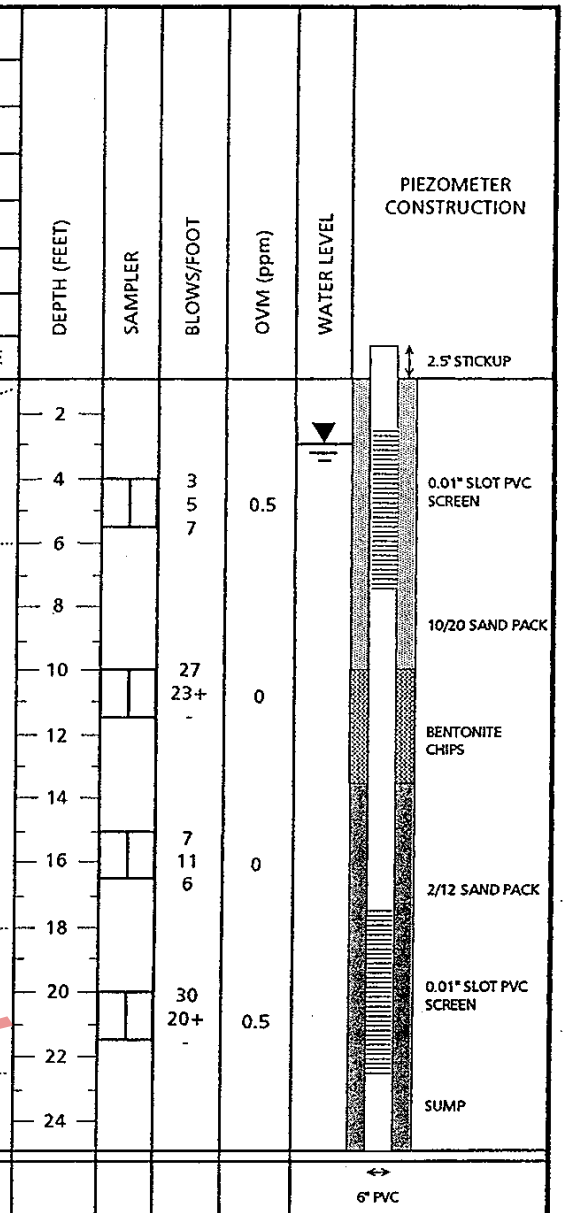
S:\1404.drw

DATE DRILLED:	8/13/01
LOGGED BY:	LBB
REFERENCE ELEVATION:	
DRILL RIG:	CME 75
BORING DIAMETER:	15" 10.25" ID HSA; Pilot with 4.25" HSA and 2" Spoons
DEPTH TO GROUNDWATER:	≅ 3' Below Ground Surface

DESCRIPTION AND CLASSIFICATION

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE
Concrete 6"			
SAND, fine to medium, minor Gravel, moist to wet, 2" of rounded pea gravel at bottom of split spoon	Brown	Medium Dense	Fill
SAND, fine to medium, minor Gravel, wet, large % is fine Sand	Brown	Very Dense	SP
no Gravel present		Medium Dense	
SAND, fine to coarse with Gravel, wet	Dark Brown	Very Dense	SW
Clayey SILT, wet, observed on bottom 2' of lead auger	Gray		ML
BOTTOM OF WELL @ 25'			

Indicates split-spoon sampler



WASATCH ENVIRONMENTAL, INC.

WELL LOG

MAGIC CLEANERS
LAKE FORREST PARK, WASHINGTON

PROJECT NO.: 1494-02 | WELL NO.: DDC 4

S:\1404.drw

DATE DRILLED:	8/16/01
LOGGED BY:	LBB
REFERENCE ELEVATION:	
DRILL RIG:	CME 75
BORING DIAMETER:	15" 10.25" ID HSA; Pilot with 4.25" HSA and 2" Spoons
DEPTH TO GROUNDWATER:	≅ 4.5' Below Ground Surface

DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE
Grass SAND, fine to coarse, with Gravel and Cobble	Brown		Fill
SAND, fine, with lenses of silt, wet	Gray Brown (lenses)		SP ML (lenses)
SAND, fine to coarse, with Gravel, wet	Dark Brown Gray		SW
SAND, fine to coarse, with minor Gravel, wet large % is fine Sand	Gray		SP
BOTTOM OF WELL @ 25'			

DEPTH (FEET): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24

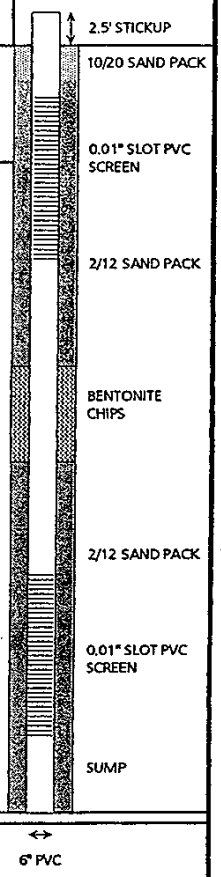
SAMPLER

BLOWS/FOOT: 3, 5, 5, 14, 15, 19, 10, 11, 13

OVM (ppm)

WATER LEVEL

PIEZOMETER CONSTRUCTION



Indicates split-spoon sampler

WASATCH ENVIRONMENTAL, INC.

WELL LOG

MAGIC CLEANERS
LAKE FORREST PARK, WASHINGTON

PROJECT NO.: 1494-02 | WELL NO.: DDC 5

S:\1404.drw

DATE DRILLED:	8/15/01
LOGGED BY:	LBB
REFERENCE ELEVATION:	
DRILL RIG:	CME 75
BORING DIAMETER:	15" 10.25" ID HSA; Pilot with 4.25" HSA and 2" Spoons
DEPTH TO GROUNDWATER:	≅ 4.5' Below Ground Surface

DESCRIPTION AND CLASSIFICATION				DEPTH (FEET)	SAMPLER	BLOWS/FOOT	OVM (ppm)	WATER LEVEL	PIEZOMETER CONSTRUCTION
DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE						
Asphalt 2"									2.5' STICKUP
GRAVEL, with Sand	Brown		Fill	2					
SAND, fine to medium, with Gravel, and Cobble, wet, large % is fine Sand	Brown		SW	4		15			0.01" SLOT PVC SCREENS
SAND, fine with minor Silt, wet	Gray		SM	6		18 20			
SAND, fine, wet	Gray		SP	8					2"
				10		11 11 11			2/12 SAND PACK
				12					TR 30 PELLETS
SAND, fine to medium, wet				14		15 35+ -			
GRAVEL, with medium to coarse Sand, wet	Gray		GW	16					2/12 SAND PACK
SAND, fine to coarse, with Gravel, wet	Brown to Black		SW	18					0.01" SLOT PVC SCREENS
				20		23 27+ -			
				22					
				24		27 23+ -		2"	SUMP
									6" PVC

BOTTOM OF WELL @ 25'

Indicates split-spoon sampler

WASATCH ENVIRONMENTAL, INC.

WELL LOG

MAGIC CLEANERS
LAKE FORREST PARK, WASHINGTON

PROJECT NO.: 1494-02 | WELL NO.: DDC 6

S:\1404.drw

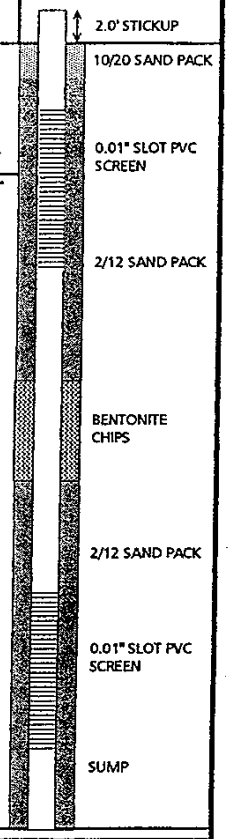
DATE DRILLED:	8/15/01
LOGGED BY:	LBB
REFERENCE ELEVATION:	
DRILL RIG:	CME 75
BORING DIAMETER:	15" 10.25" ID HSA
DEPTH TO GROUNDWATER:	≅ 5' Below Ground Surface

DESCRIPTION AND CLASSIFICATION			
DESCRIPTION AND REMARKS	COLOR	CONSIST.	TYPE
SAND, fine to coarse, with Gravel and Cobble, moist, large % is fine Sand	Brown		Fill
SAND, fine to coarse, with Gravel and Cobble, wet			SW
SAND, fine to coarse, with minor Gravel, wet, large % is fine Sand	Brown		SP
SAND, fine to coarse, wet	Brown		SW

DEPTH (FEET): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24

SAMPLER | BLOWS/FOOT | OVM (ppm) | WATER LEVEL

PIEZOMETER CONSTRUCTION



BOTTOM OF WELL @ 25.5'

Indicates split-spoon sampler

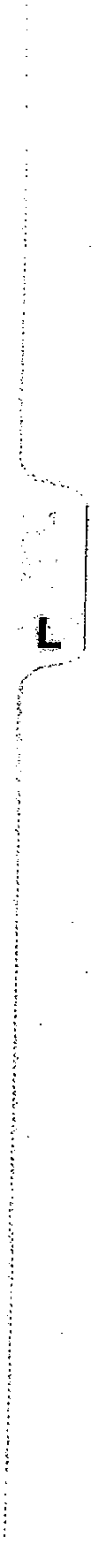
WASATCH ENVIRONMENTAL, INC.

WELL LOG

MAGIC CLEANERS
LAKE FORREST PARK, WASHINGTON

PROJECT NO.: 1494-02 | WELL NO.: DDC 7

S:\1404.drw



CHAPTER 19

Well and Pump Maintenance and Rehabilitation

Well rehabilitation is defined as restoring a well to its most efficient condition by various treatments or reconstruction methods. The necessity for well rehabilitation will depend on the effectiveness of the maintenance program and how faithfully it has been followed. In some cases, a major reconstruction of the well may be necessary, such as replacing the screen or lining a portion of the casing. Timely maintenance designed to overcome specific problems can sustain well performance, thereby prolonging well life.

Effective maintenance programs begin with well construction records showing geologic conditions, water quality, and pumping performance, especially specific capacity. A careful study of the operating history of other wells in the local region should suggest logical steps for devising maintenance schedules or rehabilitation procedures. So many variables are involved, however, that a single maintenance program cannot be devised that will work for every hydrogeologic condition and every type of well.

Inspection and routine maintenance schedules must be established on the basis of the individual characteristics of the well and pump. It is important to take note of any changes in the operating characteristics of the well and pump, because both can deteriorate to the point where rehabilitation is difficult, if not impossible. Experience indicates that if the specific capacity of a well declines by 25 percent, it is time to initiate rehabilitation procedures. Further neglect increases costs for maintenance significantly.

To determine any loss in performance, some reference mark will be needed. Performance standards are established by conducting a pumping test as part of the completion of every new well. The data from this test should be given to the owner in the form of a written report. This will allow the well owner to monitor the performance of the well to detect any drop in yield. These data also guide a rehabilitation contractor in devising an appropriate rehabilitation procedure. A form listing the important information to be retained at the well site is in the pocket of this book.

Loss of a major water supply, even temporarily, is intolerable in many cases. Therefore, ongoing performance evaluation of the well is mandatory if well failures are to

be avoided. The checklist below can be used to evaluate the performance of a well.

- What is the static water level in the production well?
- What is the pumping rate after a specified period of continuous pumping?
- What is the pumping water level after a specified period of continuous pumping?
- What is the specific capacity after a specified period of continuous pumping?
- What is the sand content in a water sample after a specified period of continuous pumping?
- What is the total depth of the well?
- What is the efficiency of the well?
- What is the normal pumping rate and how many hours per day does it operate?
- What has been the general trend in water levels in wells in the area?
- How much drawdown is created in the production well because of pumping of nearby wells?

A significant change in any of the first 7 conditions listed above indicates that a well or pump is in need of attention. For instance, a decline in the specific capacity might indicate plugging of the screen-slot openings.

Once inspection procedures have been established, they should be followed in every subsequent inspection. The pumping tests, for example, should be run for the same length of time at the same rate, and have the same period of recovery. Local well-drilling or pump-maintenance contractors are helpful in establishing procedures, and sometimes offer maintenance contracts. These individuals retain records of all maintenance they perform and provide written reports to the well owner. A typical pumping (aquifer) test data form that can be used for maintenance evaluation is in the pocket of this book.

After the pumping-test data have been recorded, they can be compared with the original numbers and an evaluation made regarding any decline in the well's performance since the last survey. Storage of well records can be facilitated by the use of computers. For relatively low cost, complete well records can be maintained that can help forecast when maintenance and rehabilitation work should be undertaken.

Table 19.1 lists the most prevalent well problems occurring in various types of aquifers and the typical maintenance frequency required. The maintenance figures in Table 19.1 are based on wells constructed to locally acceptable design and construction standards in the United States that may not be consistent with the best materials or methods available. Therefore, although these maintenance schedules are realistic in light of the materials and construction methods used, they probably indicate greater frequencies than would be anticipated if the best technology were used.

MAJOR CAUSES OF DETERIORATING WELL PERFORMANCE

Five major problems occur with wells over time. The first involves a reduction in the well yield. Well yield may be reduced by chemical incrustation or biofouling of the well screen and the formation materials around the intake portion of the well. Deteriorating screen and formation conditions can be alleviated by the maintenance procedures discussed below. Of course, other environmental factors, either natural or manmade, may lead to reduced yields, but correction of these conditions may be difficult or impossible because of political, engineering, or natural constraints. For example, a general drop in the water table caused mainly by short- or long-term

climatic trends will reduce well yield, as will interference from nearby wells. Also, the pumping level may drop over time in wells pumped continuously when the transmissivity of the aquifer limits the amount of water that can reach the wells, even

Table 19.1. Most Prevalent Well Problems Occurring in Various Types of Aquifers and the Typical Maintenance Frequency Required

Aquifer Type	Most Prevalent Well Problems*	Major Maintenance Frequency Requirement (Municipal)
Alluvial	Silt, clay, sand intrusion; iron precipitation; incrustation of screens; biologic fouling; limited recharge; casing failure	2-5 years
Sandstone	Fissure plugging; casing failure; sand production; corrosion	6-10 years
Limestone	Fissure plugging by clay, silt, and carbonate scale	6-12 years
Basaltic lavas	Fissure and vesicle plugging by clay and silt; some scale deposition	6-12 years
Interbedded sandstone and shale	Low initial yields; plugging of aquifer by clay and silt; fissure plugging; limited recharge; casing failure	4-7 years
Metamorphic	Low initial yield; fissure plugging by silt and clay; mineralization of fissures	12-15 years
Consolidated sedimentary	Fissure plugging by iron and other minerals; low to medium initial yield	6-8 years
Semiconsolidated and consolidated sedimentary	Clay, silt, sand intrusion; incrustation of screens in sand and gravel wells; fissure plugging of limestone aquifers in the interbedded sand, gravel, marl, clay, silt formations; biologic fouling; iron precipitation	5-8 years

*Excluding pumps and declining water tables.

Estimates of major maintenance frequencies are based on the following assumptions:
1. Wells are being pumped continuously at the highest sustained rate they are capable of producing.
2. Major maintenance is required when the sustained yield decreases to 75 percent of the initial yield.
3. Major maintenance is considered to represent a cost expenditure of approximately 10 percent of the total current replacement cost. Minor maintenance is excluded.
4. Wells are designed in accordance with current practices, not necessarily in accordance with best available technology.

(After Gass et al.)

though enough water may exist in the aquifer on a regional basis.

Plugging of the formation around the well screen by fine particles is the second factor in deteriorating well performance. Small particles in most unconsolidated formations are disturbed during pump cycling, and while temporarily in suspension they move gradually toward the screen. This same phenomenon apparently occurs in wells constructed in igneous and metamorphic rock, where the original specific capacity is often reduced 10 to 20 percent within a few months of operation. Small particles accumulate in the cracks, fissures, joints, fractures, or cavities that provide most of the water to the well.

The third factor in well failure is the onset of sand pumping. Some wells always pump sand, a condition usually attributable to poor well design or inadequate development. Other wells may begin to pump sand after months or years of service. Localized corrosion of the well screen or casing, or incrustation on only a portion of the screen, can produce higher velocities through either the corroded opening or the nonincrusted areas of the screen. Sand grains moved by these higher velocities may erode and enlarge the screen openings mechanically, allowing larger grains to enter the screen (Figure 19.1). Thus, corrosion and incrustation are major factors in sand pumping problems that develop over time. In some well-cemented sandstones, removal of the cement by water passing into the well can weaken the sandstone to the point where sand particles begin to move into the well. If this situation occurs, sand pumping may increase steadily.

The fourth cause of well failure involves the structural collapse of the well casing or screen. This type of failure is often produced by low-pH (acidic) waters containing high total dissolved solids and carbon dioxide concentrations that combine to cause electrolytic corrosion along the casing below the static water level.

Figure 19.1. Erosion of this well screen resulted from incrustation that caused high flow velocities through the remaining open area.

The last factor affecting well performance, although indirectly, is the condition of the pump. Mistakes in the design and construction of the well can cause severe damage to the pump over time. The impellers, impeller housing, and pump shaft are particularly susceptible to sand pumping. Corrosion of pump parts is also another serious problem in low-pH waters. Either of these conditions can drastically reduce the efficient life of the pump.

WELL FAILURE CAUSED BY INCRUSTATION

Chemical and biological incrustation are major causes of well failure. Water quality chiefly determines the occurrence of incrustation. The surface characteristics of the screen itself may also play a part in regulating the rate at which incrustation occurs. If the screen is con-

structed of rough-surface metal, for example, incrustants may build up at a faster rate. The kind and amount of dissolved minerals and gases in natural waters determine their tendency to deposit mineral matter as incrustation.

Groundwater normally moves slowly through soil, sand, and gravel, and is in contact with the minerals of these earth materials for hundreds to thousands of years. The time is so long that the water, with its dissolved mineral salts, is in quasi-chemical equilibrium with its environment. Thus, the water may be nearly saturated with the major minerals in the aquifer materials. Any change in the chemical or physical conditions upsets the equilibrium and may cause precipitation of relatively insoluble materials. The chemical equilibrium is upset when the well is pumped; in general, the greater the drawdown, the greater the disequilibrium will be.

Deposition of only a minute fraction of the minerals in the water will cause serious clogging. If material is dropping out of the water entering a screen 20 ft (6.1 m) long, 12 in (305 mm) in diameter, and pumping 500 gpm (2,730 m^3/day) at a rate of 1 mg/ℓ, a deposit of 6 lb (2.7 kg) per 24 hours would result. Assume the material is half calcium carbonate and half magnesium carbonate, with an average specific gravity of 3.0. If the porosity is 20 percent, all of the voids in the sand through a thickness of 6 in (152 mm) outside the screen would be completely filled in 293 days.

The incrustation often forms a hard, brittle, cementlike deposit similar to the scale found in water pipes. Under different conditions, however, it may be a soft, pastelike sludge or a gelatinous material. The major forms of incrustation include: (1) incrustation from precipitation of calcium and magnesium carbonates or their sulfates; (2) incrustation from precipitation of iron and manganese compounds, primarily their hydroxides or hydrated oxides; and (3) plugging caused by slime-producing iron bacteria or other slime-forming organisms (biofouling).

Causes of Carbonate Incrustation

Chemical incrustation usually results from the precipitation of carbonates, principally calcium, from groundwater in the proximity of the well screen. Other substances, such as aluminum silicates and iron compounds, may also be entrapped in the scalelike carbonates that cement sand grains together around the screen. The deposit fills the voids, and the flow of water into the well is reduced proportionately.

The probable explanation for this phenomenon is as follows. Calcium carbonate can be carried in solution in proportion to the amount of dissolved carbon dioxide in the groundwater. The ability of water to hold carbon dioxide in solution varies with pressure — the higher the pressure, the higher the concentration of carbon dioxide. When water is pumped from a well in an unconfined aquifer, the water table is drawn down to produce the necessary gradient or pressure differential in the water-bearing formation to cause water to flow into the well. The hydrostatic pressure in the deeper portions of the water-bearing formation is thus decreased, with the greatest change being at the well. Because of the reduction in pressure, some carbon dioxide is released from the water. When this occurs, the water is often unable to carry its full load of dissolved calcium carbonate and part of this material is then precipitated onto the well screen and in the formation materials adjacent to the well screen. Pumping a well in a confined aquifer produces a similar pressure reduction and resulting precipitation.

Formation of calcium carbonate precipitate from calcium bicarbonate is the classic

example:

$$Ca(HCO_3)_2 \xrightarrow{-\Delta P} CaCO_3\downarrow + CO_2\uparrow + H_2O$$

where Δ P is a change in pressure. Solubility of calcium bicarbonate on the left side of this equation is about 1,300 mg/ℓ; solubility of calcium carbonate on the right side is about 13 mg/ℓ. Carbon dioxide (CO_2) escapes when the head, or pressure, is reduced.

Magnesium bicarbonate changes to magnesium carbonate in the same manner when the carbon dioxide is released, but magnesium carbonate incrustation occurs only in special instances because it is still soluble at concentrations over 5,000 mg/ℓ (Kemmer, 1979). Precipitation occurs, therefore, only when the carbonate concentration exceeds this level.

Causes of Iron and Manganese Incrustation

Many rocks throughout the world contain iron and manganese, and are the source of iron and manganese ions found in groundwater if the pH is about 5 or less. During pumping, velocity-induced pressure changes can disturb the chemical equilibrium of the groundwater and result in the deposition of insoluble iron and manganese hydroxides. These hydroxides have the consistency of a gel, and may occupy relatively large volumes; over time, they harden into scale deposits. Dissolved iron is affected by pressure reduction as indicated:

$$Fe(HCO_3)_2 \xrightarrow{-\Delta P} Fe(OH)_2\downarrow + 2CO_2\uparrow$$

Solubility of ferrous hydroxide on the right side of this equation is less than 20 mg/ℓ. If oxygen is introduced by aeration during pumping, additional precipitation of ferric hydroxide occurs:

$$4Fe(OH)_2 + 2H_2O + O_2 \rightarrow 4Fe(OH)_3\downarrow$$

Solubility of ferric hydroxide on the right side of this equation is less than 0.01 mg/ℓ.

Soluble manganese becomes insoluble in the same way as iron:

$$2Mn(HCO_3)_2 + O_2 + 2H_2O \rightarrow 2Mn(OH)_4\downarrow + 4CO_2\uparrow$$

Further oxidation of the hydroxides of iron and manganese, or an increase in pH, causes the formation of hydrated oxides containing these ions. Ferrous iron in solution, for example, can react with oxygen to form ferric oxide:

$$2Fe^{+2} + 4HCO_3^- + H_2O + \tfrac{1}{2}O_2 = Fe_2O_3 + 4CO_2 + 3H_2O$$

The ferric oxide is a reddish brown deposit similar to rust, whereas the hydrated ferrous oxide is a black sludge. The insoluble manganese oxide is also black or dark brown. Iron and manganese deposits are often found associated with calcium- and magnesium-carbonate scale.

Sometimes the chemical deposits are hardly noticeable. For example, samples of the formation sand adjacent to well screens at a city in Michigan, an industrial plant in northern Indiana, and a plant in southern Illinois revealed no extraneous material

in the sand voids, but all the sand particles were coated with hydrated iron oxide. These wells had suffered severe reduction in specific capacity over a period of three or four years. It is also quite possible that ferrous hydroxide, a white and fluffy precipitate, had been lodged in the voids of the formation but was broken up when the samples were taken and was unnoticeable.

In the cone of depression around a well in an unconfined aquifer, air enters the voids and oxidizes iron in the films of water adhering to individual sand grains. If pumping is started and stopped intermittently, a coating of iron oxide can build up, thereby gradually reducing the void space in this part of the formation. This action reduces the formation's storage capacity in the vicinity of the well, and the cone of depression enlarges more rapidly than it would otherwise.

Prevention and Treatment of Incrustation Problems

Thus far, a means of preventing the incrustation of well screens has not been found. One unique method does exist, however, that is designed to reduce the amount of iron incrusting materials reaching the well screen. This method, called the Vyredox™ System, uses a series of injection wells located in a circle around the production well. Oxygenated water is injected into the wells to oxidize iron in solution and promote the growth of iron bacteria so that little iron reaches the production well. See Chapter 23 for a more detailed description of this method.

For most wells where incrusting materials cannot be removed before reaching the well, several actions can be taken to delay incrustation and make it a less serious problem. First, the well screen should be designed to have the maximum possible inlet area to reduce the flow velocity to a minimum through the screen openings. Second, the well should be developed thoroughly. Third, the pumping rate may be reduced and the pumping period increased, thereby decreasing entrance velocities. Fourth, the pumping load may be divided among a larger number of smaller diameter wells instead of obtaining all of the supply from only one or a few larger diameter wells.

Fifth, a more frequent maintenance or cleaning procedure for each well should be practiced wherever local experience shows considerable difficulty from incrustation. In these areas, a qualified water well contractor should be called to perform the necessary maintenance. Corrective measures should not be put off until drastic means must be taken. Contractors generally know the best procedure to use from their past experience in the local area.

In localities where incrustation of wells is prevalent, samples of the incrusting materials and the water should be analyzed. Samples of the incrustants can often be obtained from the outer surfaces of pumps, suction pipes, or well screens. The constituents will normally include calcium carbonate, iron oxide, silica, aluminum silicate, or organic material. The material causing the clogging will usually be a mixture of several things, not a single substance. Recent research has shown, for example, that incrustants on the outside of a well screen may consist of precipitated elements from the groundwater, whereas most of the depositional products on the inside of the screen originate from the screen itself (Figure 19.2a and b). The proportions of the various substances shown by the chemical analysis should indicate the kind of treatment and the type of chemicals that would be most successful in recovering well yield.

Acid Treatment of Wells

Chemical incrustation can best be removed by treating the well with a strong acid solution that chemically dissolves the incrusting materials so they can be pumped from the well. Strong acids are used more often than any other type of chemical for well rehabilitation. Their chief value lies in their ability to dissolve mineral scale as well as some of the iron deposits formed by iron bacteria. The acids most commonly used in well rehabilitation are hydrochloric (HCl), sulfamic (H_3NO_3S), and hydroxyacetic ($C_2H_4O_3$).

Hydrochloric (Muriatic) Acid

Hydrochloric acid (prepared commercially under the name muriatic acid) is one of the most effective acids for removing mineral scale. Commercially prepared hydrochloric acid is a clear to yellowish solution of hydrogen chloride gas dissolved in water. It is available in several strengths that are identified by degrees Baumé*; common strengths are 18 and 20 degrees Baumé which are 28 and 31 percent hydrochloric acid, respectively. Hydrochloric acid is commonly ordered with an inhibitor that minimizes the acid's corrosive effect on metal wells screens, casing, and pump components.

In treating wells, hydrochloric acid is usually introduced into the well screen by conducting it from ground surface through a small-diameter plastic or black iron pipe. It is best to use a quantity of acid equal to the amount of water in the screen plus an additional volume of 25 to 50 percent. To reach farther into the formation, acid volumes of up to twice the screen volume can be used. Table 19.2 shows the proper amount of hydrochloric acid to use in small- and large-diameter wells.

Although it is an extremely effective well cleaner, hydrochloric acid has a number of drawbacks. It is extremely dangerous to handle. Once placed in the well, the acid produces large quantities of toxic fumes that are expelled from the well bore within moments. Inhalation of these toxic fumes will cause death, and contact of the liquid with human tissue can easily result in serious injury.

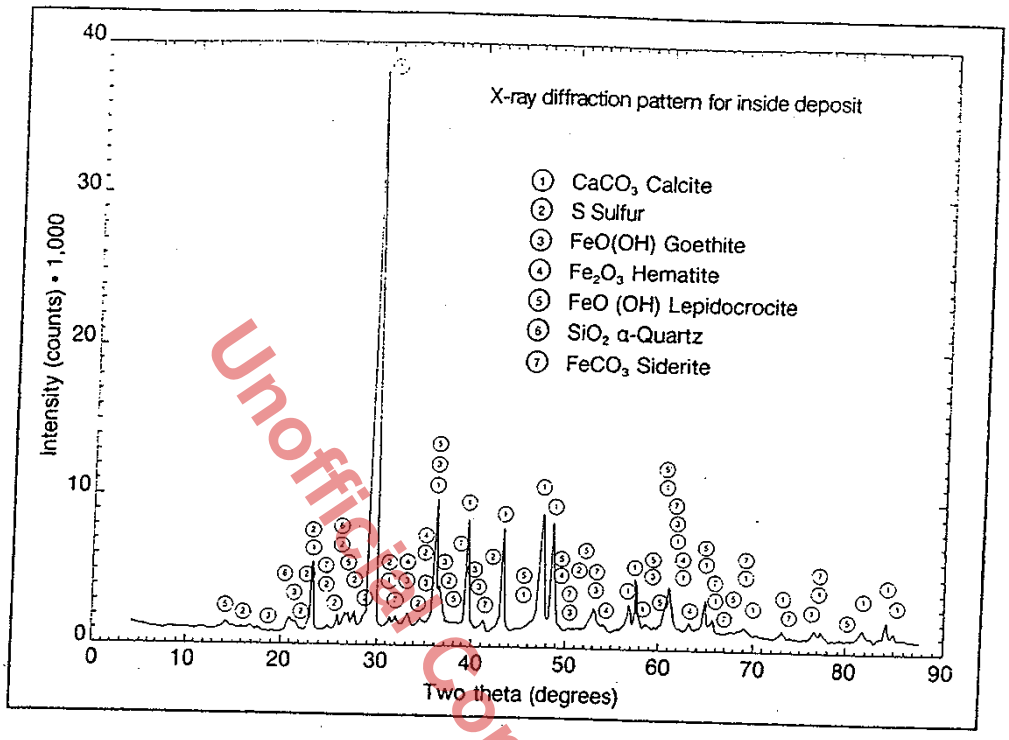
Figure 19.2a. Incrustants have formed on the inside and outside of this steel pipe-based well screen that is wrapped with a slotted-brass filter. Visual examination of the incrustants suggests that the porous incrustants on the inside of the screen contain different minerals than the dense, well-bonded incrustants on the outside.

Sulfamic Acid

Sulfamic acid† is a dry, white, granular material that produces a strong acid when mixed with water. Its solubility in water increases with temperature, ranging from

*Degrees Baumé is a scale referring to the specific gravity of the solution as determined by the acid concentration. As the degrees Baumé increase, the strength of the solution also increases.

†Also known as aminosulfonic, amidosulfonic, and amidosulfuric



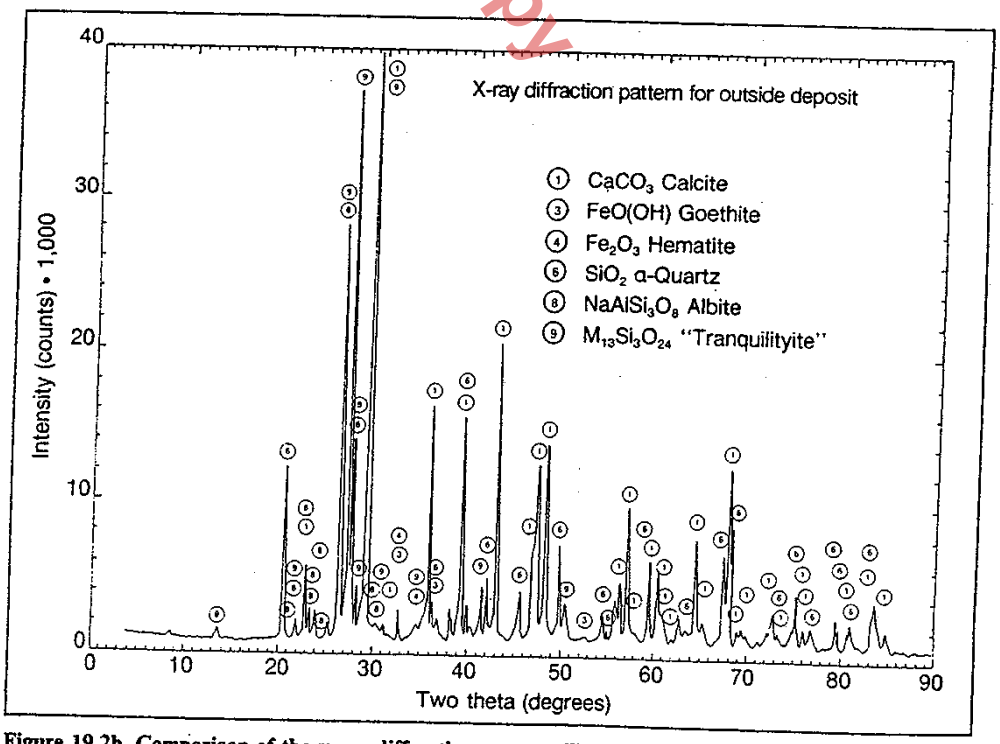


Figure 19.2b. Comparison of the x-ray diffraction patterns illustrates the chemical differences between incrustants. The incrustants on the inside of the screen consist principally of goethite, siderite, and lepidocrocite, which are indicative of iron and steel corrosion. Incrustants on the outside of the screen are derived mainly from the groundwater and include calcite, quartz, hematite, albite, and goethite.

15 to 20 percent by weight at most prevailing groundwater temperatures.

Although it is more expensive than hydrochloric acid and is less aggressive, sulfamic acid offers a number of advantages. In its dry form, it is relatively safe to handle; the dry material does not give off fumes and will not irritate dry skin. If spillage occurs, it may be cleaned up easily and safely, thus providing for safer shipping and handling. If mixed at the surface, however, sulfamic acid should be handled as if it were hydrochloric acid. During treatment, this slowly dissolving acid releases dangerous fumes at a relatively slow rate; nevertheless, proper ventilation should always be provided. Less corrosion of pumps, screens, and casings will occur when an inhibitor is added to the acid. For example, little corrosion results when stainless steel well screens are treated repeatedly with an inhibited sulfamic acid. Sulfamic acid is available in pelletized, granular, and powdered form. The pelletized form is used in wells completed with relatively short screens where the screens are located at the bottom of the well. Because the pellets are heavier than water, they sink through the column of water standing in the casing and then dissolve inside the screen. The pellets should

Table 19.2. Amount of Hydrochloric Acid Required to Treat an Incrusted Screen

Screen Diameter		Amount of HCl Acid (18° to 20° Baumé) per ft (0.3 m) of Screen	
in	mm	Gallons	Liters
1½	38	0.11 - 0.14	0.42 - 0.53
2	51	0.20 - 0.24	0.76 - 0.91
2½	64	0.33 - 0.39	1.25 - 1.48
3	76	0.46 - 0.56	1.74 - 2.12
3½	89	0.63 - 0.75	2.38 - 2.84
4	102	0.81 - 0.98	3.07 - 3.71
4½	114	1.04 - 1.25	3.94 - 4.73
5	127	1.28 - 1.53	4.84 - 5.79
5½	140	1.54 - 1.85	5.83 - 7.00
6	152	1.84 - 2.21	6.96 - 8.36
7	178	2.50 - 3.00	9.5 - 11.4
8	203	3.26 - 3.92	12.3 - 14.8
10	254	5.10 - 6.12	19.3 - 23.2
12	305	7.35 - 8.82	27.8 - 33.4
14	356	10.0 - 12.0	37.9 - 45.4
16	406	13.1 - 15.7	49.4 - 59.4
18	457	16.5 - 19.8	62.6 - 75.1
20	508	20.4 - 24.5	77.2 - 92.7
22	559	24.7 - 29.6	93.5 - 112
24	610	29.4 - 35.3	111 - 133
26	660	34.5 - 41.4	131 - 157
28	711	40.0 - 48.0	151 - 182
30	762	45.9 - 55.1	174 - 208
32	813	52.2 - 62.7	198 - 237
34	864	59.0 - 70.7	223 - 268
36	914	66.1 - 79.3	250 - 300

dissolve in approximately 4 hours if oversaturation does not occur. Agitation of the water in the screen increases the solution rate of the chemical. The proper quantity of pelletized sulfamic acid required to treat the well is generally determined by the length and diameter of the well screen or by the weight of water standing in the screen. Table 19.3 shows the proper quantities of Nu-Well®, a pelletized sulfamic acid, to use for small- and large-diameter screens less than 100 ft (30.5 m) long.

The granular form of sulfamic acid is generally used when acidizing long screens [greater than 100 ft (30.5 m)] or screens separated by casing. It is usually dumped directly into the casing, where it saturates the entire column with acid. The acid goes into solution as the granules descend slowly in the casing. Enough clear water is then added to force the volume of acid standing in the casing above the screen into the formation. For deep wells with high static water levels, granular or powdered acid should be premixed at the surface so it can be piped to the intake portion of the well. A 10-percent solution of granular sulfamic acid is sometimes used for long screens, although a 30-percent solution provides better results.

Sulfamic acid is particularly useful in treating calcium and magnesium incrustants, but is less effective when iron or manganese incrustants are present. The addition of rock salt to sulfamic acid, however, will increase the acid's ability to dissolve iron deposits. Approximately 2 lb (0.9 kg) of rock salt are added to 10 lb (4.5 kg) of Nu-

Table 19.3. Amount of Nu-Well® Required to Treat a Moderately Plugged 1-ft (0.3-m) Section of Screen

Screen Diameter (Pipe Size)		Screen Capacity		Nu-Well Required	
in	mm	gal/ft	ℓ/m	lbs/ft	kg/m
1½	38	0.1	1.2	0.2	0.3
2	51	0.2	2.5	0.4	0.6
3	76	0.4	5.0	0.9	1.3
4	102	0.7	8.7	1.6	2.4
5	127	1.0	12.4	2.6	3.9
6	152	1.5	18.6	3.7	5.5
8	203	2.6	32.3	6.5	9.7
10	254	4.1	50.9	10.2	15.2
12	305	5.9	73.2	14.7	21.9
14	356	8.0	99.3	20.0	29.8
16	406	10.4	129	26.1	38.9
18	457	13.2	164	33.0	49.2
20	508	16.3	202	40.8	60.8
22	559	19.8	246	49.4	73.6
24	610	23.5	292	58.7	87.5
28	711	32.0	397	80.0	119
30	762	36.7	455	91.8	137
32	813	41.8	519	104	156
34	864	47.2	586	118	176
36	914	52.9	657	132	197

The quantities of Nu-Well® are equal to 30 percent of the weight of water in the well screen. This ratio is used for treating relatively short screens that have been affected by moderate incrustation.

Well® (20 percent of the weight of the acid) to create a solution that will treat iron and manganese incrustants.

Sulfamic acid reacts chemically with mineral deposits in the same manner as hydrochloric acid, although at a slower rate. Consequently, longer contact time is usually required to achieve the same results; at least 15 hours is recommended. The effectiveness of the treatment is enhanced considerably if the acid is agitated while and immediately after it dissolves. Forceful agitation is also recommended before the acid is pumped to waste.

Sulfamic acid should not be confused with sulfuric acid. Sulfuric is a strong liquid acid that has been used successfully on rare occasions in well treatment. Its major limitation in well treatment is that when it combines chemically with calcium scale, it forms calcium sulfate which is nearly insoluble in water. Thus, a sulfuric acid treatment may actually reduce the well's performance. In addition, sulfuric acid, even when inhibited, is extremely aggressive in attacking metallic casing and screens.

Hydroxyacetic Acid

Hydroxyacetic acid, also known as glycolic acid, is a liquid organic acid available commercially in 70-percent concentrations. Although not as well known or commonly used as either hydrochloric or sulfamic acid, its use has achieved excellent results in well treatment. It is quite safe to use because it is relatively noncorrosive and produces little or no toxic fumes.

In addition to its ability to dissolve mineral scale, hydroxyacetic acid offers advantages not available with sulfamic or hydrochloric acid. It is an excellent bactericide and therefore may be effective in treating wells with iron bacteria problems. It kills

Table 19.4. Amount of Hydroxyacetic Acid Required per 1 ft (0.3 m) of Screen Length or Open Borehole

Diameter of Well		Amount of 70% Hydroxyacetic Acid per 1 ft (0.3 m) of Screen or Borehole	
in	mm	gal	ℓ
1½	38	0.006 - 0.009	0.02 - 0.03
2	51	0.01 - 0.02	0.04 - 0.08
3	76	0.02 - 0.04	0.08 - 0.15
4	102	0.04 - 0.07	0.15 - 0.27
6	152	0.10 - 0.15	0.38 - 0.57
8	203	0.17 - 0.26	0.64 - 0.98
10	254	0.27 - 0.41	1.02 - 1.55
12	305	0.39 - 0.59	1.48 - 2.23
16	406	0.70 - 1.00	2.65 - 3.79
20	508	1.09 - 1.64	4.13 - 6.21
24	610	1.57 - 2.36	5.94 - 8.93
28	711	2.14 - 3.21	8.10 - 12.1
30	762	2.45 - 3.68	9.27 - 13.9
32	813	2.79 - 4.19	10.6 - 15.9
34	864	3.15 - 4.73	11.9 - 17.9
36	914	3.53 - 5.30	13.4 - 20.1

the bacteria and simultaneously dissolves the bacterial iron deposits as well as other mineral scale.

In addition to its bactericidal properties, hydroxyacetic acid is a chelating or sequestering agent. This means that it has the ability to "surround" metal ions (such as iron, calcium, and magnesium) in solution and keep them from combining chemically with other ions. This insures that all the scale dissolved by the acid remains in solution during the entire treatment period.

Hydroxyacetic acid is placed in the well in the same manner as hydrochloric acid. About 1 gal (3.8 ℓ) of 70-percent hydroxyacetic should be used for every 10 to 15 gal (38 to 56.7 ℓ) of water standing in the well screen. Table 19.4 shows the proper amount of hydroxyacetic acid to use in treating wells of various diameters.

Hydroxyacetic acid is weaker than both hydrochloric and sulfamic acid, and longer contact time is required to achieve the same amount of scale removal. The rate at which an acid removes scale is related to the acid's pH (acid strength). Figure 19.3 shows how pH varies with concentration for the acids described above. Note that hydrochloric acid has the lowest pH and thus will work the fastest, whereas hydroxyacetic has the highest pH and will work more slowly than the other acids.

General Procedure for Acid Treatment

Great care should be taken in placing liquid acid into a well. Only experienced personnel with specialized equipment should attempt to use it in rehabilitating a well. When using any liquid acid, personnel should wear protective rubber clothing and goggles. A breathing respirator should also be used by all personnel handling the acid and by other persons near the well. All mixing tanks, chemical pumps, and piping (tremie pipes) should be constructed of plastic or black iron to minimize reaction to the acid. A large quantity of water, or a water tank with a mixture of sodium bicarbonate, should be available in the event that an accident occurs. Proper ventilation must be maintained because the fumes released from the well during treatment are lethal.

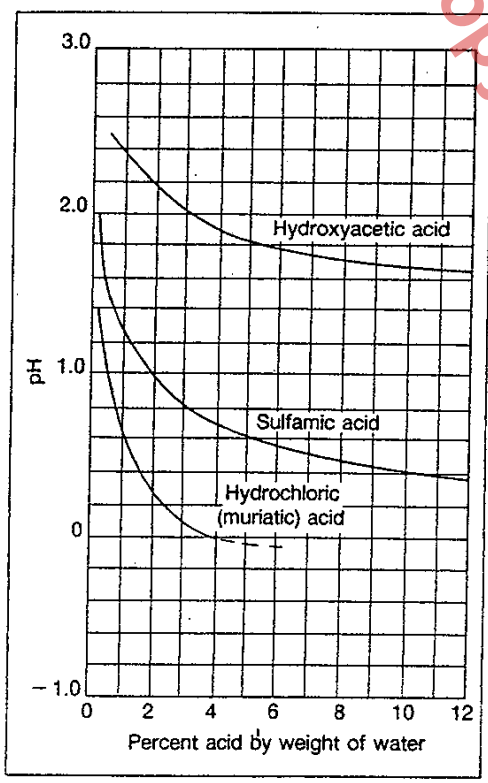


Figure 19.3. Equal concentrations of different acids form solutions with different pH values; pH of an acid-water solution varies with concentration.

Liquid acid should be introduced into the well through a small-diameter pipe. If the screen is more than 5 ft (1.5 m) long, enough acid should be added to fill the lower 5 ft of screen. Then the pipe should be raised and the next 5 ft of screen filled with acid, continuing in this way until the entire screen is full. Pelletized forms of sulfamic acid dropped into the casing will accumulate in the screen where the pellets dissolve. When the granular forms are

poured into the casing, they go into solution throughout the entire column of water in the well.

After the acid is placed in the well (or the pellets dissolve), a volume of water equal to that standing in the well screen is poured into the well to force the acid solution through the screen-slot openings into the formation. Some form of mechanical agitation, such as surging, should be employed while the acid is in the well to help break up the incrustation and improve the overall efficiency of the process. This step is particularly important because it exposes the incrustant to the acid, thereby assuring maximum removal.

The use of surge blocks or jetting tools are effective methods of agitating the well. The agitation time will depend on the amount of incrustant in the well. If a surge block is used, the surging effect drives the acid into the formation and brings loosened material into the screen. In the jetting operation, the acid is first poured into the well. The screen or the face of the well bore can then be jetted with clean water from the surface or acidized water from the well (Figure 19.4). A pump pressure of 100 to 250 psi (690 to 1,720 kPa) is sufficient for this type of operation. Circulation of the acid solution may be corrosive to the jetting pump and other equipment, but the wide use of plastic impellers has eliminated most of this type of corrosion damage. If the job requires recirculating the jetting acid at the surface, it is best to call on a well servicing company that has specialized equipment for this work. Great care should always be exercised whenever acid is being pumped in any well rehabilitation operation.

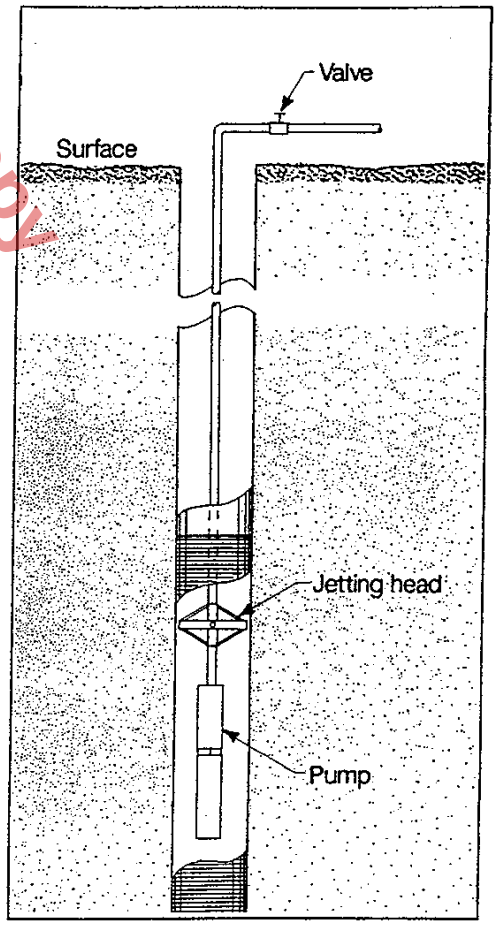


Figure 19.4. To avoid the dangerous practice of pumping acid at the surface, jetting can be accomplished by setting a pump in the well and using the acidified water in the borehole.

An extended zone of the formation around the well screen may be wholly or partially clogged. Thus, it must never be assumed that the chemical solution moves uniformly outward into the voids of the water-bearing materials in all directions throughout the full thickness of the formation. The chemical solutions will flow most readily into those areas where the formation or screen is the most open, that is, where resistance to flow is the least. Therefore, it may be extremely difficult and even impossible to diffuse the chemical solution to all points where it can dissolve or otherwise remove the unwanted deposits.

The use of chelating agents is recommended if iron and manganese incrustants are present and the pH of the treatment solution is approximately 3 or less.

At this pH, these cations form insoluble precipitates that settle out and reduce the effectiveness of the acid treatment. Citric, phosphoric, and tartaric acids are three common chelating agents. Four pounds (1.8 kg) of chelating agent are usually added to each gal (3.8 ℓ) of 31-percent (20 degrees Baumé) hydrochloric acid and 1 lb (0.5 kg) of chelating agent to 15 lbs (6.8 kg) of sulfamic (granular) acid.

After mechanical agitation, the solution is left in the well to react with the incrusting materials until the pH is between 6.5 and 7, then agitated again and pumped to waste. The time for the reaction to be completed will vary from a few hours to more than 15 hours, depending on the type of acid used and the amount of incrustants. To minimize disposal problems, the water in the well should be neutralized if necessary before it is removed from the well. In many communities, the water well contractor may be required to haul away the spent acid and dispose of it according to local regulatory agencies. If not, the spent acid should be run onto a sandy section of ground as far away as practicable from the well head. Some contractors neutralize acid waste-water by running it through a limestone-filled container.

Many water well contractors will redevelop the well after it has been acid treated. Solid particles of incrustant can be removed along with any fine sediments that may have entered the zone immediately around the screen after the well was placed in service. In many instances, effective redevelopment of an older, acid-treated well will result in a specific capacity that equals or even exceeds the original specific capacity. The various development procedures are discussed in Chapter 15.

Mechanical Methods to Remove Incrustants

Although removal of most incrustants by acid treatment is extremely effective, several mechanical methods are useful either in preparing for acid treatment or as a primary method of removing incrustants. Wire brushing or other means of mechanical scraping can remove incrustants that have been deposited on the inside of the well screen. The loosened material is then removed from the well by bailing, air-lift pumping, or other means. Removal of these incrustants minimizes the quantity of acid that must be used in any subsequent acid treatment, enhances the effectiveness of this treatment, and reduces the time required for the acidizing process.

Controlled blasting techniques are often useful for temporarily improving well yield by fracturing the incrusting matrix so that water can reach the screen. Incrusting materials are sometimes deposited on formation materials several inches or more away from the screen. The incrustant may become so massive that all voids in the formation become filled and little water can reach the screen. Blasting procedures create cracks in the incrustant, allowing water to enter the well. Some fragments of the incrustant will break away and can be pumped from the well. Unfortunately, the opened cracks eventually will also become incrusted and additional blasting or acidizing treatments will be needed to maintain yield. This technique, when combined with acidizing, is particularly effective. Special service companies have formed to provide this type of blasting service.

Incrustation of Rock Wells

Although this discussion has referred only to screened wells in unconsolidated formations, wells in consolidated rock also suffer from incrustation of the borehole wall or the cracks and fissures leading to the borehole. Many rock wells require

treatment from time to time to recover the original yield. Both chemical treatments and blasting have proved to be effective procedures and in some cases both are used.

When blasting incrustant, 5- to 10-lb (2.3- to 4.5-kg) shots of explosive are set at 5-ft (1.5-m) intervals in the production zone of the well. More powerful amounts of explosives are sometimes used at different spacings, depending on the experience of the contractor and the nature of the formation and the incrustant. The explosive charges are set off sequentially, beginning at the bottom of the open hole. Do not set off charges within 50 ft (15.2 m) of a shale layer or the bottom of the casing. After blasting, the loosened material should be removed from the borehole and the well redeveloped completely. Samples of sandstone removed after blasting have shown that most of the incrustation extends only about 0.5 in (12.7 mm) beyond the face of the borehole.

Wells constructed in fissured limestone can be successfully treated with acid. An appropriate quantity of hydrochloric or sulfamic acid is placed in the well and the well head capped. A pressure gauge is installed so that the pressure can be monitored. If the pressure build-up is high, the acid is being contained near the borehole. If the pressure does not build substantially, most of the force is being transmitted away from the well bore by means of cavities or enlarged fissures. The solution effect is still beneficial, nevertheless, even if the pressure build-up is low. When the acid stops working, the gauge will indicate a noticeable pressure drop. Work can then begin on redevelopment by jetting, surging, or other means of agitation. All loosened material should be removed before placing the well back in service.

Johnson Division makes no guarantee of results and disclaims all liability in connection with the information or the safety suggestions given for the methods described. Also, it should be understood that not all the acceptable safety procedures are contained herein and that certain circumstances may call for additional precautions. The suggestions given here do not supplement nor modify any state, municipal, federal, and insurance requirements or codes relating to blasting or acidizing.

Acid Treatment of Municipal Wells in Las Vegas, Nevada

A case history from the Las Vegas (Nevada) Valley Water District demonstrates the effectiveness of acid treatment using sulfamic chemicals. The district wells had become heavily incrusted with calcium and magnesium scale, reducing the yields substantially. Both blasting and dry-ice treatment were used to fracture the incrusted formations. A series of small explosive charges were placed in the well and detonated sequentially. In dry-ice treatment, carbon dioxide gases released by dry ice in the well produce extremely high pressures and cause additional fracturing of the incrustant.

The District then undertook an acid rehabilitation program for five of their most heavily used wells. Each of the five wells had been completed with 16-in casing to an average depth of over 900 ft. Length of perforated areas ranged from 278 to 651 ft. The average yield before treatment was 1,870 gpm per well.

A 10-percent acid solution (by weight of water in the casing) of granular sulfamic acid was determined to be adequate to dissolve the incrustant, which consisted primarily of calcium carbonate. This amounts to 0.75 lb of sulfamic acid per gallon of water in the casing. Six 480-lb loads were placed in each well while the pump was still in place. After each 480-lb load was added, the pump was used briefly to surge the well five times to mix the acid and distribute the solution throughout the casing.

When all the acid had been placed in the wells, the wells were surged ten times every 4 hours for the next 24 hours. The wells were then left for an additional 24 hours to guarantee removal of the most firmly imbedded incrustants and then pumped to waste.

During the treatment, silt and sand that were once cemented together by the incrustants were loosened. In order to obtain optimum yields, it was important to remove these materials so the original permeability of the sediments would be restored. To accomplish this, 300 lb of tetrasodium pyrophosphate were added to each well, surged five times, and allowed to stand in the wells for 24 hours. The addition of phosphates helped break up and disperse silt, clay, and other byproducts of the acid treatment. The wells were again pumped to waste.

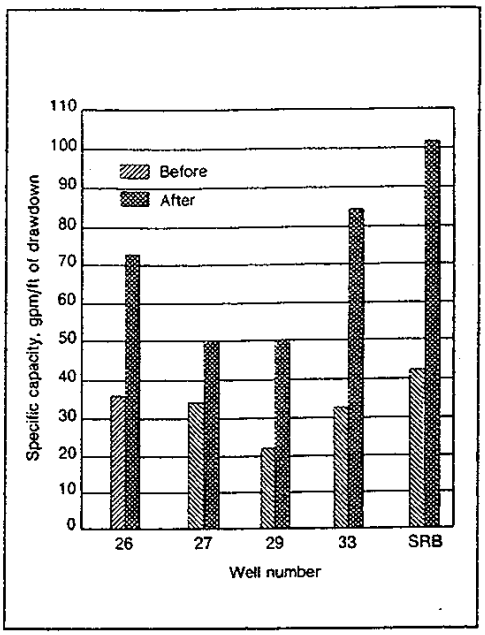


Figure 19.5. Specific capacity of wells before and after acid and polyphosphate treatment.

Before acid treatment, the well characteristics were monitored and recorded as a guide to determine the effectiveness of the treatment. A comparison of specific capacities before and after treatment revealed exceptional results. Figure 19.5 illustrates a range of improvement from 45 to 160 percent of pretreatment specific capacities. After the acid treatment, significant reductions in drawdown resulted in saving the District $16,000 annually in pumping costs alone. The payback time for the investment in materials and labor was estimated to be 1.5 years (Varhol, 1980).

WELL FAILURE CAUSED BY IRON BACTERIA

Iron bacteria occur widely in wells open to the atmosphere when sufficient iron and/or manganese are present in the groundwater in conjunction with dissolved organic material, bicarbonate, or carbon dioxide. Although iron bacteria have been found in wells in all the conterminous United States, the most seriously affected areas include the Southeastern states, the Upper Midwest, and Southern California. In these regions, the principal forms of iron bacteria plug wells by enzymatically catalyzing the oxidation of iron (and manganese), using the energy to promote the growth of threadlike slimes, and accumulating large amounts of ferric hydroxide in the slime (Figure 19.6). In this process, the bacteria obtain their energy by oxidizing ferrous ions to ferric ions, which are then precipitated as hydrated ferric hydroxide on or in their mucilaginous sheaths. Precipitation of the iron and rapid growth of the bacteria create a voluminous material that quickly plugs the screen pores of the sediment surrounding the well bore. Sometimes the explosive growth rates of iron bacteria can render a well virtually useless within a matter of months.

Many other forms of iron bacteria induce the precipitation of iron through nonenzymatic means. Found almost everywhere in both water and soil, these bacteria promote precipitation of iron by four major mechanisms:

1. Raising the pH of the water by (a) metabolizing certain protein or protein-derived materials, resulting in the formation of ammonia, which is alkaline; (b) consuming the salts of organic acids, which can lead to the synthesis of alkaline hydroxyl groups; and (c) assimilation of dissolved carbon dioxide in water by cyanobacteria or algae during photosynthesis.
2. Changing the redox potential of the water by algal photosynthesis. In this process, oxygen given off by plants increases the redox potential, thereby causing the precipitation of iron.
3. Liberating chelated iron by inducing a breakdown in the bond between iron and oxalate, citrate, humic acids, or tannins.

Still other forms of iron bacteria can reduce iron to a ferrous state under anaerobic conditions. Although researchers have not been able to classify many major types of iron bacteria in regard to how they participate in the process of iron deposition, the classification shown in Appendix 19.A provides a tentative guide for enzymatic and nonenzymatic bacteria likely to be found in water wells.

It is unclear whether iron bacteria exist in groundwater before well construction takes place and simply multiply as the amount of iron increases, or whether they are introduced into the aquifer from the subsoil, in mix water during well construction, or by backsiphoning from an affected well to an unaffected well. For example, drilling fluid mix water taken from swamps, marshes, or other stagnant surface-water sources may contain high concentrations of iron bacteria. There is also some evidence to show that iron bacteria can be carried from well to well on drill rods, bits, pumps, and water tanks.

Gallionella, a common enyzmatic form of iron bacteria, is usually found in water having certain physical and chemical characteristics. Generally the water:

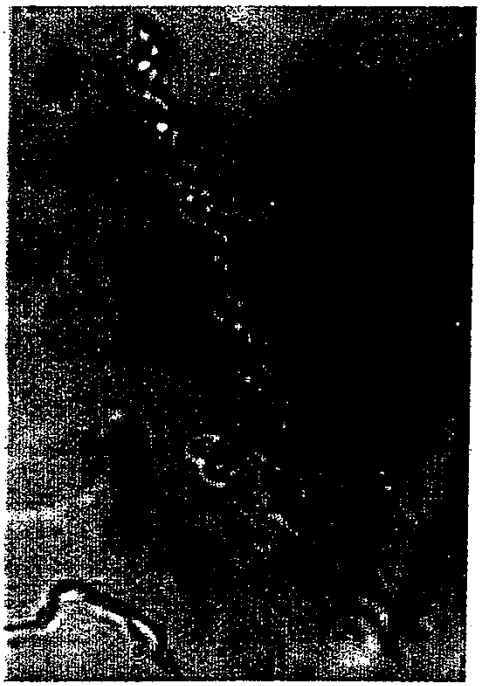


Figure 19.6. Iron bacteria on pump column pipe.

1. Has an iron content of 1 to 25 mg/ℓ and contains only traces of organic matter.
2. Is low in oxygen, typically in the 0.1 to 1 mg/ℓ range.
3. Is usually fresh, although *Gallionella* has been found growing in salt water.
4. Contains over 20 mg/ℓ carbon dioxide.
5. Has a redox potential in the range of 200 to 300 millivolts (mv).
6. Has a pH in the range of 6 to 7.6.
7. Has a temperature from 40 to 60°F (4.4 to 15.6°C).

Presumably, many forms of enzymatic bacteria that could grow in water wells would prefer waters with these same general characteristics. But other forms of iron bacteria, such as *Thiobacillus Ferrooxidans*, *Sulfolobus Acidocaldarius*, *Sulfobacillus Thermosulfidooxidans*, and

Leptospirillum Ferrooxidans can grow in waters having extremely low pH (2 to 6) and much higher temperatures [60 to 185°F (15.6 to 85°C)].

A second classification of iron bacteria generally used in the water-well industry is one based on the physical form of these organisms. This method of classification is helpful in identifying which genus of iron-fixing bacteria is contained in a particular water sample. The three general forms recognized are:

1. The capsulated coccoid form, of which only one genus is known, *Siderocapsa*. This organism consists of numerous short rods surrounded by a mucoid capsule. The deposit surrounding the capsule is hydrous ferric oxide, a rust-brown precipitate. This organism probably produces iron precipitates by breaking down the bond between the iron and the chelating agent.

2. The stalked iron-fixing bacteria, composed of twisted bands resembling a ribbon or chain. The genus of this physical form is *Gallionella*, sometimes called *Spirophyllum*, although *Gallionella* is the preferred name. *Gallionella* can be recognized by the twisted stalk and the bean-shaped bacterial cell at the end of the twisted stalk. The only living part of this organism is the bean-shaped cell at the end of the stalk. *Gallionella* is probably the principal enzymatic bacteria occurring in wells.

3. The filamentous group, consisting of four genera: *Crenothrix*, *Sphaerotilus*, *Clonothrix*, and *Leptothrix*. Species of the genus *Crenothrix* have a thin attached end that gradually thickens toward the free end. The separate cells that make up a thread of *Crenothrix* are rod shaped and lie end to end in a sheath. The free end of the filament contains spherical, nonmotile cells called conidia, which are frequently prevented from leaving the sheath. They germinate within the sheath and thrust their filaments through the walls, giving the appearance of numerous branches extending from the parent filament. Members of the genus *Sphaerotilus* exhibit colorless filaments that show false branching. Another iron bacterium that shows false branching is *Clonothrix* (Figure 19.7). This form differs from others in the filamentous group in that its sheath is tapered. The fourth genus in the filamentous group is *Leptrothrix*, a simple thread form, usually incrusted with iron along the entire sheath. The sheath of this organism is generally the same width throughout its length and contains colorless cylindrical cells that lie end to end (Figure 19.8). *Leptrothrix* and *Sphaerotilus* contain only a relatively small volume of iron in their sheaths and probably do

Figure 19.7. Iron bacteria, genera *Clonothrix*.

Figure 19.8. Iron bacteria, genera *Leptothrix.*

not derive energy from iron oxidation. This may also be true for *Crenothrix* and *Clonothrix.*

If the presence of iron bacteria is suspected in a well, samples of the organism can be obtained by a filtering device attached to the discharge of the pump for one week. The water passing through the filter during this period leaves a dark brown precipitate on the porcelain cover which can be examined for iron bacteria by a qualified laboratory.

Another method of sample collection is to examine the material scraped from valves or pump discharge lines from suspected wells, pump shaft seals, water closets, or small steel objects suspended temporarily in the well. However, unless a microscope with a magnification of at least 1,000X is available, it is best to send the samples to a state water laboratory or a private firm familiar with iron bacteria identification. Correct identification of iron bacteria is best accomplished by scanning electron or transmission electron microscopy and phase contrast techniques.

Prevention and Treatment of Iron Bacteria

The water well contractor should use great care to avoid introducing iron bacteria into a well during drilling and repair work. All drilling fluid mix water should be chlorinated initially to a 50 mg/ℓ free chlorine concentration, even if secured from a chlorinated municipal water supply. Because chlorine is not stable in a drilling fluid, more must be added periodically to maintain a 10 mg/ℓ free chlorine residual. The drill rods, bits, and tools should be chlorinated thoroughly to eliminate any bacteria remaining from the previous job. Filter-pack material should also be chlorinated before emplacement. This is usually done by adding dry calcium hypochlorite to the pack before it is placed in the well, or chlorinating the water if the pack is pumped into the well. Once the well is completed, it should be sealed immediately to prevent the introduction of airborne bacteria.

Chemical Methods to Control Iron Bacteria

If iron bacteria do grow in a well, they can be controlled by chemical treatments and various types of physical methods (Table 19.5). In general, chemical treatments are more effective and less expensive than physical methods. But for maximum effectiveness, any chemical treatment must be accompanied by physical agitation of the well. Jetting, air surging, air-lift pumping, and valved surge blocks are the principal methods used to agitate the well.

Many effective bactericides are strong oxidizing agents. As this term implies, these

Table 19.5. Methods to Control Iron Bacteria

Chemical	Physical
Oxidizing agents such as chlorine	Heat
pH adjustors such as acids	Vyredox™ technology
Quaternary ammonium compounds	Explosives
	Ultrasonics
	Radiation
	Anoxic blocks

chemicals can oxidize or literally "burn up" organic material. Oxidation is the most common method of killing bacteria, and dissolving and loosening the organic sludge they produce.

Chlorine

Chlorine, a strong oxidizing agent, is used widely to limit the growth of iron bacteria. Chlorine compounds offer significant advantages over other types of bactericides: they are inexpensive, readily available, effective, and generally accepted (actually required in many instances) by health officials as suitable for use in potable water supplies.

The correct chlorine concentration depends on the type of treatment being administered. As little as 50 mg/ℓ free available chlorine is used for routine disinfection of wells and piping following construction, repair, or pump installation, whereas concentrations as high as 500 to 2,000 mg/ℓ are usually desirable for treating wells severely plugged with iron bacteria. A solution strength of 500 mg/ℓ is by definition the strength obtained by dissolving 500 lb (227 kg) of chlorine gas in 1 million lb (454,000 kg) of water. On a smaller scale, this is equivalent to 0.5 lb (0.2 kg) of chlorine gas in 1,000 lb (454 kg) of water [120 gal (0.5 m^3)]. The term "shock chlorination" is reserved for chlorine solutions having a concentration of 1,000 mg/ℓ or more. Table 18.6 (page 621) shows the quantities of chlorine-containing materials necessary to achieve various chlorine solution strengths.

Chlorine gas is the most powerful of the chlorinating agents available commercially. Because it is a gas at normal temperatures and pressures, it must be stored in pressurized cylinders much the same way that propane or acetylene gas is stored. It is extremely corrosive and causes severe damage to human tissues immediately on contact. The use of chlorine gas has generally been restricted to high-capacity municipal and industrial wells because of the skill and equipment required to handle it safely.

During treatment, chlorine gas is usually conducted through a small-diameter plastic tube into the well, where it mixes readily with the water to form the chlorinating solution. A centering device should be used to keep the lower opening of the plastic tube centered in the well screen, because the chlorine gas is so corrosive that holes can form in well screens and casing in a short time, thereby causing sand pumping and ultimately well failure.

After the chlorine solution has been produced in the well, it should be forced through the screen-slot openings into the water-bearing formation by adding water to the well. Then, as with acid treatment, mechanical agitation should be used to enhance the effectiveness of the treatment. As the chlorine disintegrates the organic slime, the mechanical agitation helps dislodge it and move it from the formation into the well, where

it can be removed by pumping. Agitation also helps to move fresh chemicals into areas where they may have become expended.

Without some agitation, chlorine may not be effective when treating iron bacteria, because the iron bacteria form a thick, protective slime layer around the cells that is impregnated with oxides and hydroxides of iron and manganese. This layer restricts the movement of chlorine into the cell to the point where the cell may not be inhibited or killed by ordinary lethal doses. In addition, the cells are layered and thus a disinfectant has to penetrate through a series of slime layers, inhibiting and killing the cells as they become exposed. Subsequent disintegration of the dead slime leaves an exposed layer of living iron bacteria beneath which the infestation will continue to grow. Acid treatments are also effective in killing iron bacteria because they generally cannot live at a pH below 2. Figure 19.9 demonstrates that once iron bacteria establish a foothold in a well, they are extremely difficult to eliminate completely by treatment. In this case, the specific capacity of the well is halved in a little over two years.

Agitation can best be achieved by jetting chlorinated water into the formation, because jetting concentrates the greatest amount of energy over the smallest area. Other suitable methods of agitating the chlorine solution include surging by operating a surge plunger in the casing above the screen, or by capping the well and alternately injecting and releasing compressed air, thereby forcing the chlorine solution back and forth through the screen openings. If the pump remains in the well during treatment and there is no foot valve or check valve on the pump, good results may be obtained by pumping and backwashing (alternately starting and stopping the pump). The only requirement is that there not be a net removal of water from the well, because this would

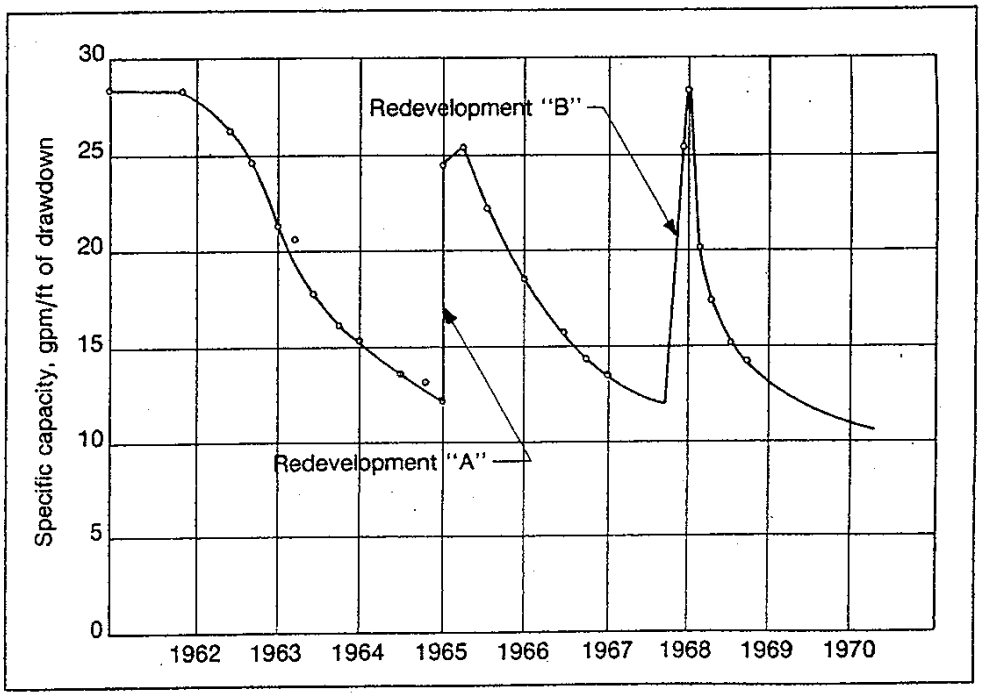


Figure 19.9. Performance record of a well in New Jersey shows declines in specific capacity caused by the growth of iron bacteria, and recovery of specific capacity produced by periodic treatment. Shock treatment with chlorine once a year would help maintain the yield at a satisfactory level. *(A. C. Schultes Company)*

result in removal and waste of the chlorine solution.

Hypochlorites

A relatively safe and convenient alternative to the use of chlorine gas in well treatment is the use of one of several hypochlorite products. In their commercial form, this family of chemicals eliminates some of the dangers inherent in handling chlorine gas and is easily applied to well treatment.

Calcium hypochlorite is a dry mixture containing about 65 percent available chlorine. It can be mixed with water at the surface and poured or piped into the well. Alternatively, the dry material may be poured into the well or suspended in a weighted mesh container, porous sack, or drive point. This latter method is an efficient way to place chlorine at the bottom of an artesian well. If large quantities of dry material are placed directly in the well, some provision should be made for stirring or agitating the water to help dissolve the chemical. Once the chemical has been placed in the well, rehabilitation procedures similar to those used with chlorine gas should be employed. In isolated instances, so much calcium hypochlorite may be introduced that once it combines with the naturally occurring calcium in the water, a precipitate of calcium hydroxide may form that plugs the pores of the formation. For this reason, rehabilitation procedures using calcium hypochlorite may fail to restore the original yield of the well.

Another hypochlorite chemical, sodium hypochlorite, is available in liquid form, typically in solutions of 5 to 15 percent sodium hypochlorite. Pure sodium hypochlorite is highly unstable, actually explosive, and thus cannot be handled safely unless it is dissolved. Even in liquid form, sodium hypochlorite is somewhat unstable and tends to deteriorate with time. During six months storage, a 10-percent solution of sodium hypochlorite loses 20 to 50 percent of its useful chlorine.

Sodium hypochlorite is frequently used in well treatment for routine disinfection of domestic-size wells because it is readily available in the form of household bleach. In addition, it has been used quite successfully to treat iron bacteria problems. The 5.25-percent solution in household bleach contains 5.25 percent available chlorine. Comparing this with calcium hypochlorite which contains 65 percent available chlorine, 1.7 gal (6.4 ℓ) of bleach solution must be used to provide the same disinfecting power as 1 lb (0.5 kg) of calcium hypochlorite.

Chlorine dioxide (ClO_2) is sometimes used for disinfecting drinking water supplies because it produces less trihalomethanes than chlorine except in high-pH waters (Lykins and Griese, 1982). Research has also shown that chlorine dioxide may have stronger oxidative properties than chlorine but its use produces no undesirable organic by-products other than those produced by the use of chlorine. Chlorine dioxide can be used to treat wells or prevent the premature breakdown of drilling fluid made with polymeric additives. In the gaseous form, chlorine dioxide is extremely unstable, and a 10-percent concentration of gas in air is explosive and easily detonated by sunlight. However, in liquid concentrations of 2 to 4 percent, it is relatively stable and can be added to the mix water. The major drawbacks of chlorine dioxide are its relatively high cost and its short lifetime in water (10 minutes).

Table 19.6 contains a list of many of the common chlorinating agents and indicates the amount of each chemical required to provide the same amount of available free chlorine as 1 lb (0.5 kg) of chlorine gas.

Table 19.6. Quantities of Various Chlorine Compounds Required to Provide as Much Available Chlorine as 1 lb of Chlorine Gas

Chemical	% Available Chlorine	Number of lb Equivalent to 1 lb Cl_2
Chlorine Gas	100	1.0
Calcium Hypochlorite	65	1.54
Lithium Hypochlorite	36	2.78
Sodium Hypochlorite	12.5	8.0
Sodium Hypochlorite	5.25	19.05
Trichloroisocyanuric Acid*	90	1.11
Sodium Dichloroisocyanurate*	63	1.59
Potassium Dichloroisocyanurate*	60	1.67
Chlorine Dioxide	4	25.0
Chlorine Dioxide	2	50.0

*Chlorine compounds that incorporate isocyanuric acid stabilize the chlorine against degradation from sunlight. Except for storage, the advantage offered by the addition of isocyanuric acid is less valuable in water wells.

Potassium permanganate, like chlorine gas, is a strong oxidizing agent that is an excellent bactericide. It has been used successfully to control the growth of iron bacteria in wells. Potassium permanganate is available as a dry, purplish-colored crystal that is both inexpensive and relatively safe to use.

In treating wells infected with iron bacteria, dry potassium permanganate is dissolved in enough water to fill the well screen; the solution is then piped into the screen. A solution strength of 1,000 to 2,000 mg/ℓ has been found to achieve excellent results [1,000 mg/ℓ is equal to 0.83 lb (0.38 kg) in 100 gal (0.4 m^3) of water]. Once the chemical has been placed in the well, vigorous mechanical agitation by surging or jetting should be utilized during treatment to promote loosening and disintegration of the organic plugging material and enhance the overall effectiveness of the procedure.

In treating iron bacteria problems, it must be remembered that the clogging of the well screen and aquifer is caused not only by the organic material produced by the bacteria, but also by the oxides and hydroxides of iron and manganese generally associated with these organisms. In addition, it is usually a matrix of these materials in combination with other mineral scales such as calcium carbonate that causes the problem. Because of the presence of inorganic chemicals, better results are nearly always obtained by treating the well alternately with a bactericide to attack the organic material and a strong acid to dissolve the iron deposits and mineral scale. Between each treatment, the well is pumped to waste. The chlorine and acid must never be in the well at the same time.

Longer time intervals between treatments have been achieved by using a three-step treatment consisting of initial shock chlorination followed by acidizing and then a final shock chlorination of the entire water distribution system. Occasionally, acid is applied first to reduce the thickness of the sheath so that the chlorine is more effective in destroying the tubercles. The added cost of applying three separate treatments is almost always offset by the improved results. A more detailed description of the recommended chlorine-acid treatment process is given at the end of this section.

Physical Methods to Control Iron Bacteria

Pasteurization is a physical method that has been developed to control the growth of iron bacteria. Pasteurization treatments have been shown to be quite effective in maintaining well yield in Saskatchewan in spite of iron concentrations of 1 to 8 mg/ℓ in the well water (Cullimore, 1981). In this treament method, hot water [176°F (80°C)] is circulated continuously in the well until the return water reaches the same temperature. The water is kept at approximately 176°F until temperatures from 113 to 129°F (45 to 54°C) have been reached throughout the layer of iron bacteria. At 113°F the bacterial plugging is dispersed, and at 129°F the bacteria are killed. Tests after pasteurization show a significant drop in the iron bacteria concentration, although bacteria that exist in the formation can quickly reinfest the well.

The cost of treating small-diameter wells by pasteurization is relatively low, because the equipment and procedures are rather simple. However, generating the necessary heat for treating large-diameter wells requires expensive equipment that may make the pasteurization process infeasible economically. Furthermore, depending on the ambient temperatures of the groundwater, the amount of down time required to perform the process may not be tolerable.

Vyredox™ techniques are sometimes used to control the iron content of water and therefore the growth of iron bacteria (see Chapter 23 for a discussion of this technology). By increasing the redox potential of the groundwater around the production well, iron and manganese will precipitate in the aquifer. If the iron concentration can be reduced in the production well to about 0.1 mg/ℓ, iron bacteria probably cannot survive.

The use of explosives and ultrasonic technology to kill iron bacteria have not been effective. Apparently the slime layers can easily absorb the explosive energy or the sound waves with little damage to the bacteria. Although radiation techniques may prove successful in the future in killing bacteria, the use of this technology in wells may not be acceptable to health departments. The effectiveness of creating anoxic blocks in wells to produce anaerobic conditions and thereby kill aerobic iron bacteria has not been ascertained.

Recommended Procedure for Controlling Iron Bacteria

The procedure given below will control the growth of iron bacteria in a large production well. Less complex treatments consisting of only chlorine applications are suitable for most small-diameter wells. It should be noted that virtually no combination of procedures is effective enough to kill all the bacteria in the well. Normally any procedures used will only control the growth of the iron bacteria.

The recommended chlorine-acid procedure is as follows:

1. Inject a mixture of acid, inhibitor, and wetting agent. The addition of a chelating agent such as hydroxyacetic acid may sometimes be beneficial.
2. Agitate the solution with a jetting tool.
3. Pump to waste a volume of solution equal to the volume of the well bore.
4. Determine the pH of the waste. If it is more than 3, repeat steps 1 to 3. (A pH of 3 or less assures that dissolved iron will stay in solution.)
5. Inject a mixture of chlorine and one or more chlorine-stable surfactants (detergents and wetting agents, for example). The concentration of the chlorine should exceed 1 percent.

6. Agitate the solution with a jetting tool.
7. Pump to waste a volume of solution equal to the volume of the well bore.
8. Determine chlorine concentration. If the value is less than 10 percent of the original concentration, repeat steps 5 to 7.
9. Determine the specific capacity of the well. If the specific capacity has improved by more than 5 percent, repeat the entire procedure until the specific capacity does not improve by 5 percent.

WELL FAILURE CAUSED BY PHYSICAL PLUGGING OF SCREEN AND SURROUNDING FORMATION

Over time, almost all screened wells will undergo some loss in specific capacity. Some of this loss is attributable to the slow movement of fine formation particles into the area around the screen. Depending on the type of screen-slot opening, many of these particles may partially plug the screen itself, or even erode the slot openings under certain conditions. Thus, the invasion of small particles reduces the yield, increases the drawdown, and may damage the screen.

Fine-particle movement results from:

1. Improper well design
   a. Poorly designed filter pack
   b. Improper screen placement
   c. Poor slot selection
   d. Inaccurate aquifer sampling techniques
2. Insufficient or improper development when the well was placed in service.
3. Removal of cement holding the sand grains together around the well screen.
4. Corrosion of the screen or casing.
5. Increase in the pumping rate beyond the designed capacity (actually over pumping).
6. Excessive pump cycling.

If the well screen becomes plugged with sediment or incrustants, the entrance velocity of the water passing through the remaining openings increases significantly. As a result, fine sediment is entrained that continually erodes the slot openings. As the slots enlarge, more sediment will pass into the screen. Just how much sand must enter a well to cause failure depends in part on the type of well. Experience indicates that up to 1 mg/ℓ is acceptable in a system with many valves and small orifices, such as a drip-irrigation system. Most industrial and municipal systems can tolerate 2 to 4 mg/ℓ, and some irrigation systems can handle as much as 20 mg/ℓ. At 20 mg/ℓ, a well pumping 700 gpm (3,820 m^3/day) will yield 168 lb (76.2 kg) of sand per day. Over a period of several weeks or months, many tons of sand pass through the pump. To prevent pump damage, the screen may have to be replaced.

Prevention and Treatment of Physical Plugging

Movement of sediment into the formation around the screen can be largely prevented by thorough development of the well during its completion. As suggested in Chapter 15, certain development methods are more suitable for specific types of aquifers. Application of an appropriate development technique for a sufficient length of time will stabilize the formation materials so that subsequent pump cycling and higher discharge rates will not result in sediment movement.

Not all fine-particle problems result from natural formation materials. Occasionally some clay additives used in the drilling fluids may remain in the formation after development. Thus, over time small amounts of these clay residuals enter the well along with other fine material. To completely remove the clay, a chemical treatment may be necessary in the development process.

Polyphosphates and Surfactants

Silt and clay particles tend to adhere strongly to one another in a viscous state, which makes their removal from sand and gravel aquifers quite difficult. Wells that are plugged with silt and clay particles are most effectively restored to efficient conditions by treatment with dispersing and sequestering (chelating) compounds that belong to the polyphosphate family of chemicals. They have the power to separate clay particles. Dispersing agents cause the particles to repel one another, increasing their mobility sufficiently to allow them to move when water is pumped into and out of the well during the development process. Furthermore, the calcium, magnesium, and iron ions adhering to the fine particles can be sequestered (caused to remain in a soluble state) by the use of polyphosphates. Therefore, particles bonded together by these ions can be removed more easily from the aquifer.

Sodium polyphosphates, a family of white, free-flowing dry materials, have been used widely with great success in treating clay-plugging problems. There are two types of sodium polyphosphates, crystalline and glassy. Crystalline polyphosphates that help remove clays from the aquifer are sodium acid pyrophosphate (SAPP), tetrasodium pyrophosphate (TSPP), and sodium tripolyphosphate (STP). Sodium hexametaphosphate (SHMP) is a glassy phosphate that is readily available and therefore often used in rehabilitating wells. Commercial tradenames for sodium hexametaphosphate include Calgon™, Quadrafos™, and Polyphos™. Weltone™ is sodium hexametaphosphate mixed with a chlorinating chemical and wetting agent.

For treating wells, about 15 lb (6.8 kg) of dry polyphosphate should be mixed with 100 gal (0.4 m^3) of water. It is best to mix the material at the surface in warm water in a small container; then dilute with a larger volume of cooler water, chlorinate to 125 mg/ℓ, and put the prepared solution into the well with a tremie pipe, particularly when using the glassy phosphates. If a slug of dry glassy phosphate material is just dumped into the well, it will sink to the bottom and form a large gelatinous mass that could remain undissolved in the well for some time. This mass may plug a significant part of the formation and be extremely difficult to remove. A small amount of hypochlorite should always be used with phosphates because polyphosphates act as a food source for bacteria. This chlorinates the well and kills any bacteria that may be present. About 1.6 lb (0.7 kg) of calcium hypochlorite should be used for each 1,000 gal (3.8 m^3) of water in the well.

Most surfactants are long-chain organic molecules derived from petroleum products. These agents consist of particles that are attracted to oil at one end of the particle and water at the other. Oil can be pulled into a water solution by these particles and removed easily from the porous medium. The presence of a small amount of surfactant speeds penetration of the cleaning chemical by modifying the surface tension of the materials to be cleaned.

The wetting and soil-dispersing properties of surfactants make them ideally suited for use in well cleaning. Those used for wells should be low foaming or used with a

defoaming agent to minimize sudsing. Preferably, they should be of the nonionic type — that is, surfactants that do not form ions when dissolved in water. Ionizing surfactants (anionic and cationic types) often react with other chemicals used in the rehabilitation process to form insoluble preciptates that have no cleaning value.

Surfactants are inexpensive to use because only relatively low concentrations of 250 to 500 mg/ℓ are required. They can enhance the dispersing efficiency of the polyphosphates in the removal of silt and clay. Likewise, acidizing is more effective when a surfactant is used with the acid. This is because the surfactant enables the acid solution to soak into all of the pores and cracks of the incrusting deposit, increasing the total contact area between acid and incrustation and thereby speeding the rate of removal of incrustation.

Physical Agitation

Agitation of the phosphate or surfactant solution is important in removing the maximum amount of fine material from the formation. Agitation of the chemical solution during rehabilitation can be done by using a surge plunger, compressed air, well pump, or high-velocity jet. One of the most efficient methods of redeveloping wells with polyphosphates is high-velocity jetting, where the appropriate polyphosphate solution is used as the jetting fluid. If high-velocity jetting is not used, the polyphosphate solution should be placed in the well, forced into the formation adjacent to the screen, and agitated by one of the development techniques described in Chapter 15. Applying these methods in well treatment, however, requires some minor changes in the details of operation. For example, when compressed air is used for surging the chemical solution, the solution must not be discharged from the well before disaggregation of the particles has occurred.

When agitating with a high-velocity jet, it may be desirable to pump the well periodically at a low rate. In operation, jetting adds water to the well at the rate of 25 to 200 gpm (136 to 1,090 m^3/day), depending on the size of the jetting nozzles and the pump pressure. The water pumped from the well can be recirculated to continue the jetting operation. Movement of water through the screen openings into the well carries with it some of the sediment loosened by the jetting process. Thus, material should be settled out in a tank or pit before being recirculated to avoid damaging the screen, pump, or jetting nozzles. Continuous removal of loosened material from the formation will greatly improve the effectiveness of the polyphosphate treatment by allowing the phosphate to reach untreated parts of the formation more quickly. Even though chlorine is used in the phosphate solution, it is good practice to disinfect the well following the polyphosphate treatment to make sure that the well is left in a sanitary condition.

IMPORTANCE OF SCREEN DESIGN ON REHABILITATION

When rehabilitating a well screen, its design will influence considerably the results that can be obtained from various types of chemical treatment and mechanical agitation, particularly horizontal jetting. The force of the jet must be directed through the screen openings. Screens with high open area and uniformly arranged, closely spaced slots that allow direct access to the formation assure the maximum agitation effect from the jetting process. For example, pipe-base and mill-slotted screens offer insufficient open area through the perforations in the pipe. Louver and bridge-slot

screens present an almost solid vertical metal surface to the horizontal jet. Continuous-slot screens, on the other hand, have maximum open area and slot configurations that maximize the impact of flow from the jetting tool.

The shape of the screen openings is also important in influencing the effectiveness of the agitation created by the jet. In other words, certain slot configurations will allow the jetting energy to reach deeper into the formation. The best type of opening is a V-shaped slot that widens toward the inside of the screen. When the jet is projected through this V-shaped opening as shown in Figure 15.18 (page 519), the slot opening concentrates the effect of the stream like a second nozzle or venturi. Other slot configurations tend to block or disperse the stream and reduce its force before it reaches the incrusted formation beyond the outer face of the screen.

WELL FAILURE FROM CORROSION

Metals are generally not found in nature in forms that can be used directly by man. They usually exist as ores, that is, stable mineral compounds that are in physical and chemical harmony with the natural environment. These natural minerals must be processed by electrochemical methods to reduce the ores to elemental metals that are suitable for pumps, casing, and well screens. Thus, the chemical and physical properties of ores differ from those of the pure metals. Unfortunately, in the elemental state most metals are not inherently stable. In the environment, elemental metals naturally revert back into more stable mineral compounds. This reaction, called corrosion, is a completely natural process that changes the chemical and physical properties of metals, frequently destroys the usefulness of fabricated metallic articles or structures, and may, over time, reduce or destroy metal products. Corrosion, then, is really the natural reversion of metal to its former state.

Corrosion can severely limit the useful life of water wells in four ways:

1. Enlargement of screen slots or development of holes in the casing, followed by sand pumping.
2. Reduction in strength, followed by failure of well screen or casing.
3. Deposition of corrosion products, thereby blocking screen-slot openings and reducing yield.
4. Inflow of low-quality water caused by corrosion of the casing.

Chemical and Electrochemical Corrosion

Corrosion results from chemical and electrochemical processes. Chemical corrosion occurs when a particular constituent is present in water in sufficient concentration to cause rapid removal of material over broad areas. Commonly, these constituents are carbon dioxide (CO_2), oxygen (O_2), hydrogen sulfide (H_2S), hydrochloric acid (HCl), chloride (Cl), and sulfuric acid (H_2SO_4). Chemical corrosion can cause severe damage in wells, regardless of the amount of total dissolved solids. The number of wells affected by chemical corrosion is small, however, in comparison to wells affected by electrochemical corrosion.

In electrochemical corrosion, flow of an electric current facilitates the corrosive attack on a metal. Two conditions are necessary: a difference in electrical potential on metal surfaces, and water containing enough dissolved solids to be a conductive fluid (electrolyte). A potential (electrical) difference may develop between two different kinds of metals, or between nearby but separate

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Exhibit II

Supplemental Letter dated March 17, 2004

URS

March 17, 2004

Mr. Nnamdi Madakor
Department of Ecology
3190 160th Avenue SE
Bellevue, WA 98008-5452

Response to Ecology
Cleanup Action & Performance Monitoring
Former Magic Cleaners
Lake Forest Park, WA
TCP ID #NW0081
URS Job No. 33756663

Dear Mr. Madakor:

Thank you for your comments on URS' Voluntary Cleanup Action & Performance Monitoring Report (URS, 2003) for the Former Magic Cleaners site presented in your January 29, 2004 letter to Tanya Barnett, of Brown Reavis & Manning. This letter is provided to address your questions and comments outlined in your January 29th letter which is provided in Attachment 1. To facilitate your review, we have provided your question/comment followed by our response below.

Ecology Question/Comment 1. – *What are the physical condition of the groundwater monitoring wells MW-1 and MW-5 and what is the groundwater quality condition at these general locations?*

URS Response – Monitoring wells MW-1 and MW-5 are still in good condition and the historic groundwater quality data for these locations is provided in Table 1. These two wells were not selected for long term monitoring based their locations (e.g., MW-1 upgradient from former source area and MW-5 cross gradient from volatile organic compound (VOC) plume).

Ecology Question/Comment 2. – *According to the report, and as shown on Figure 2, it appears that the Tetrachloroethylene (PCE) plume is trapped inland between MW-3 and MW-6 and it is assumes that MW-5 mentioned above is not impacted. Hence, the Density Driven Convention (DDC) remedial technology appears to have successfully contained and prevented the PCE plume from further migration into the Lyons Creek. Now that the plume appears to be contained in place by the use of the DCC, what is your long term plan for this plume? If your long term plan is to maintain the status quo via containment by the use of the DDC, then your request to stop monitoring MW-2 and MW-4 is premature at this time regardless of the clean groundwater quality conditions at these sentry wells (MW-2 and MW-4). Had these sentry wells been impacted it would mean that the containment objective of the DDC had failed and you will be required to install additional sentry wells in front of the plume. In a containment cleanup strategy, on-going groundwater quality monitoring of sentry wells are imperative to ensure the continued effectiveness of the*

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containment cleanup actions for the live of the containment activity. You may propose a reduced frequency of the groundwater quality monitoring for the sentry monitoring wells MW-2, MW-4 (and MW-5?)

URS Response – The long-term plan for the two Density Driven Convection (DDC) remedial systems is to continue operations as described in our April 17, 2003 performance monitoring program as amended by this letter. While URS does not see the need to expand the number of wells beyond what we proposed in April 2003, we have been directed by our client to add wells MW-2, MW-4 and MW-5 to the performance monitoring program to address Ecology's above concern.

Ecology Question/Comment 3. – *Alternatively, this may be an appropriate time for the potentially liable party (PLP) to re-evaluate the long term cleanup strategy for the PCE plume that appears to be contained through the use of the DDC in order to reduce or better manage the long term costs associated with containment cleanup strategies.*

URS Response – As, stated above, the present cleanup strategy will continue to include the operation of the two DDC remediation systems. The low concentrations of VOCs detected during the sampling of the DDC well piezometers indicated that the system is successfully reducing contaminant levels.

Ecology Question/Comment 4. – *Your request to monitor the impacted wells, MW-3 and MW-6 as presented in the report (without knowing the groundwater quality conditions at MW-5), on a biannual basis, once during the high water table of the winter and another during the low water table of the summer is hereby approved. Under this biannual frequency of sampling, an unconditional no further action (NFA) for the groundwater quality for PCE and its daughter products will be met if the sampling results are below the state standards for two consecutive years. If you were sampling on a quarterly basis, an unconditional NFA for groundwater will be met if four quarterly consecutive sampling results are below the state standards (1 year).*

URS Response – Since submitting the April 17, 2003 report URS has sampled the monitoring wells in June 2003 and December 2004. The URS field technician accidentally sampled well MW-4 instead of MW-3 during the summer (June 2003) sampling event. The winter monitoring event (December 2003 and February 2004) included monitoring wells MW-3, MW-4, MW-5 and W-6. Future bi-annual monitoring will be performed at wells MW-2, MW-3, MW-4, MW-5 and MW-6 (Figure 1).

The results of our recent summer and winter groundwater monitoring events are summarized in Table 2. PCE concentrations in central portion of the plume have steadily declined as demonstrated at monitoring well MW-6 (Figure 2). The common degradation products of PCE, trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride (VC) were detected in the samples indicating that biodegradation of the VOCs also continues to occur. Levels of PCE further downgradient from the former source area in the Rite Aid (Figure 1) have been stable to slightly declining as indicated at MW-3. TCE and DCE have also been detected in this well, however, VC has not been detected since November of 2000. VOCs have not been

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detected in either MW-4 or MW-5, which is consistent with the previous sampling results. Based on the biannual monitoring conducted to date, URS recommends continued implementation of the program proposed in our April 17, 2003 report as amended by this letter.

We trust that this information meets your requirements. Please do not hesitate to contact us if you have any questions or require any additional information.

Very truly yours,

URS Corporation

David R. Raubvogel
Senior Geologist

Copy: Ms. Rebecca Coles
Ms. Tanya Barnett; Brown Reavis and Manning

Attachments:
Figures 1 and 2
Tables 1 and 2
Attachment 1 – Ecology January 29, 2004 Letter

URS

Table 1
Summary of Historic Groundwater Analytical Results
Former Magic Cleaners

Monitoring Well	Sample Date	Volatile Organic Compounds[1] (µg/L)			
		PCE	TCE	cis1,2-DCE	Vinyl Chloride
MW-1	01/30/97	ND	ND	ND	ND
	05/30/97	ND	ND	ND	ND
	09/12/97	ND	ND	ND	ND
	12/10/97	ND	ND	ND	ND
MW-2	01/30/97	ND	ND	ND	ND
	05/30/97	ND	ND	ND	ND
	09/12/97	ND	ND	ND	ND
	12/10/97	ND	ND	ND	ND
	01/28/99[2]	ND	ND	ND	ND
	03/8/99[3]	ND	ND	ND	ND
	06/10/99	ND	ND	ND	ND
	04/21/00	ND	ND	ND	ND
	11/30/00	ND	ND	ND	ND
	01/03/03	ND	ND	ND	ND
MW-5	01/30/97	ND	ND	ND	ND
	05/30/97	ND	ND	ND	ND
	09/12/97	ND	ND	ND	ND
	12/10/97	ND	ND	ND	ND
	02/13/04	ND	ND	ND	ND
MTCA Method A or B Groundwater Cleanup Level		5 (A)	5 (A)	80 (B)	0.2 (A)

Notes:
MTCA - Model Toxics Control Act
Method A and B values are reported with the same concentration units as the sample results.
Numbers in **bold** font indicate that the reporting limit exceeds the MTCA cleanup level.
NA- Not available (not sampled)
ND - Not detected above the reporting limit.
[1] Analyses performed by using EPA Method 8010B (1997, 1998) and EPA Method 8260B. All other VOCs not listed were not detected.
DDC remedial system startup 10-14-01

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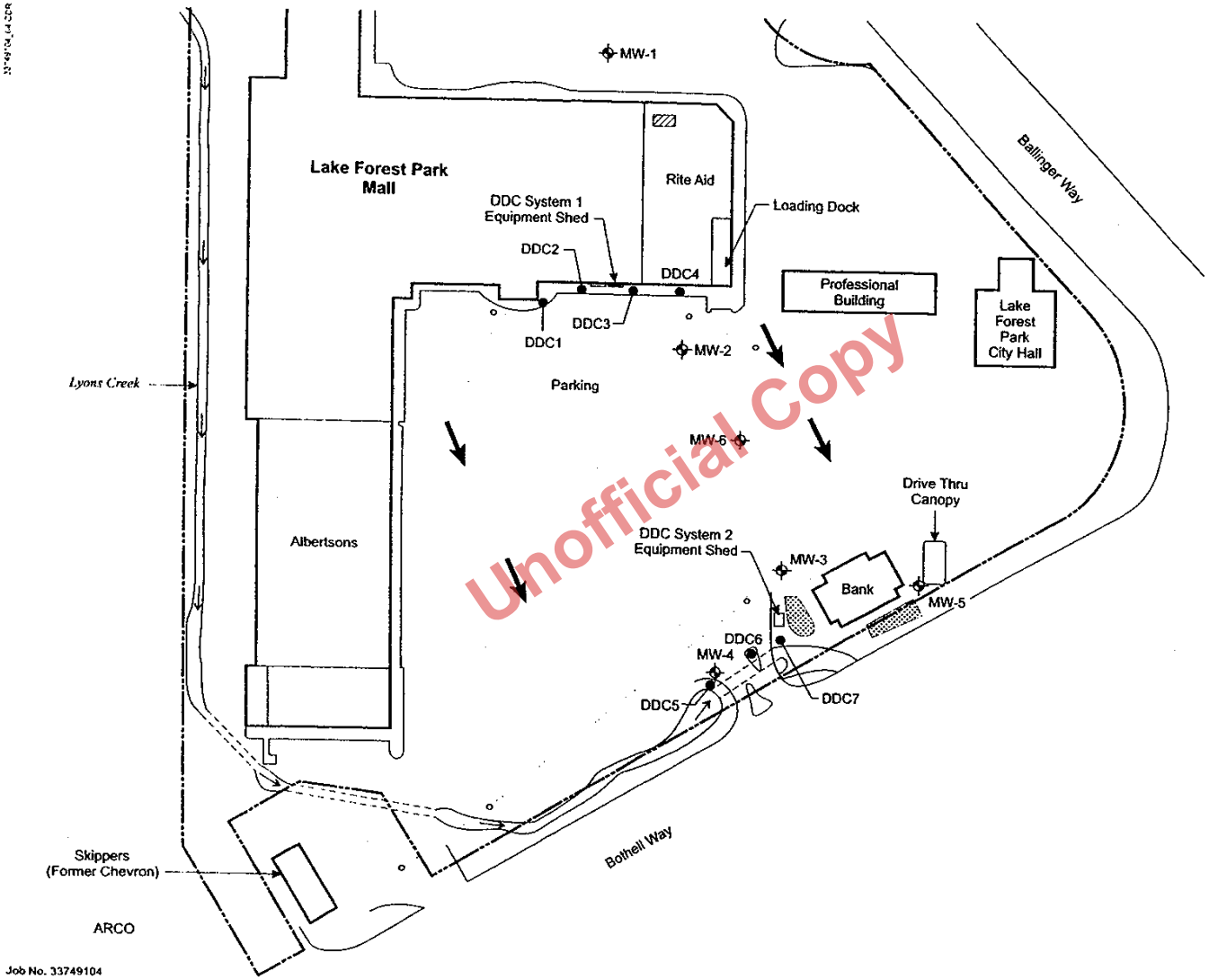
Table 2
Summary of Compliance Monitoring Groundwater Analytical Results
Former Magic Cleaners

Monitoring Well	Sample Date	Volatile Organic Compounds[1] (µg/L)			
		PCE	TCE	cis1,2-DCE	Vinyl Chloride
MW-3	01/30/97	**27.90**	2.42	3.54	ND
	05/30/97	**37.30**	3.41	2.68	ND
	09/12/97	**18.70**	3.72	3.28	ND
	12/10/97	**33.60**	2.97	2.85	ND
	09/22/98	**11.00**	3.20	2.80	ND
	01/28/99[2]	**32.00**	3.17	2.87	ND
	3/8/99[3]	**24.10**	2.65	2.53	**0.437**
	06/10/99	**23.7**	3.72	2.68	ND
	04/24/00	**26.6**	2.35	1.84	0.169
	11/30/00	**18.7**	2.49	2.36	**0.228**
	01/23/02	**23.5**	4.16	2.49	ND
	05/03/02	**24.5**	4.32	2.22	ND
	09/20/02	4.45	3.90	4.58	ND
	01/03/03	**22.3**	3.60	1.72	ND
	02/05/04	**26.5**	3.14	1.65	ND
MW-4	04/21/00	ND	ND	ND	ND
	11/30/00	ND	ND	ND	ND
	01/23/02	ND	ND	ND	ND
	05/03/02	ND	ND	ND	ND
	09/20/02	ND	ND	ND	ND
	01/03/03	ND	ND	ND	ND
	06/11/03	ND	ND	ND	ND
	12/31/03	ND	ND	ND	ND
MW-5	02/13/04	ND	ND	ND	ND
MW-6	01/28/99[2]	**49.50**	4.48	3.67	ND
	3/8/99[3]	**52.70**	3.83	3.30	ND
	06/10/99	**43.70**	**5.53**	4.65	**0.212**
	04/21/00	**47.30**	**6.11**	4.94	ND
	11/30/00	**19.20**	**5.80**	7.99	**0.998**
	01/23/02	**17.20**	3.61	3.74	**0.597**
	05/03/02	**21.00**	4.84	4.77	ND
	09/20/02	**23.9**	4.47	4.99	**0.576**
	01/03/03	**11.8**	2.82	3.57	ND
	06/11/03	**12.5**	3.17	3.21	**0.48**
	12/31/03	**9.34**	3.41	4.07	**0.80**
MTCA Method A or B Groundwater Cleanup Level		5 (A)	5 (A)	80 (B)	0.2 (A)

Notes:
MTCA - Model Toxics Control Act
Method A and B values are reported with the same concentration units as the sample results.
Numbers in **bold** font indicate that the reporting limit exceeds the MTCA cleanup level.
NA- Not available (not sampled)
ND - Not detected above the reporting limit.
[1] Analyses performed by using EPA Method 8010B (1997, 1998) and EPA Method 8260B. All other VOCs not listed were not detected.
[2] Sample collected following periodic groundwater extraction from monitoring wells MW-3 and MW-6 from 12-30-98 to 01-12-99.
[3] Sample collected following periodic groundwater extraction from monitoring wells MW-3 & MW-6 from 02-23-99 to 03-04-99.
[4] Surface water sample collected from Lyons Creek.
DDC remedial system startup 10-14-01



Job No. 33749104

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Figure 1

Site Plan and DDC Remedial System Layout

Former Magic Cleaners
Lake Forest Park, Washington

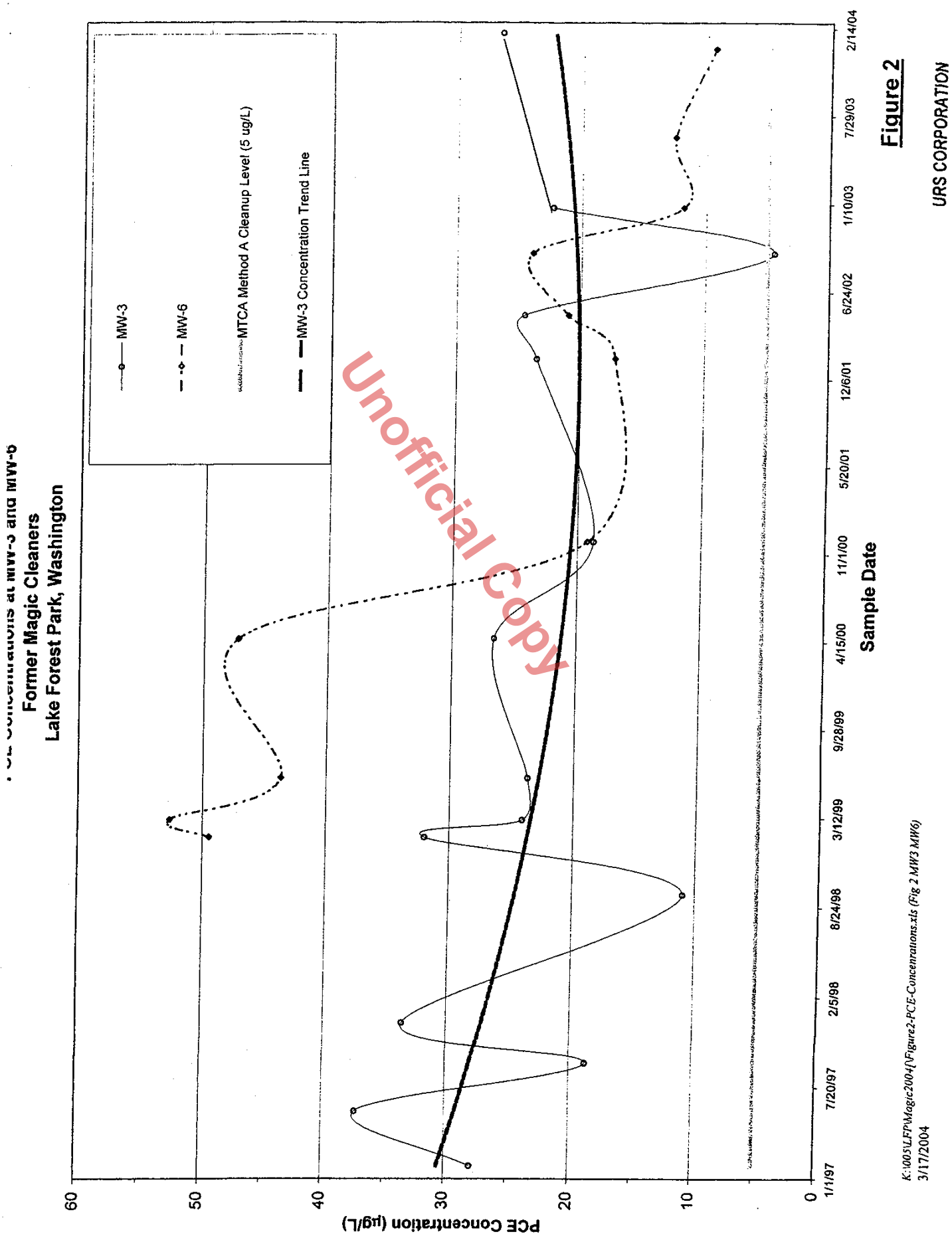

Figure 2

URS CORPORATION

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. Box 47600 • Olympia, Washington 98504-7600
(360) 407-6000 • TDD Only (Hearing Impaired) (360) 407-6006

January 29, 2004

Tanya Barnett, Attorney
Brown Reavis & Manning
421 South Capitol Way, Suite 303
Olympia, WA 98501

Dear Ms. Barnett:

Re: Voluntary Cleanup Program, Cleanup Actions & Performance Monitoring, Former Magic Cleaners, Lake Forest Park, WA, 98155. TCP I.D. #NW0081.

Thank you for submitting your Voluntary Cleanup Actions & Performance Monitoring Report of April 17, 2003 and request for Washington State Department of Ecology's (Ecology) review and advice. Ecology appreciates your initiative in pursuing a voluntary cleanup under the Model Toxics Control Act (MTCA).

Ecology's Toxics Cleanup Program has reviewed the following information regarding the Former Magic Cleaners, located at Lake Forest Park, WA, 98155:

1. Voluntary Cleanup Actions & Performance Monitoring Report of April 17, 2003. Former Magic Cleaners, by URS of 4/17/03 Project No. 33755952.

Based upon the information listed above, Ecology has determined that, at this time:

1. What are the physical conditions of the groundwater monitoring wells MW-1 and MW-5 and what is the groundwater quality condition at these general locations?

2. According to the report, and as shown on Figure 2, it appears that the Tetrachloroethylene (PCE) plume is trapped inland between MW-3 and MW-6 and it is assumes that MW-5 mentioned above is not impacted. Hence, the Density Driven Convention (DDC) remedial technology appears to have successfully contained and prevented the PCE plume from further migration into the Lyons Creek. Now that the plume appears to be contained in place by the use the DDC, what is your long term

plan for this plume? If your long term plan is to maintain the status quo via containment by the use of the DDC, then your request to stop monitoring MW2 and MW-4 is premature at this time regardless of the clean groundwater quality conditions at these sentry wells (MW2 and MW-4). Had these sentry wells been impacted it would mean that the containment objective of the DDC had failed and you will be required to install additional sentry wells in front of the plume. In a containment cleanup strategy, on-going groundwater quality monitoring of sentry wells are imperative to ensure the continued effectiveness of the containment cleanup actions for the live of the containment activity. You may propose a reduced frequency of the groundwater quality monitoring for the sentry monitoring wells MW-2, MW-4 (and MW-5?).

3. Alternatively, this may be an appropriate time for the potentially liable party (PLP) to re-evaluate the long term cleanup strategy for the PCE plume that appears to be contained through the use of the DDC in order to reduce or better manage the long term costs associated with containment cleanup strategies.

4. Your request to monitor the impacted wells, MW-3 and MW-6 as presented in the report (without knowing the groundwater quality conditions at MW-5), on a biannual basis, once during the high water table of the winter and another during the low water table of the summer is hereby approved. Under this biannual frequency of sampling, an unconditional no further action (NFA) for the groundwater quality for PCE and its daughter products will be met if the sampling results are below the state standards for two consecutive years. If you were sampling on a quarterly basis, an unconditional NFA for groundwater will be met if four quarterly consecutive sampling results are below the state standards (1 year).

Please note that because your actions were not, or will not be conducted under a consent decree with Ecology, this letter is not a settlement by the state under RCW 70.105D.040(4) and is not binding on the agency. Further action could be required at your site regardless of how strictly you follow Ecology's advice.

The opinions presented by Ecology in this letter are made only with respect to the information provided in the report and document(s) listed above. This opinion is only applicable to the specified site (or area of site) and may not be used to justify action at another site (or area of the site).

Ecology does not assume any liability for any release, threatened release or other conditions at the site, or for any actions taken or omitted by any person or his\her agents or employees with regard to the release, threatened release, or other conditions at the site.

Again, thank you for taking the initiative to voluntarily address the contamination at your site. Your efforts are recognized by Ecology as a positive step in our work to protect human health and the environment in Washington State.

If you have any questions regarding this letter, please contact me at (360) 407-7244.

Sincerely,

Nnamdi Madakor, P.G., P.HG
Senior Hydrogeologist IV
Toxics Cleanup Program, HQ

NM: lt

cc: Ty Peterson, A.I.C.P, City of Lake Forest Park.

State of Washington
Hydrogeologist
293
Licensed Geologist
NNAMDI I. MADAKOR

Exhibit III

Subslab Ventilation System O&M Manual

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Sub-Slab Ventilation System
Operation and Maintenance Manual

Rite Aid Store #5225
Lake Forest Park Towne Center
17171 Bothell Way Northeast
Lake Forest Park, Washington

Prepared by:

URS Corporation
1501 4th Avenue, Suite 1400
Seattle, WA 98101
206-438-2700

Prepared for:
Seattle LFP Associates, LP.

February 2006

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Attachments:
Attachment A – H2 Oil Recovery Equipment Manual and Documentation
Attachment B – Mechanical Permit
Attachment C – Performance Monitoring Plan

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1.0 INTRODUCTION

This document is the Operation and Maintenance (O&M) Manual for the sub-slab ventilation system (SSVS) installed at the former Magic Cleaners site within Rite Aid Store #5225 located at 17171 Bothell Way Northeast in Lake Forest Park, Washington (subject property)(SSVS As-Built Report Figure 1 and Figure 2). This document provides information on the operation and maintenance of the system. The SSVS consists of: two horizontal extraction laterals (located in a south trench and a north trench), an extraction blower, a knock out tank (KOT) with high level shutdown switch, and two vapor phase granular activated carbon vessels. The major sections of this manual include:

- Section 2.0: Description of Equipment- This section provides a summary of the SSVS system and major components associated with the system.
- Section 3.0: System Operation- This section provides a summary of the system permit conditions and start-up, operation, and shutdown procedures.
- Section 4.0: Maintenance- This section provides detailed description of the periodic maintenance and carbon vessel monitoring/replacement.
- Section 5.0: Troubleshooting and Repair- This section provides a guide to assist in troubleshooting and repairs associated with the SSVS equipment.

The attachments in this manual provide vendor equipment manuals, permits, and the Performance Monitoring Plan.

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2.0 DESCRIPTION OF FACILITIES

The SSVS (SSVS As-Built Report Figures 3 and 4) consists of the following main components:

- Extraction trenches containing perforated piping (South Trench and North Trench)
- Aboveground piping
- SSVS equipment, including:
    - Extraction Blower (1 hp Rotron 404 – in soundproof enclosure)
    - Moisture Knock-Out Tank (KOT)
    - Vapor Phase 55-gallon Carbon Vessels (2)
    - Associated Valving and Instrumentation

The site layout is shown on Figure 2. Trench sections and plans are shown on Figure 3. An equipment plan and a process and instrumentation diagram (P&ID) is shown on Figure 4. A site plan showing the trench layout and equipment location within the tenant space currently occupied by Rite Aid is shown on Figure 5. An electrical one-line diagram for the site is included along with a detailed description of the above equipment in H2 Oil Recovery Equipment's documentation provided in Attachment A.

2.1 Extraction Trenches

Two extraction trenches (South Trench and North Trench) containing perforated high-density polyethylene (HDPE) piping are utilized at the site as part of the SSVS. Figure 5 shows the location of the trenches, while Figure 3 shows the trench construction details. Extraction piping is located with each trench as shown on Figure 3. A flush-mount access vault is located at the west end of each extraction trench, and each contains a dilution valve, air filter, and vacuum gauge.

2.2 Aboveground Piping

Extracted vapors are transferred to the SSVS equipment via aboveground piping. Figure 5 shows the routes of the aboveground piping at the site. The aboveground piping is sloped both toward the SSVS equipment location and toward a sump located at the base of the exhaust stack to assist in the movement of water toward two collection locations: the moisture KOT at the equipment location, and the sump at the base of the exhaust stack. Both locations should be checked monthly for accumulation of water, and water should be removed as necessary. Aboveground piping is constructed of Schedule 40 polyvinyl chloride (PVC). Extracted vapors are routed through flexible hose at the connections to the SSVS equipment.

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2.3 SSVS Equipment

The SSVS equipment was fabricated in 2005 by:

H2 Oil Recovery Equipment, Inc.
PO Box 9028
Bend, Oregon 97708
Telephone: 542-382-7070
Order #: 250357

Equipment information is provided in Attachment A.

Extracted vapors are routed through two granular activated carbon (GAC) vessels prior to discharge to the atmosphere through a 15-foot stack. Vapor flow rates are measured through three air flow meters (Ametek Rotron Flow Meter). One flow meter is located on piping routing from each of the two trench laterals, and one flow meter is located on the exhaust piping.

2.4 Electrical Supply

Electrical service is supplied to the SSVS from a central mall location. Power (110 volt, 1-phase) is brought to the enclosure from a disconnect panel located immediately west of the swinging doors at the northeast corner of the Rite Aid retail space. Power is supplied from the central mall location through a 30 amp circuit breaker. Electrical servicing should be coordinated through mall management.

An electrical one-line diagram for the SSVS equipment is provided in Attachment A.

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3.0 System Operation

The SSVS equipment is designed to operate continuously. The following section provides a summary of the site operating permit conditions, and start-up, operation, and shutdown procedures.

3.1 Permit Conditions

A mechanical permit was issued for the SSVS blower by the City of Lake Forest Park (Attachment B). It is anticipated that a permit for air discharge from the system will not be required by the Puget Sound Clean Air Agency (PSCAA). A summary of PSCAA permit requirements is provided in Table 3-1. Under no circumstances will the permit requirements be exceeded without written approval from PSCAA.

Table 3-1

Parameter	Permit Requirement
Air Emissions (PSCAA)	
Flow Rate	100 scfm
Pre-Treatment Vapor VOC Concentration	approximately 5 ppm_v (pending)
Discharge Temperature	90 °F

3.2 Start-Up

Startup procedures for the SSVS equipment, extraction trenches, and the vapor phase carbon vessels are provided in the following sections.

3.2.1 SSVS Equipment

Refer to manuals provided by H2 Oil located in Attachment 1. Start-up procedures for the SSVS equipment are as follows:

1. Verify that the main disconnect switch located by the swinging doors to the Rite Aid retail space is in the "ON" position.
2. Verify that valves to the extraction trenches are in the "OPEN" position, in which the valve handle is aligned with the piping.
3. Locate the system CONTROL PANEL. Turn the CONTROL POWER switch to the "ON" position.

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3.2.2 Extraction Trenches

Startup procedures for the two extraction trenches (South Trench and North Trench) are as follows:

1. Verify that dilution valves located in the access vaults at the west end of each trench are closed (Figure 4).
2. Verify that vacuum exists at both ends of trench (Figure 4).

3.2.3 Auxiliary Equipment

Following start-up of the SSVS equipment and extraction trenches, the following procedures should be followed to further ensure proper system operation:

1. Ensure that the vapors are properly flowing through the activated carbon vessels and exiting through the exhaust stack. This can be verifed at pressure and flow gauges.
2. Ensure that liquids are not impeding vapor flow through the exhaust piping by unthreading the cap on the sump at the base of the exhaust stack.

3.3 Operation

Since the SSVS is designed to operate continuously, once the system is started and operating properly, no further actions are necessary. In the event that the SSVS is not operating properly, refer to Attachment A for troubleshooting information.

3.4 Shut-Down Procedures

The following procedures are to be followed when shutting down the SSVS equipment.

1. SSVS Equipment:
   a. To stop operations of the system, simply turn the control switch to the "OFF" position.

If the SSVS will be shut down for an extended period (i.e. more than three days), the following tasks should be completed:

2. Turn the main disconnect switch to the "OFF" position to shut down the blower

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enclosure cooling fan.
3. Drain the moisture KOT of any accumulated liquids.
4. Drain the exhaust stack sump of any accumulated liquids.

3.5 Emergency Shut-Down Procedures

In the event of an emergency situation the following steps should be followed:

Turn the main disconnect switch to the "OFF" position.

4.0 Maintenance

Maintenance activities including periodic manufacturer-recommended tasks, carbon vessel monitoring and replacement, and routing operation and maintenance activities, are described in Attachment A.

4.1 Performance Monitoring

A Performance Monitoring Plan (PMP) has been developed to summarize monitoring activities for the SSVS equipment (Attachment C). Activities described in the PMP include gauge measurement recording, vapor monitoring and sampling, and reporting.

4.2 Carbon Replacement

Monitoring and sampling of the activated carbon vessels to determine replacement is described in detail in the Performance Monitoring Plan (Attachment C). Once it has been determined that the carbon must be replaced, 55-gallon carbon vessels can be removed and replaced as complete units.

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5.0 Troubleshooting and Repair

Troubleshooting, alarm, and repair information for the SSVS equipment is provided in Attachment A. Contact information for vendor support of troubleshooting and repairs issues is as follows:

H2 Oil Recovery Equipment, Inc.
PO Box 9028
Bend, Oregon 97708
Main Office Telephone: 542-382-7070
Order #: 250357

ATTACHMENT A

H2 OIL RECOVERY EQUIPMENT MANUAL

H2 OIL RECOVERY EQUIPMENT, INC.

MAIN OFFICE
P.O. BOX 9028
Bend, OR 97708
Telephone (541) 382-7070
FAX (541) 382-2242

Release Date - November 9, 1998

PREFACE

CAUTION NOTE

This instruction manual has been prepared to serve as a general guide in operating and maintaining Soil Vapor Extraction (SVE) equipment furnished by H2 Oil Recovery Equipment, Inc. It is intended for use by **qualified personnel** with a knowledge of SVE systems and their operation. It is not intended to cover all possible variations in equipment or to provide for specific operating problems, which may arise. Should additional information be required, H2 Oil or its field representatives should be contacted.

It is recognized that no amount of written instructions can replace intelligent thinking and reasoning on the part of the operators. This manual is not intended to relieve the operating personnel of the responsibility for proper operation of the equipment. Personnel should become thoroughly familiar with the equipment before operating or maintaining the equipment.

Please consider the **Tenets of Operational Excellence** as listed below:

1. Always operate within design or environmental limits.
2. Always operate in a safe and controlled condition.
3. Always ensure safety devices are in place and functioning.
4. Always follow safe work practices and procedures.
5. Always meet or exceed customer's requirements.
6. Always maintain integrity of dedicated systems.
7. Always comply with all applicable rules and regulations.
8. Always address abnormal conditions.
9. Always follow written procedures for high-risk or unusual situations.
10. Always involve the right people in decisions that affect procedures and equipment.

H2 Oil Recovery Equipment, Inc.'s liability for the equipment furnished is as set forth in the contract. H2 Oil does not assume responsibility for any equipment not furnished by H2 Oil. No employee of H2 Oil is authorized to assume any responsibility for equipment not furnished by H2 Oil.

Competent supervision of mechanical and electrical equipment operation and maintenance is necessary to maintain safe and reliable operation.

PRIOR TO INITIAL OPERATION, PLEASE READ THIS MANUAL AND ALL EQUIPMENT MANUALS INCLUDED THOROUGHLY IN ORDER TO AVOID ANY POSSIBLE DAMAGE TO PERSONNEL OR THE EQUIPMENT.

SAFETY CONSIDERATIONS

Your company's policies and procedures for safely operating the SVE system supersede the safety considerations listed below. It is your responsibility to follow your company's safety procedure. If there aren't any, follow those established by OSHA, DEQ and/or NEC, as a minimum.

ELECTRICAL SAFETY

- Before attempting any procedures, locate the main electrical source and understand how to safely control it.
- Whenever possible, be sure to lockout and tagout the electrical before beginning any repair or replacement tasks. Refer to your H2 Oil equipment manual and your company's safety policies and procedures for specific instructions.
- During periods of lightning activity, do not connect or disconnect any cables or perform installation, maintenance or reconfiguration.
- Notify nearby personnel that you are attempting to operate or service this system. Follow your company's lockout/tagout procedure.

BEFORE POWERING UP THE SVE SYSTEM -

- Know how to stop the system and automatic operation in an emergency.
- Ensure that all safety devices in the work area are properly installed and functional.

1.0 SYSTEM OPERATION

The following procedure is to be followed under normal conditions. If you are unsure about the safety of operating this equipment under your current site conditions, please call H2 Oil Recovery for technical advice.

1.1 START-UP PROCEDURE

1) Connect all plumbing, safety devices and wiring.

2) Place the SVE BLOWER / CONTROLS "OFF-ON" switch in the "OFF" position.

3) Turn the remote mounted circuit breaker ON.

4) Place the SVE BLOWER / CONTROLS "OFF-ON" switch in the "ON" position.

The system should now operate as long as no alarm conditions become present.

2.0 SYSTEM ALARMS

The following is a list of alarms and an explanation of how you can recover the system from the alarm condition.

1. **Moisture Separator High Level** - To recover from this alarm, drain the liquid from the moisture separator, then turn the main OFF/ON switch "OFF". After you have determined that all site conditions are safe for normal operation, re-start the blower by turning the switch "ON".

   Note: To determine that you have experienced a moisture Separator High Level alarm, look at the indicating light on Relay 1. The light illuminates only after a High Level alarm has occurred.

2. **Blower Motor Overload** - To recover from this alarm, push the RESET button located on the motor starter overload.

   Note: To determine that you have experienced a moisture Separator High Level alarm, look at the indicator located on the overload relay. It will have the letter "T" displayed on newer versions of relays. On the older relay versions, the indicator will appear to be yellow when tripped.

1.0 MAINTENANCE PROCEDURES.

This Soil Vapor Extraction system has several items that will require periodic maintenance for proper and reliable operation. Your site conditions could greatly impact the time frame or frequency in which this maintenance will be required. At a minimum, you should provide equipment maintenance every month.

The following is a list of maintenance items:

1. **SVE INLET FILTER** - This filter is located on the interior of the moisture separator. To maintain the filter:

   A. Stop blower operation.
   B. Lock out and tag out proper circuit breaker.
   C. Remove moisture separator top.
   D. Inspect filter (Filter is washable) or replace, if needed.
   E. Re-assemble.

2. **MOISTURE SEPARATOR HIGH LEVEL FLOAT** - This float is also located on the interior of the moisture separator. To maintain the float switch:

   A. Stop blower operation.
   B. Lock out and tag out proper circuit breaker.
   C. Remove moisture separator top.
   D. Inspect float switch (float is washable) or replace, if needed.
   E. Test float to assure that it operates properly.
   F. Re-assemble.

3. **BLOWER MOTOR AMPERAGE** - To test that the blower is operating within its limits, please check the motor amperage with an analog clamp on meter. Compare the amp draw to the blower motor nameplate amperage rating. Your recorded amperage should always be less than the nameplate information.

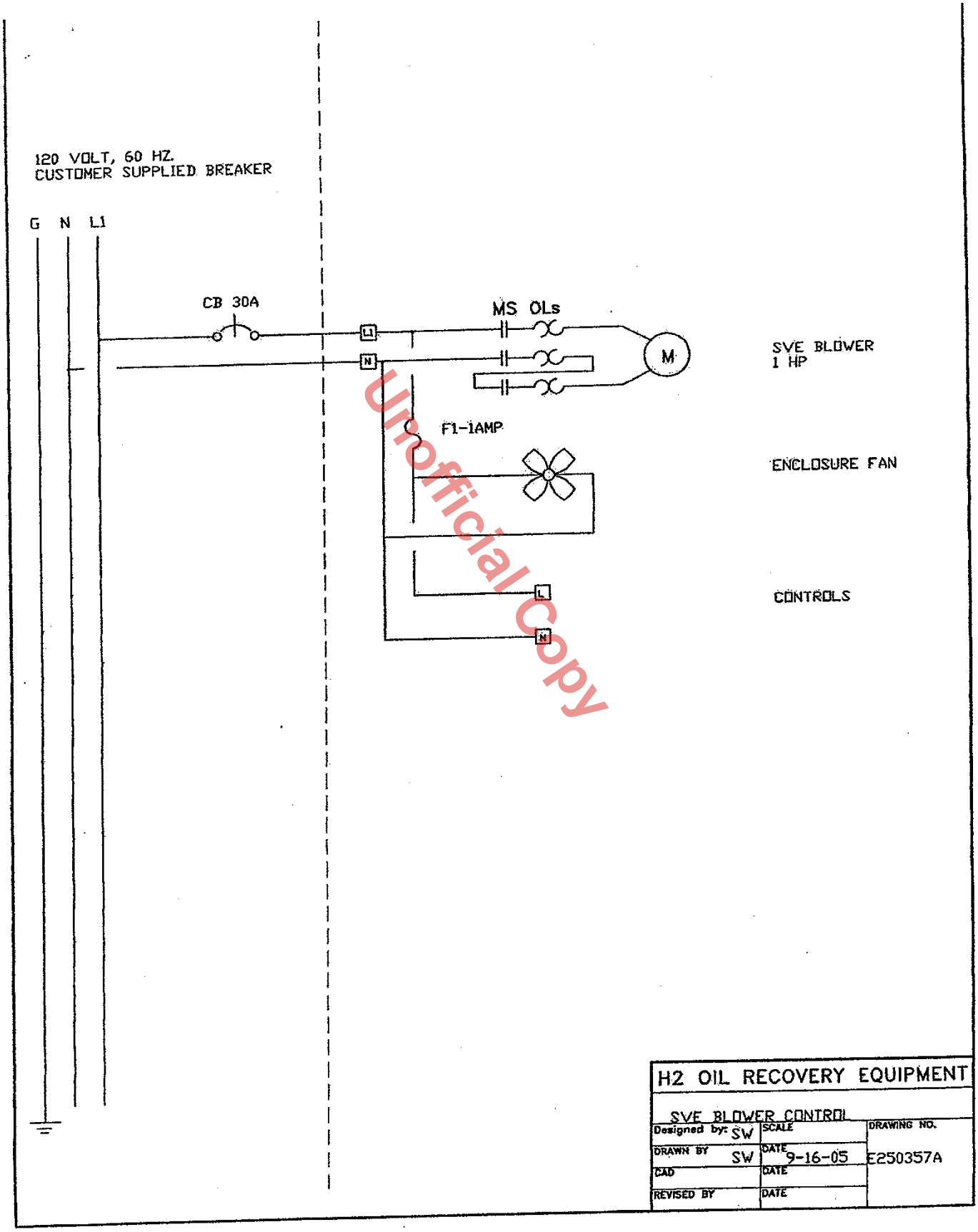
4. **COOLING FAN OPERATION** - The SVE Blower is located on the inside of a sound abatement enclosure. The sound enclosure is equipped with a cooling fan that supplies a continuous flow of air. To maintain the fan:

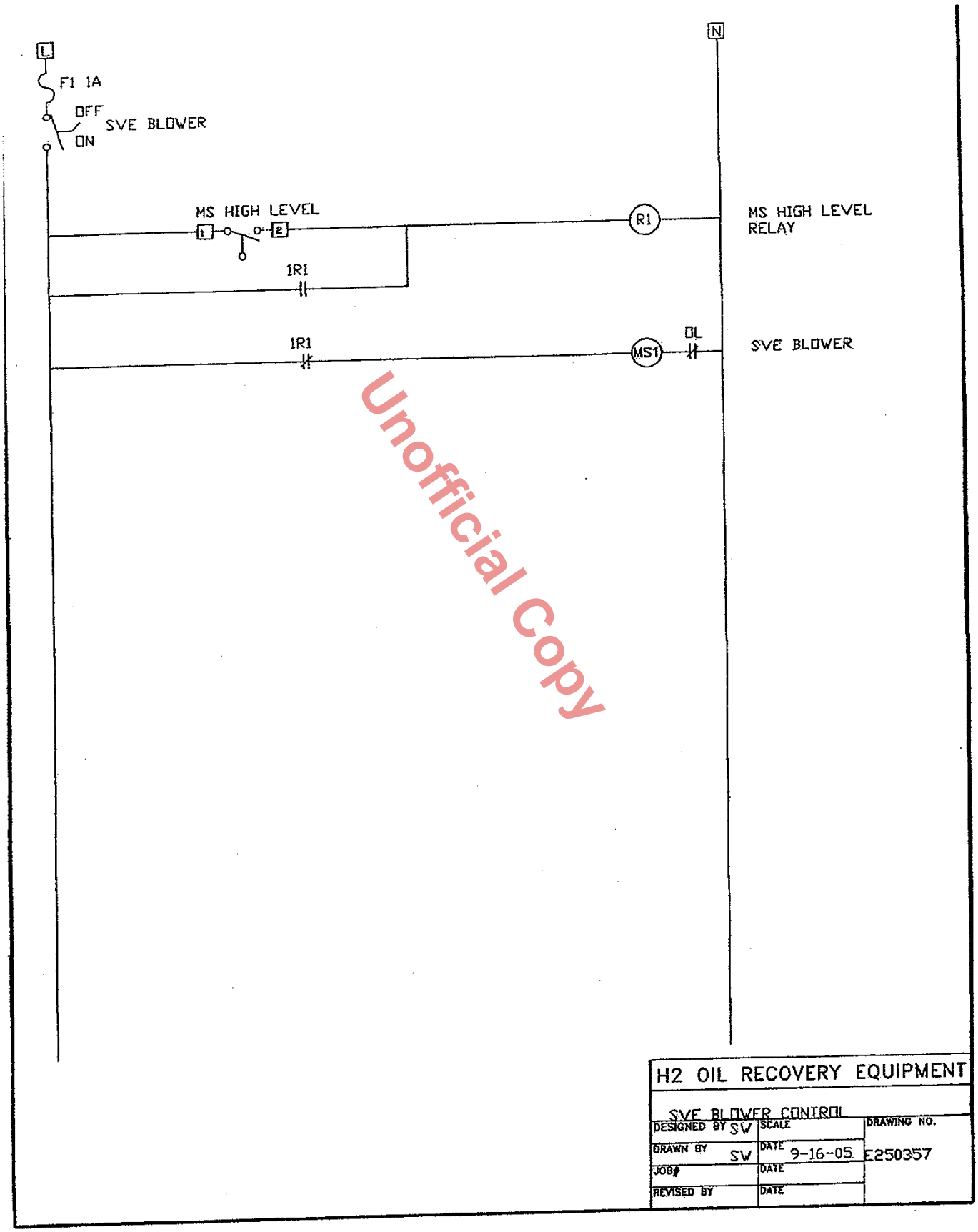
   A. Stop blower operation.
   B. Lock out and tag out proper circuit breaker.
   C. Inspect the fan and guards. Remove any debris that may hinder fan performance.
   D. Restart system.
   E. Check fan operation.

5. **CARBON FILTERS** - The carbon filters are located on the effluent side of the SVE blower. These filters need to be monitored monthly for plugging. To determine that you have no filter plugging:

   A. Take pressure readings on the inlet of both carbon filters on initial system startup. (Record readings)
   B. Take pressure readings on the inlet of both carbon filters after operating system for one month.
   C. Compare readings.

   If you are seeing a pressure increase, it is probable that you are plugging the carbon filters with debris or condensate.





WARRANTY - DISCLAIMER

H2 warrants its products to be free from defects in materials and workmanship for a period of one (1) year from the original date of installation or eighteen (18) months from original date of shipment, whichever period is shorter. In the event of a covered defect and subject to proper reporting by Buyer and the opportunity to inspect as set forth below, H2 will repair or replace the defective equipment at its option. H2 shall not be responsible for consequential damages, if any, incurred or claimed by Buyer, including, but not limited to leakage related to the failure of H2 manufactured equipment, loss of income, expenses arising from use and/or installation of the equipment, or unforeseen circumstances related to equipment operation. Manufacturer's liability as stated herein cannot be altered or enlarged except when approved in writing and signed by an officer of the Manufacturer.

Buyer shall report all claimed defects to H2, in writing, within (4) four business days of discovery by Buyer and shall not undertake repair or replacement until H2 has been allowed to inspect the claimed defect. H2 shall make every effort to make a prompt inspection after receipt of notice from Buyer. Pending inspection and/or repair, Buyer will follow all instructions of H2 for preservation and protection of the equipment. **ALL REPAIRS AND RELATED EXPENSES TO BE MADE BY AUTHORIZED H2 PERSONNEL ONLY.**

The warranty granted herein does not extend to products sold by H2 that are warranted by the original equipment manufacturer. Buyer shall be responsible for travel, mileage, labor and per diem connected to the repair or replacement of products not manufactured by H2, per H2's rate schedule. Any freight charges are to be prepaid by Buyer.

Products manufactured and/or sold by H2 Oil Recovery Equipment, Inc. are sold "as is" WITHOUT WARRANTY, EXPRESS OR IMPLIED, AND WITH ALL FAULTS, including warranties of title, against infringement, merchantability and suitability of the product for any particular application or purpose, **except otherwise expressly set forth herein.**

Buyer's order was placed in Deschutes County, Oregon. The Warranty-Disclaimer shall be governed and construed according to the laws of the state of Oregon. Other than in the event of lien foreclosure proceedings commenced in the jurisdiction in which the equipment is installed, any suit or action between H2 and Buyer arising out of this shall be brought in Deschutes County, Oregon. In the event suit or action is instituted to enforce any of the terms, the losing party shall pay, in addition to court costs, the prevailing party's attorney fees, whether at trial or on appeal.

ABOVE WARRANTY IS VOID IN THE EVENT OF ANY UNAUTHORIZED ALTERATIONS TO PRODUCT, LACK OF RECOMMENDED SAFETY OR FILTRATION DEVICES, IMPROPER INSTALLATION BY OTHERS, ABUSE, MISUSE, NEGLIGENCE, ABNORMAL USE, EXCESSIVE PRESSURE OR VACUUM, TRANSIT DAMAGE, FIRE OR ACCIDENT.

rev 05/21/02

L - Black 1
Back BLU 2

Operating Instructions & Parts Manual

4WT33, 4WT40, 4WT41, 4WT42A thru 4WT45A and 4WT46 thru 4WT49

Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.

Dayton® AC Axial Fans

Description

Dayton AC axial fans are single speed units used for spot cooling where space is limited. They are widely used in computers, copy machines, electronic instrumentation, cabinet cooling, machine tool products, and solar systems. They are field interchangeable with most other axial fans and can be mounted in any discharge position. Molded polycarbonate fan blade is driven by an impedance protected, shaded pole, unit bearing motor with a cast zinc venturi. Model 4WT42A, 4WT43A, 4WT44A and 4WT45A have a PSC, thermally protected ball bearing motor. Optional finger guard and cordset (4WT40 and 4WT41 can not use a cordset) are available as accessories. Order separately.

Figure 1

Specifications & Performance

Specifications								Performance†					
		Overall Dimensions (in.)			Mounting Hole Dimensions	Mounting Hole	No. Blade	CFM Air				* SIL	Max. Amb. Temp.
Model	Motor Pwr. Req'd	Dia.	H & W	D	on Center (in.)	Dia. (in.)	Wings	Delivery	RPM	Watts	Amps	db	(°F)
4WT33	230V 60 Hz	–	4 11/16	1 1/2	4 1/8	0.169	5	105	2900	19	0.11	48	158
4WT40	115V 60 Hz	–	3 1/8	1 1/2	2 25/32	0.169	7	30	2750	12	0.13	35	158
4WT41	230V 60 Hz	–	3 1/8	1 1/2	2 25/32	0.169	7	30	2750	16	0.08	35	158
4WT42A	†† 115V 60 Hz	6 1/4	5 7/8	2	6 1/8	0.177	5	239	3200	27	0.23	55	176
4WT43A	†† 230V 60 Hz	6 1/4	5 7/8	2	6 1/8	0.177	5	239	3200	26	0.11	55	176
4WT44A	†† 115V 60 Hz	10	–	3 1/2	9 11/16	0.177	3	665	1600	26	0.23	52	176
4WT45A	†† 230V 60 Hz	10	–	3 1/2	9 11/16	0.177	3	665	1600	30	0.13	52	176
4WT46	115V 60 Hz	–	4 11/16	1 1/2	4 1/8	0.169	5	115	3100	20	0.24	49	158
4WT47	115V 60 Hz	–	4 11/16	1 1/2	4 1/8	0.169	5	105	2900	18	0.18	48	158
4WT48	115V 60 Hz	–	4 11/16	1 1/2	4 1/8	0.169	5	70	2000	11	0.13	36	158
4WT49	115V 60 Hz	–	4 11/16	1 1/2	4 1/8	0.169	5	55	1750	11.3	0.12	33.5	158

NOTE: All data based on 60 Hz operation. When operated on 50 Hz, a decrease of approximately 20% will occur in flow rate performance.

(†) At free air.

(*) SIL db – Speech interference Level in decibels. This figure represents an average of the sound pressure levels in the 500, 1000, and 2000 Hz octave bands.

(††) Ball bearing.

General Safety Information

⚠WARNING ***Disconnect power before installing or servicing***

1. Follow all local electrical and safety codes, the National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA) in the United States.
2. Fan must be securely and adequately grounded. This can be accomplished by connecting a separate ground wire to the fan frame with a self-threading screw (not furnished) in the hole provided.
3. Lock and tag power disconnect to prevent unexpected application of power.

Form 5S4298

Printed in Taiwan
04634
0804/173/VCPVP

SUN001
08/04

Dayton

Dayton Operating Instructions and Parts Manual

4WT33, 4WT40, 4WT41, 4WT42A thru 4WT45A and 4WT46 thru 4WT49

Dayton® AC Axial Fans

General Safety Information (Continued)

4. Guard all moving parts.
5. Protect the power cable from coming in contact with sharp objects.
6. Do not kink power cable and never allow the cable to come in contact with oil, grease, hot surfaces, or chemicals.
7. Make certain that the power source conforms to the requirements of your equipment.

⚠WARNING ***Do not use in explosive atmospheres.***

Installation

1. Mount fan in the position most desirable to your needs.
2. Secure fan in place with screws and tinnerman clips or nuts and bolts (Mounting hardware not included).

WIRING

Refer to Grainger Catalog for a complete list of cordsets. Plug cordset into fan and connect leads to 115 volt or 230 volt power source. Models 4WT40 and 4WT41 have 12" leads and do not require a cordset.

⚠CAUTION ***Exposed wires should not come in contact with fan housing.***

3. Fan must be adequately grounded. This can be accomplished by connecting a separate ground wire to the fan housing with a #10 self-threading screw (not furnished) in the hole provided.

Operation

Dayton Unit Bearing Axial Fans are designed to operate optimally in horizontal airflow position. Arrows stamped on housing indicate direction of blade rotation and airflow. Ball Bearing Axial Fans are designed to mount in any position.

Maintenance

⚠WARNING ***Always disconnect power supply before inspecting the axial fan or working with the unit for any reason.***

Axial fan cannot be field serviced. Replace entire unit if defective.

NOTE: No replacement parts available.

Accessories

Refer to Grainger Catalog for complete list of axial fan accessories.

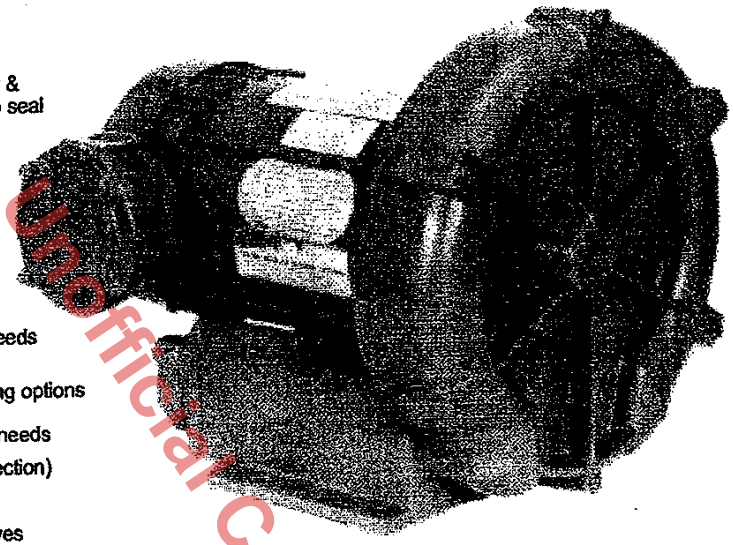
Manufactured for Dayton Electric Mfg. Co.
Niles, Illinois 60714 U.S.A.

Dayton®

AMETEK® Rotron® Industrial Products

EN 404M & CP 404M
Sealed Regenerative Blower w/Explosion-Proof Motor

FEATURES
- Manufactured in the USA – ISO 9001 compliant
- Maximum flow: 107 SCFM
- Maximum pressure: 57 IWG
- Maximum vacuum: 52 IWG
- Standard motor: 1.0 HP, explosion-proof
- Cast aluminum blower housing, cover, impeller & manifold; cast iron flanges (threaded); teflon lip seal
- UL & CSA approved motor with permanently sealed ball bearings for explosive gas atmospheres Class I Group D minimum
- Sealed blower assembly
- Quiet operation within OSHA standards

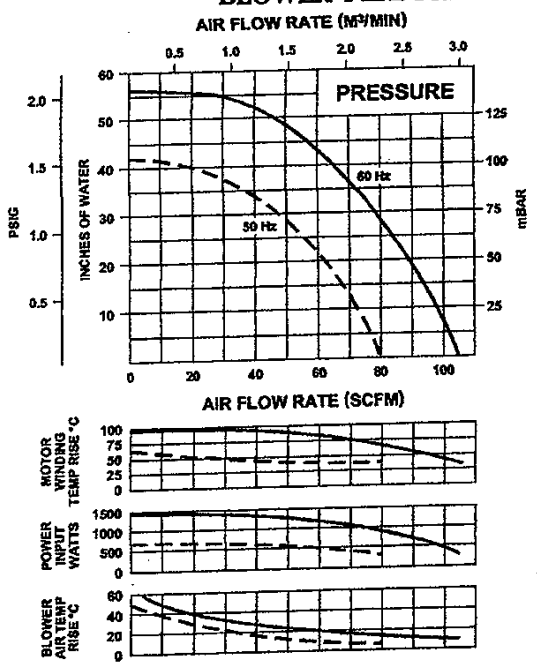


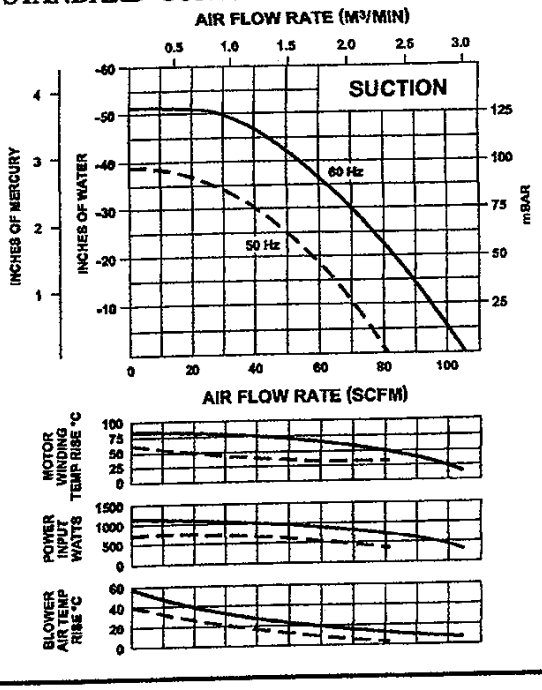
MOTOR OPTIONS
- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

BLOWER OPTIONS
- Corrosion resistant surface treatments & sealing options
- Remote drive (motorless) models
- Slip-on or face flanges for application-specific needs

ACCESSORIES (See Catalog Accessory Section)
- Flowmeters reading in SCFM
- Filters & moisture separators
- Pressure gauges, vacuum gauges & relief valves
- Switches – air flow, pressure, vacuum or temperature
- External mufflers for additional silencing
- Air knives (used on blow-off applications)
- Variable frequency drive package

BLOWER PERFORMANCE AT STANDARD CONDITIONS



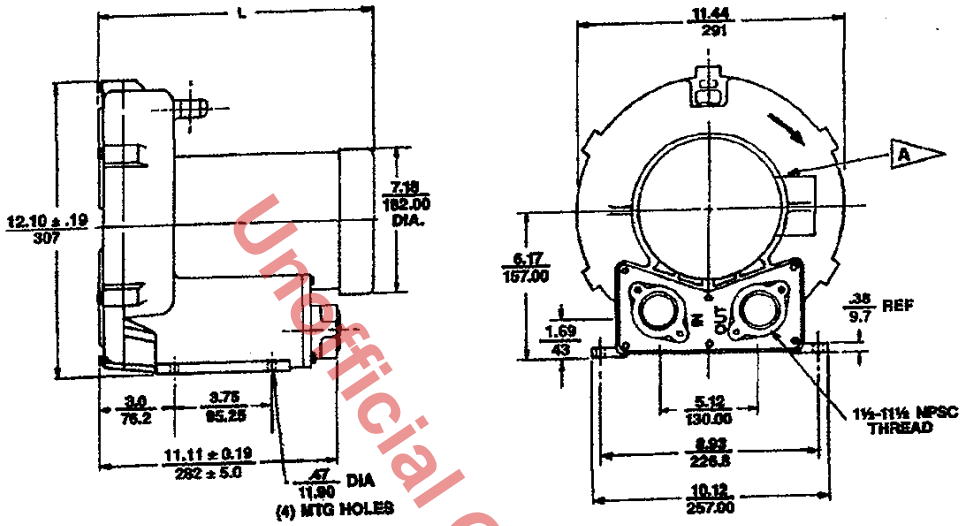


Rev. 2/01

AMETEK® Rotron® Industrial Products

EN 404M & CP 404M
Sealed Regenerative Blower w/Explosion-Proof Motor

Scale CAD drawing available upon request.



DIMENSIONS: IN / MM
TOLERANCES: .XX ± .08 / 2.0
.XXX ± .030 / .800
(UNLESS OTHERWISE NOTED)

MODEL	L (IN) ± .30	L (MM) ± 8
EN/CP404AR72ML	14.58	370.3
EN/CP404AR58ML	15.58	396

A 0.75" NPT CONDUIT CONNECTION AT 12 O'CLOCK POSITION

SPECIFICATIONS

MODEL	EN404AR58ML		EN404AR72ML		CP404FQ58MLR	CP404FQ72MLR
Part No.	038173		038174		080075	038958
Motor Enclosure – Shaft Material	Explosion-proof – CS		Explosion-proof – CS		Chem XP – SS	Chem XP – SS
Horsepower	1.0		1.0		Same as EN404AR58ML – 038173 except add Chemical Processing (CP) features from catalog inside front cover	Same as EN404AR72ML – 038174 except add Chemical Processing (CP) features from catalog inside front cover
Phase – Frequency [1]	Single - 60 Hz		Three - 60 Hz			
Voltage [1]	115	230	208-230	460		
Motor Nameplate Amps	11.4	5.69	3.5-3.2	1.6		
Max. Blower Amps [3]	14.4	7.2	4.2	2.1		
Inrush Amps	72	36	20.2	10.1		
Starter Size	0	00	00	00		
Service Factor	1.0		1.0			
Thermal Protection [2]	Class B - Automatic		Class B - Pilot Duty			
XP Motor Class – Group	I-D, II-F&G		I-D, II-F&G			
Shipping Weight	72 lb (33 kg)		65 lb (30 kg)			

1 Rotron motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: **208-230/415-460 VAC-3 ph-60 Hz** and **190-208/380-415 VAC-3 ph-50 Hz.** Our dual voltage 1 phase motors are factory tested and certified to operate on both: **104-115/208-230 VAC-1 ph-60 Hz** and **100-110/200-220 VAC-1 ph-50 Hz.** All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

2 Maximum operating temperature: Motor winding temperature (winding rise plus ambient) should not exceed 140°C for Class F rated motors or 120°C for Class B rated motors. Blower outlet air temperature should not exceed 140°C (air temperature rise plus inlet temperature). Performance curve maximum pressure and suction points are based on a 40°C inlet and ambient temperature. Consult factory for inlet or ambient temperatures above 40°C.

3 Maximum blower amps corresponds to the performance point at which the motor or blower temperature rise with a 40°C inlet and/or ambient temperature reaches the maximum operating temperature.

Specifications subject to change without notice. Please consult your Local Field Sales Engineer for specification updates.

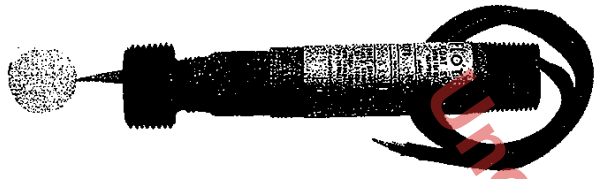
Rev. 2/01

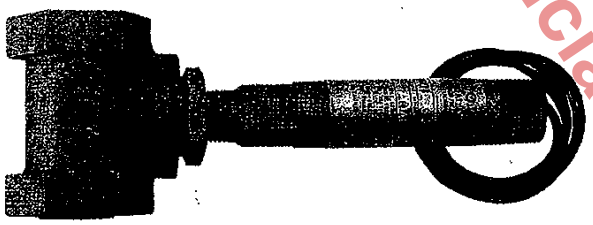
Bulletin E-20

Model L6 FLOTECT® Float Switch

Specifications - Installation and Operating Instructions

Explosion-Proof; UL and CSA Listed -
Class I, Groups *A, B, C, & D
Class II, Groups E, F & G
Directive 94/9/EC (ATEX) Compliant for CE ⟨Ex⟩
II 2 G EEx d IIC T6 Process Temp≤75°C
*(Group A, stainless steel body only)





SPECIFICATIONS

Service: Liquids compatible with wetted materials.
Wetted Materials:
Float: Solid polypropylene or 304 SS.
Lower Body: Brass or 303 SS.
Magnet: Ceramic.
External Float Chamber (Tee): Matches lower body choice of brass or 303 SS.
Other: Lever Arm, Spring, Pin, etc.: 301 SS.
Temperature Limit: -4 to 220°F (-20 to 105°C) Standard, MT high temperature option 400°F (205°C)(MT not UL, CSA or ATEX). ATEX compliant AT option ambient temperature -4 to 167°F (-20 to 75°C) process temperature: -4 to 220°F (-20 to 105°C).
Pressure Limits: See next page.
Enclosure Rating: Weatherproof and Explosion-proof. Listed with UL and CSA for Class I, Groups A, B, C and D; Class II, Groups E, F, and G. (Group A on stainless steel body models only). CE 0344 ⟨Ex⟩ II 2 G EEx d IIC T6 Process Temp≤75°C.
EC-Type Certificate No.: KEMA 04ATEX2128
Switch Type: SPDT snap switch standard, DPDT snap switch optional.
Electrical Rating: UL models: 5A @ 125/250 VAC (V~). CSA and ATEX models: 5A @ 125/250 VAC (V~); 5A res., 3A ind. @ 30 VDC (V=). MV option: .1A @ 125 VAC (V~). MT option: 5A @125/250 VAC (V~). [MT option not UL, CSA or ATEX].
Electrical Connections: UL models: 18 AWG, 18" (460 mm) long. ATEX/CSA models: terminal block.
Upper Body: Brass or 303 SS.
Conduit Connection: 3/4" male NPT standard, 3/4" female NPT on junction box models.
Process Connection: 1" male NPT on models without external float chamber, 1" female NPT on models with external float chamber.
Mounting Orientation: Horizontal with index arrow pointing down.
Weight: Approximately 1 lb (.5 kg) without external float chamber, 1.75 lb (.8 kg) with external float chamber.
Specific Gravity: See next page.

Example	L6	EP	B	B	S	3	B	MT		L6EPB-B-S-3-B-MT level switch; brass upper housing, brass lower housing, brass tee with Polypropylene spherical float, SPDT snap switch, and high temperature option
Series	L6									Series L6 level switch
Construction		EP								Explosion proof and weatherproof
Upper Body Material			B S							Brass 303 Stainless Steel
Lower Body Material				B S						Brass 303 Stainless Steel
Circuit (Switch) Type					S D					SPDT DPDT
Line Size						3 4 5 6				1" NPT 1-1/4" NPT (No tee models only) 1-1/2" NPT (No tee models only) 2" NPT
Tee and Float Options							0 A B C H L S			No Tee, Solid Polypropylene Spherical Float* No Tee, 304 SS Cylindrical Float Brass Tee, Solid Polypropylene Spherical Float* No Tee, 304 SS Spherical Float Brass Tee, 304 SS Spherical Float 303 SS Tee, 304 SS Spherical Float 303 SS Tee, Solid Polypropylene Spherical Float*
Switch Options								MV MT		Gold Contacts on snap switch for dry circuits (see specifications for ratings) High Temperature switch rated 400°F (205°C) (see specifications for ratings)*
Options									AT CSA GL ID JCT TBC TOP	ATEX approved construction (with JCT option standard) CSA approved construction (with JCT option standard)* Ground Lead* Customer Information on standard nameplate Weatherproof and explosion-proof junction box* Terminal Block Connector* Top Mounted (No tee models only)*

* Options that do not have ATEX

MAXIMUM PRESSURE CHART

Model Number	Float	Minimum Sp. Gr.	Pressure Rating psig (bar)
L6EPB-B-S-3-A	Cylindrical SS	0.5	200 (13.8)
L6EPB-B-S-3-B	Polypropylene	0.9	250 (17.2)
L6EPB-B-S-3-C	Round SS	0.7	350 (24.1)
L6EPB-B-S-3-H	Round SS	0.7	250 (17.2)
L6EPB-B-S-3-O	Polypropylene	0.9	1000 (69.0)
L6EPB-S-S-3-A	Cylindrical SS	0.5	200 (13.8)
L6EPB-S-S-3-C	Round SS	0.7	350 (24.1)
L6EPB-S-S-3-L	Round SS	0.7	350 (24.1)
L6EPB-S-S-3-O	Polypropylene	0.9	2000 (138)
L6EPB-S-S-3-S	Polypropylene	0.9	2000 (138)

WETTED MATERIALS CHART

Model	Brass	Bronze	Ceramic	Polypropylene	301SS	303SS	304SS
B-S-3-A	X		X		X		X
B-S-3-B	X	X	X	X	X		
B-S-3-C	X		X		X		X
B-S-3-H	X	X	X		X		X
B-S-3-O	X	X	X	X	X		
S-S-3-A			X	X	X		X
S-S-3-C			X		X	X	X
S-S-3-L			X		X	X	X
S-S-3-O			X	X	X	X	
S-S-3-S			X	X	X	X	

INSTALLATION

Unpack switch and remove any packing material found inside lower housing or float chamber.

Switch must be installed with body in a horizontal plane and arrow on side pointing down.

If switch has an external float chamber (tee), connect it to vertical sections of 1" NPT pipe installed outside vessel walls at appropriate levels. If unit has no external float chamber, it must be mounted in a 1" NPT half coupling welded to the vessel wall. The coupling must extend through the wall.

Inspect and clean wetted parts at regular intervals.

ELECTRICAL CONNECTIONS

Connect wire leads in accordance with local electrical codes and switch action required. N.O. contacts will close and N.C. contacts will open when liquid level causes float to rise. They will return to "normal" condition on decreasing liquid level. Black = common, Blue = N.O. and Red = N.C.

For units supplied with both internal and external grounds the ground screw inside the housing must be used to ground the control. The external ground screw is for supplementary bonding when allowed or required by local code. Some CSA listed models are furnished with a separate green ground wire. Such units must be equipped with a junction box, no supplied but available on special order.

EC-Type Certificate Installation Instructions:

Cable Connection

The cable entry device shall be an EEx d certified cable gland suitable for conditions of use and correctly installed. The certificate cable gland and cable shall be rated for minimum temperature of 80°C.

Conduit Connection

An EEx d certified seal device such as a conduit seal with setting compound suitable for conditions of use and correctly installed shall be provided immediately to the entrance of the electrical housing. The certified conduit seal and setting compound and cable shall be rated for a minimum temperature of 80°C.

Note: ATEX units only: The temperature class is determined by the maximum ambient and or process temperature. Units are intended to be used in ambient of -20°C≤ Tamb ≤75°C. Units may be used in process temperatures up to 105°C providing the enclosure and switch body temperatures do not exceed 75°C. The standard Temperature Class is T6 Process Temp ≤75°C.

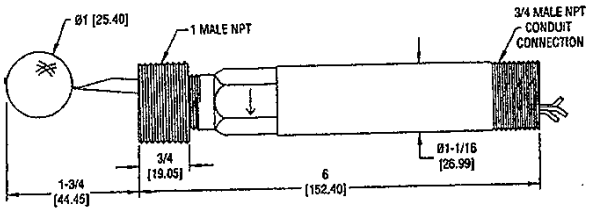
All wiring, conduit and enclosures must meet applicable codes for hazardous areas. Conduits and enclosures must be properly sealed. For outdoor or other locations where temperatures vary widely, precautions should be taken to prevent condensation inside switch or enclosure. Electrical components must be kept dry at all times.

CAUTION: To prevent ignition of hazardous atmospheres, disconnect the device from the supply circuit before opening. Keep assembly tightly closed when in use.

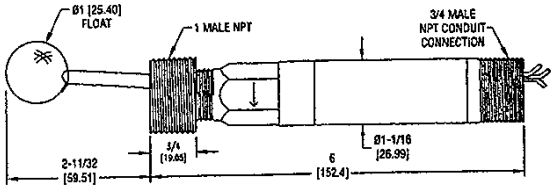
MAINTENANCE

Inspect and clean wetted parts at regular intervals. The cover should be in place at all times to protect, the internal components from dirt, dust and weather and to maintain hazardous location ratings. Disconnect device from the supply circuit before opening to prevent ignition of hazardous atmosphere.

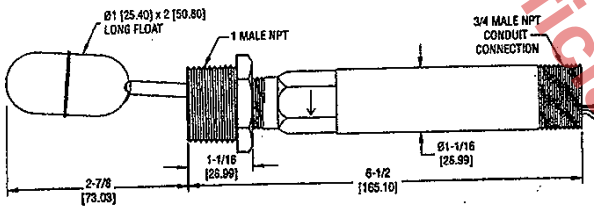
FLOTECT® MODEL L-6 FLOAT SWITCH — DIMENSION DRAWINGS



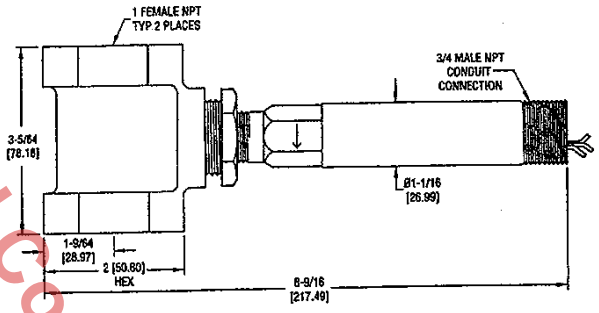
Polypropylene Float



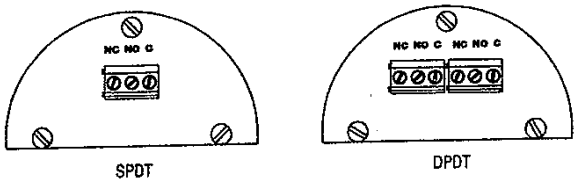
Round Stainless Steel Float



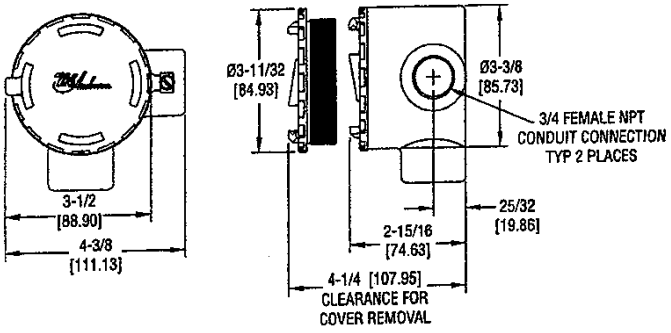
Cylindrical Stainless Steel Float



With External Chamber (Tee)



Terminal Connections CSA, ATEX Enclosures



CSA, ATEX Conduit Enclosure

Limited Warranty: The Seller warrants all Dwyer instruments and equipment to be free from defects in workmanship or material under normal use and service for a period of one year from date of shipment. Liability under this warranty is limited to repair or replacement F.O.B. factory of any parts which prove to be defective within that time or repayment of the purchase price at the Seller's option provided the instruments have been returned, transportation prepaid, within one year from the date of purchase. All technical advice, recommendations and services are based on technical data and information which the Seller believes to be reliable and are intended for use by persons having skill and knowledge of the business, at their own discretion. In no case is Seller liable beyond replacement of equipment F.O.B. factory or the full purchase price. This warranty does not apply if the maximum ratings label is removed or if the instrument or equipment is abused, altered, used at ratings above the maximum specified, or otherwise misused in any way.

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Buyers Remedies: THE BUYER'S EXCLUSIVE AND SOLE REMEDY ON ACCOUNT OF OR IN RESPECT TO THE FURNISHING OF NON-CONFORMING OR DEFECTIVE MATERIAL SHALL BE TO SECURE REPLACEMENT THEREOF AS AFORESAID. THE SELLER SHALL NOT IN ANY EVENT BE LIABLE FOR THE COST OF ANY LABOR EXPENDED ON ANY SUCH MATERIAL OR FORM ANY SPECIAL, DIRECT, INDIRECT OR CONSEQUENTIAL DAMAGES TO ANYONE BY REASON OF THE FACT THAT IT SHALL HAVE BEEN NON-CONFORMING OR DEFECTIVE.

 Printed in U.S.A. 6/04 FR# 82-440726-00 Rev. 1

3-Pole Non-Reversing Contactors
AC or DC Operating Coil

Telemecanique
www.squared.com
FOR CURRENT INFORMATION


LC1D2510


LP1D1210


LC1D11500


LC1F115

3-Pole Contactors with AC and DC Operating Coils

Maximum Horsepower Ratings						Maximum Current		Auxiliary Contacts Built In		AC Control		DC Control	
Single Phase		Three Phase				Inductive	Resistive			Catalog Number▲	Price	Catalog Number▲	Price
115V HP	230V HP	200V HP	230V HP	460V HP	575V HP	AC3 Amperes	AC1 Amperes	N.O.	N.C.				
0.5	1	2	2	5	7.5	9	20	1	0	LC1D0910●●♦	$ 91.	LP1D0910●●♦	$ 115.
								0	1	LC1D0901●●♦	91.	LP1D0901●●♦	115.
1	2	3	3	7.5	10	12	25	1	0	LC1D1210●●♦	115.	LP1D1210●●♦	140.
								0	1	LC1D1201●●♦	115.	LP1D1201●●♦	140.
1	3	5	5	10	15	18	35	1	0	LC1D1810●●♦	131.	LP1D1810●●♦	155.
								0	1	LC1D1801●●♦	131.	LP1D1801●●♦	155.
2	3	7.5	7.5	15	20	25	40	1	0	LC1D2510●●♦	146.	LP1D2510●●♦	175.
								0	1	LC1D2501●●♦	146.	LP1D2501●●♦	175.
2	5	10	10	20	30	32	50	1	0	LC1D3210●●♦	166.	LP1D3210●●♦	206.
								0	1	LC1D3201●●♦	166.	LP1D3201●●♦	206.
3	5	10	10	30	30	40	60	1	1	LC1D4011●●♦	211.	LP1D4011●●♦	266.
3	7.5	15	15	40	40	50	70	1	1	LC1D5011●●♦	226.	LP1D5011●●♦	281.
5	10	20	20	50	50	65	80	1	1	LC1D6511●●♦	311.	LP1D6511●●♦	366.
7.5	15	30	30	60	60	80	110	1	1	LC1D8011●●♦	351.	LP1D8011●●♦	406.
		30	40	75	100	115	175	0	0	LC1D1150●●♦	463.	LC1D11500●●♦	463.
		40	50	100	125	150	200	0	0	LC1D1500●●♦	672.	LC1D15000●●♦	672.
		30	40	75	100	115	175	1*	0	LC1F115●	463.	LC1F115●	463.
		40	50	100	125	150	200	1*	0	LC1F150●	672.	LC1F150●	672.
		50	60	125	150	185	200	1*	0	LC1F185●	906.	LC1F185●	906.
		60	75	150	175	265	285	1*	0	LC1F265●	1139.	LC1F265●	1139.
		75	100	200	250	330	360	1*	0	LC1F330●	1566.	LC1F330●	1566.
		100	125	250	300	400	420	1*	0	LC1F400●	1785.	LC1F400●	1785.
		150	200	400	500	500	700	1*	0	LC1F500●	4802.	LC1F500●	4802.
		250	300	600	800	630	1000	1*	0	LC1F630●	6640.	LC1F630●	6640.
		Current rated				780	1350	0	0	LC1F780●	7525.	LC1F780●	7525.
		—	450	800	900	800	1000	0	0	LC1F800●□	6450.	LC1F800●□	6450.

* This one normally open holding circuit contact is incorporated in the design of the standard coil.
▲ Contactor catalog number to be completed by the code corresponding to the coil voltage.
♦ Contactor supplied with touch safe cable clamps. For ring terminal configuration add "6" before coil voltage suffix.

●● AC Coil voltages for LC1 D09 to D80 and LC1D115 to D150

Volts AC	24	48	110	120	127	208	220	240	277	380	415	440	480	575	600	660
50 Hz	B5	E5	F5	-	G5	-	M5	U5	-	Q5	N5	R5	-	-	-	Y5
60 Hz	B6	E6	F6	G6	-	L6	M6	U6	W6	Q6		R6	T6	S6	X6	-
50/60 Hz	B7	E7	F7	-	-	-	M7	U7	-	Q7	N7	R7	-	-	-	-

(D115/D150 include surge suppression)

●● DC Coil voltages for LP1 D09 to D80 and LC1D115 to D150

Volts DC	12	24	36	48	60	72	110	125	220	250	440	-	-	-	-	-
Coil code	JD	BD	CD	ED	ND	SD	FD	GD	MD	UD	RD	-	-	-	-	-

(D115/D150 include surge suppression)

● AC Coil voltages for LC1 F115 to F780

Contactor	Hz	24V	48V	110V	120V	125V	208V	220V	240V	250V	380V	415V	440V	480V	600V
F115, F150	50Hz	B5	E5	F5	-	-	-	M5	U5	-	Q5	-	-	-	-
F185	60 Hz	B6	E6	F6	G6	-	L6	M6	U6	-	Q6	N5	-	Q5	SC
F265, F330	50/60 Hz	B7	E7	F7	G7	-	L7	M7	U7	-	Q7	Q7	-	S7	X7
F400-F780	50/60 Hz	-	E7	F7	F7	-	L7	M7	U7	-	Q7	N7	-	N7	X7♦

Application Note: If contactor dropout time is critical, see Pages 15-17 or 15-19 before selecting a coil code suffix for LC1 F265 through F780.

♦ 600 volt coil not available for F780.

● DC Coil voltages for LC1 F115 to F780

F115-F330	-	BD	ED	FD	-	GD	-	MD	-	UD	-	-	RD	-	-
F400-F780	-	-	ED	FD	-	GD	-	MD	-	UD	-	-	RD	-	-

Application Note: If contactor dropout time is critical, see Pages 15-17 or 15-19 before selecting a coil code suffix for LC1 F265 through F780.

□ AC and DC Coil voltages for F800 (includes built-in surge suppressor)

Volts AC/DC	24	48	110	120	127	208	220	240	277	380	415	440	480	575	600	660
	-	-	FW	FW	FW	-	MW	MW	-	QW	QW	QW	-	-	-	-

Lugs

Contactor Type LC1	Lug Kit Catalog Number	Cable Size AL/CU	Price
F115	DZ2FF6	14 to 2/0	$ 38.
F150, F185	DZ2FG6	6 to 3/0	63.
F265, F330	DZ2FH6	6 to 300 MCM	63.
F400	DZ2FJ6	4 to 500 MCM	63.
F500	DZ2FK6	2 x 2 x 600 MCM	127.
F630, F800	DZ2FL6	2 x 2 x 600 MCM	158.
F780	DZ2FX6	1 x 1/0 x 750 MCM	158.

Lugs for LC1F must be ordered separately. Each kit consists of six (6) lugs. Mounting hardware (screws, washers nuts.) are provided with the contactor, not the lugs.

For additional information about D-Line, reference catalog number 8502CT9704 or D-Fax™ number 1614, 1709, 1714, 1736, 2275, 2276,2277.
For additional information about F-Line, reference catalog number 8502CT9702 or D-Fax™ number 1615, 1684, 1686, 1688.

I12 Discount Schedule

3/00

ZB4BZ101

Contact Blocks (Mounting Base with Contact Blocks)

Description	Type of Contact N/O	Type of Contact N/C	Catalog Number	Price
Screw clamp terminal connections	1	–	ZB4BZ101	$ 10.60
	–	1	ZB4BZ102	10.60
	2	–	ZB4BZ103	18.50
	–	2	ZB4BZ104	18.50
	1	1	ZB4BZ105	18.50
	1	2	ZB4BZ141	26.40

Complete Bodies (Mounting Collar + Single Contact Block + Light Module with Protected LED)

Light Source	Type of Contact ■ N/O	Type of Contact ■ N/C	Color	Supply Voltage 24 Vac or Vdc Catalog Number	Supply Voltage 110-120 Vac Catalog Number	Price
Screw clamp terminal connections						
Protected LED	1	–	White	ZB4BW0B11	ZB4BW0G11	$ 35.50
			Green	ZB4BW0B31	ZB4BW0G31	
			Red	ZB4BW0B41	ZB4BW0G41	
			Yellow	ZB4BW0B51	ZB4BW0G51	
			Blue	ZB4BW0B61	ZB4BW0G61	
	–	1	White	ZB4BW0B12	ZB4BW0G12	35.50
			Green	ZB4BW0B32	ZB4BW0G32	
			Red	ZB4BW0B42	ZB4BW0G42	
			Yellow	ZB4BW0B52	ZB4BW0G52	
			Blue	ZB4BW0B62	ZB4BW0G62	
	2	–	White	ZB4BW0B13	ZB4BW0G13	43.40
			Green	ZB4BW0B33	ZB4BW0G33	
			Red	ZB4BW0B43	ZB4BW0G43	
			Yellow	ZB4BW0B53	ZB4BW0G53	
			Blue	ZB4BW0B63	ZB4BW0G63	
	1	1	White	ZB4BW0B15	ZB4BW0G15	43.40
			Green	ZB4BW0B35	ZB4BW0G35	
			Red	ZB4BW0B45	ZB4BW0G45	
			Yellow	ZB4BW0B55	ZB4BW0G55	
			Blue	ZB4BW0B65	ZB4BW0G65	

ZB4BW0•3

■ Can be fitted with additional contact blocks, see Page 16-26.

Contact Block and Light Module (with screw clamp terminal connections) ■

Supply	Light Source	Supply Voltage	Type of Contact ■ N/O	Type of Contact ■ N/C	Color of Light Source	Catalog Number	Price
Screw clamp terminal connections							
Direct supply	BA 9s 2.4 W max. bulb Not included ▲	≤ 250 Vac or Vdc	1	–	–	ZB4BW061	$ 26.50
			–	1	–	ZB4BW062	26.50
			2	–	–	ZB4BW063	34.40
			1	1	–	ZB4BW065	34.40
Transformer type 1.2 VA, 6 V secondary	BA 9s incandescent bulb included	110-120 Vac 50/60 Hz	1	–	–	ZB4BW031	55.00
			1	1	–	ZB4BW035	63.00
		230-240 Vac 50/60 Hz	1	–	–	ZB4BW041	55.00
			1	1	–	ZB4BW045	63.00
		400 Vac 50 Hz	1	–	–	ZB4BW051	55.00
			1	1	–	ZB4BW055	63.00

ZB4BW06•

ZB4BW0•5

■ Can be fitted with additional contact blocks, see Page 16-26.
▲ Bulb to be ordered separately, see Page 16-31.

For additional information, reference: Catalog Number 9001CT9902 or D-Fax™ #4349.

Push Buttons – XB4 22 mm
Pilot Lights

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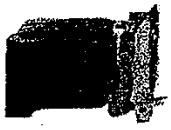
ZB4BV063


ZB4BV04


ZB4BV6


ZB4BV•


ZB4BV••

Pilot Light Heads

Shape of Head	For Use with Body Comprising Light Module Type	Color of Lens	Catalog Number	Price
○	Protected LED only	White	ZB4BV013	$ 3.70
		Green	ZB4BV033	
		Red	ZB4BV043	
		Yellow	ZB4BV053	
		Blue	ZB4BV063	
	For BA 9s incandescent bulb, neon or LED only	White	ZB4BV01	3.70
		Green	ZB4BV03	
		Red	ZB4BV04	
		Yellow	ZB4BV05	
		Blue	ZB4BV06	
		Clear	ZB4BV07	

Complete Bodies (Mounting Collar + Light Module for BA 9s Incandescent Bulb, Neon or LED)

Description	Light Source	Supply Voltage (V)	Catalog Number	Price
Screw clamp terminal connections				
Direct supply	BA 9s bulb 2.4 W max. Not included •	≤ 250	ZB4BV6	$ 18.60
Transformer type 1.2 VA, 6 V secondary	BA 9s incandescent bulb included	110-120 Vac 50/60 Hz	ZB4BV3	47.50
		230-240 Vac 50/60 Hz	ZB4BV4	
		400-50 Hz	ZB4BV5	
		440-480 Vac 60 Hz	ZB4BV8	
		550-600 Vac 60 Hz	ZB4BV9	

• Bulb to be ordered separately, see Page 16-31.

Complete Bodies (Mounting Collar + Light Module with Protected LED)

Light Source	Supply Voltage	Color of Light Source	Catalog Number	Price
Screw clamp terminal connections				
Protected LED	24 Vac or Vdc	White	ZB4BVB1	$ 27.60
		Green	ZB4BVB3	
		Red	ZB4BVB4	
		Yellow	ZB4BVB5	
		Blue	ZB4BVB6	
	110-120 Vac	White	ZB4BVG1	27.60
		Green	ZB4BVG3	
		Red	ZB4BVG4	
		Yellow	ZB4BVG5	
		Blue	ZB4BVG6	

16 PUSH BUTTONS AND OPERATOR INTERFACE

For additional information, reference: Catalog Number 9001CT9902 or D-Fax™ #4349.

Discount Schedule

3/00

Push Buttons – XB4 22 mm
Selector Switches

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ZB4BD4
Standard Lever


ZB4BJ3
Extended Lever


ZB4BG8

Non-Illuminated Selector Switches ■ ▲

Color	Number and Type of Positions		Standard Lever Catalog Number	Extended Lever Catalog Number	Price
Black	2 - maintained		ZB4BD2	ZB4BJ2	$ 11.60
Black	2 - momentary from right to left		ZB4BD4	ZB4BJ4	14.20
Black	3 - maintained		ZB4BD3	ZB4BJ3	11.60
Black	3 - momentary to center		ZB4BD5	ZB4BJ5	14.20
Black	3 - momentary from left to center		ZB4BD7	ZB4BJ7	14.20
Black	3 - momentary from right to center		ZB4BD8	ZB4BJ8	14.20

Non-Illuminated Key Switches

Shape of Head	Type of Operator	Number and Type of Positions		Catalog Number ●	Price
	Key (No. 455)	2 - maintained		ZB4BG2	$ 43.30
				ZB4BG4	
		2 - momentary from right to left		ZB4BG6	
		3 - maintained		ZB4BG0	
				ZB4BG3	
				ZB4BG5	
				ZB4BG9	
				ZB4BG09	
		3 - momentary from left to center		ZB4BG1	56.00
		3 - momentary to center		ZB4BG7	
		3 - momentary from right to center		ZB4BG8	
				ZB4BG08	

The symbol ⚿ indicates key withdrawal position(s).
■ For actuation of outside contacts only.
▲ See selector switch sequence charts below.
● Other key numbers:
- key No. 421E: add the suffix 12 to the reference.
- key No. 458A: add the suffix 10 to the reference.
- key No. 520E: add the suffix 14 to the reference.
- key No. 3131A: add the suffix 20 to the reference.

Example: The catalog number for a head with key No. 421E for a 2 position maintained, lockable selector switch, with key withdrawal from the left-hand position, becomes: ZB4BG212.

Selector Switch Sequence (using contact block assemblies, Page 16-25; or complete bodies, Page 16-25.)

2 Position Selector Switch		
①	②	Contact block guide ♦
O	X	1 N.O. (left or right)
X	O	1 N.C. (left or right)
O	X	1 N.O. and 1 N.C.
X	O	

3 Position Selector Switch			
①	②	③	Contact block guide ♦
X	O	O	1 N.O. (left)
O	X	O	2 N.C. wired in SERIES, (side by side)
O	O	X	1 N.O. (right)
X	X	O	1 N.C. (right)
O	X	X	1 N.C. (left)
X	O	X	2 N.O. wired in PARALLEL, (side by side)

♦ As viewed from the front of the panel.

For additional information, reference: Catalog Number 9001CT9902 or D-Fax™ #4349.

Discount Schedule

3/00

Push Buttons – XB4 22 mm
Complete Devices

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XB4BV85

Pilot Lights with Protected LED (screw clamp terminal connections)

Shape of Head	Supply Voltage	Color	Catalog Number (Components)	Price
Protected LED	24 Vac/Vdc	White	XB4BVB1 (ZB4BVB1 + ZB4BV013)	$ 31.30
		Green	XB4BVB3 (ZB4BVB3 + ZB4BV033)	
		Red	XB4BVB4 (ZB4BVB4 + ZB4BV043)	
		Yellow	XB4BVB5 (ZB4BVB5 + ZB4BV053)	
		Blue	XB4BVB6 (ZB4BVB6 + ZB4BV063)	
	110-120 Vac	White	XB4BVG1 (ZB4BVG1 + ZB4BV013)	31.30
		Green	XB4BVG3 (ZB4BVG3 + ZB4BV033)	
		Red	XB4BVG4 (ZB4BVG4 + ZB4BV043)	
		Yellow	XB4BVG5 (ZB4BVG5 + ZB4BV053)	
		Blue	XB4BVG6 (ZB4BVG6 + ZB4BV063)	


XB4BV64

Pilot Lights for BA 9s Bulb (screw clamp terminal connections)

Shape of Head	Supply Voltage	Color	Catalog Number (Components)	Price
Direct supply, for BA 9s (incandescent, LED, neon) V ≤ 250 V, 2.4 W bulb (bulb not included)				
	≤ 250 Vac/Vdc	White	XB4BV61 (ZB4BV6 + ZB4BV01)	$ 22.30
		Green	XB4BV63 (ZB4BV6 + ZB4BV03)	
		Red	XB4BV64 (ZB4BV6 + ZB4BV04)	
		Yellow	XB4BV65 (ZB4BV6 + ZB4BV05)	
Transformer type with 1.2 VA, 6 V secondary, BA 9s incandescent bulb included				
	110-120 Vac 50/60 Hz	White	XB4BV31 (ZB4BV3 + ZB4BV01)	51.20
		Green	XB4BV33 (ZB4BV3 + ZB4BV03)	
		Red	XB4BV34 (ZB4BV3 + ZB4BV04)	
		Yellow	XB4BV35 (ZB4BV3 + ZB4BV05)	


XB4BV33


XB4BW33B5

Illuminated Push Buttons, Momentary, Flush (screw clamp terminal connections)

Shape of Head	Description	Type of Contact N/O	Type of Contact N/C	Supply Voltage	Color of Push	Catalog Number (Components)	Price
	Protected LED	1	1	24 Vac/Vdc	White	XB4BW31B5 (ZB4BW0B15 + ZB4BW313)	$ 52.40
					Green	XB4BW33B5 (ZB4BW0B35 + ZB4BW333)	
					Red	XB4BW34B5 (ZB4BW0B45 + ZB4BW343)	
					Yellow	XB4BW35B5 (ZB4BW0B55 + ZB4BW353)	
					Blue	XB4BW36B5 (ZB4BW0B65 + ZB4BW363)	
				110-120 Vac	White	XB4BW31G5 (ZB4BW0G15 + ZB4BW313)	52.40
					Green	XB4BW33G5 (ZB4BW0G35 + ZB4BW333)	
					Red	XB4BW34G5 (ZB4BW0G45 + ZB4BW343)	
					Yellow	XB4BW35G5 (ZB4BW0G55 + ZB4BW353)	
					Blue	XB4BW36G5 (ZB4BW0G65 + ZB4BW363)	
	Direct supply for BA 9s 2.4 W max. bulb Not included	1	1	≤ 250 Vac/Vdc	White	XB4BW3165 (ZB4BW065 + ZB4BW31)	43.40
					Green	XB4BW3365 (ZB4BW065 + ZB4BW33)	
					Red	XB4BW3465 (ZB4BW065 + ZB4BW34)	
					Yellow	XB4BW3565 (ZB4BW065 + ZB4BW35)	
	Transformer type 1.2 VA, 6 V secondary, BA 9s incandescent bulb included	1	1	110-120 Vac 50/60 Hz	White	XB4BW3135 (ZB4BW035 + ZB4BW31)	72.00
					Green	XB4BW3335 (ZB4BW035 + ZB4BW33)	
					Red	XB4BW3435 (ZB4BW035 + ZB4BW34)	
					Yellow	XB4BW3535 (ZB4BW035 + ZB4BW35)	
				230-240 Vac 50/60 Hz	White	XB4BW3145 (ZB4BW045 + ZB4BW31)	72.00
					Green	XB4BW3345 (ZB4BW045 + ZB4BW33)	
					Red	XB4BW3445 (ZB4BW045 + ZB4BW34)	
					Yellow	XB4BW3545 (ZB4BW045 + ZB4BW35)	


XB4BW34G5


XB4BW3545

For additional information, reference: Catalog Number 9001CT9902 or D-Fax™ #4349.

Discount Schedule

3/00

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Push Buttons – XB4 22 mm
Characteristics

Environment

Degree of protection	Conforming to IEC 529	IP 65, unless otherwise stated IP 66, for booted push button heads
	Conforming to UL 50 and CSA C22.2 No. 94	Type 1, 2, 3, 4, 4X, 12, and 13, unless otherwise stated
Conforming to standards	CE Marked	IEC 947-1, IEC/EN 60947-5-1, IEC 947-5-4, EN 60947-1, JIS C 4520, UL 508, CSA C22.2 No. 14
Product certifications	UL Listed, CSA File E164353 CCN NKCR; File LR 44087 Class 3211 03; File E164353 CCN NKCR 2	Standard single contacts with screw clamp terminals: A600; Q600 Double contacts with screw clamp terminals: A600; Q600 Light modules with screw clamp terminals JOYSTICK XD4-PA: A600; R300
	UL Recognized, CSA	Standard single contacts for plug-in connector: A300; R300 Standard single contact for printed circuit board: B300; R300
	BV, RINA, LROS, DNV, GL (pending)	Standard single contacts and double contacts with screw clamp terminals

Electrical Characteristics of Operators and Contact Blocks

Cabling capacity	Conforming to IEC 947-1	Screw and captive clamp terminals Min: 1 x 24 AWG (0.22 mm²) without cable end 1 x 22 AWG (0.34 mm²) for linking Max: 2 x 16 AWG (1.5 mm²) with cable end Cross headed screw (Pozidrive type 1) slotted for flat 4 and 5.5 mm screwdriver
Rated operational characteristics Conforming to IEC/EN 60947-5-1	AC supply: Utilization category AC-15	Standard blocks (single or double) with screw clamp terminals: A600: Ue = 600 Vac and Ie = 1.2 A or Ue = 240 Vac and Ie = 3 A or Ue = 120 Vac and Ie = 6 A Blocks for plug-in connector: A300: Ue = 120 Vac and Ie = 6 A or Ue = 240 Vac and Ie = 3 A Standard blocks for printed circuit board connection: B300: Ue = 120 Vac and Ie = 3 A or Ue = 240 Vac and Ie = 1.5 A
	DC supply: Utilization category DC-13	Standard single or double blocks with screw clamp terminals: Q600: Ue = 600 Vdc and Ie = 0.1 A or Ue = 250 Vdc and Ie = 0.27 A or Ue = 125 Vdc and Ie = 0.55 A Joystick XD4-PA: R300: Ue = 125 Vdc and Ie = 0.22 A or Ue = 250 Vdc and Ie = 0.1 A Blocks for plug-in connector: R300: Ue = 125 Vdc and Ie = 0.22 A or Ue = 250 Vdc and Ie = 0.1 A Standard blocks for printed circuit board connection: R300: Ue = 125 Vdc and Ie = 0.22 A or Ue = 250 Vdc and Ie = 0.1 A
Electrical durability Conforming to IEC/EN 60947-5-1 Appendix C Operating rate 3600 operating cycles/hour. Load factor: 0.5	AC supply for 1 million operating cycles, utilization category AC-15	Standard blocks for screw clamp terminals:

24 Vac	120 Vac	230 Vac
4 A	3 A	2 A

Standard double blocks with screw clamp terminal or plug-in connector:

24 Vac	120 Vac	230 Vac
3 A	1.5 A	1 A

DC supply for 1 million operating cycles, utilization category DC-13

Standard single blocks for screw clamp terminals:

24 Vdc	110 Vdc
0.5 A	0.2 A

Standard double blocks with screw clamp terminal or plug-in connector:

24 Vdc	110 Vdc
0.4 A	0.15 A

Electrical Characteristics of Light Modules

Cabling capacity	Conforming to IEC 947-1	Screw and captive clamp terminals Min: 1 x 24 AWG (0.22 mm²) without cable end 1 x 22 AWG (0.34 mm²) for linking Max: 2 x 16 AWG (1.5 mm²) with cable end

Specific Characteristics of Protected LED Light Modules Only

Voltage limits	Nominal voltage	24 V: 19.2 to 30 Vdc; 21.6 to 24.6 Vac
Current consumption	Applicable to all colors	24 Vac/Vdc supply blocks: 18 mA 120 Vac supply blocks: 14 mA 240 Vac supply blocks: 14 mA

For additional information, reference: Catalog Number 9001CT9902 or D-Fax™ #4349.
For Manufacturer's Declaration of Conformity, reference D-Fax™ #4354.

Discount Schedule

TeSys™ D-Line Contactors (IEC Rated)

Non-Reversing, AC or DC Operating Coil

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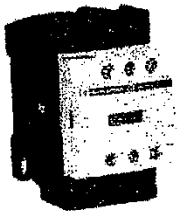
For the most up-to-date information


LC1D09


LC1D093


LC1D115


LC1DT20

3-Pole Contactors with AC and DC Operating Coils

Maximum Horsepower Ratings						Maximum Current		Auxiliary Contacts Built In		Catalog Number ▲■	AC Control Price	DC Control Price
Single Phase		Three Phase				Inductive AC3 Amperes	Resistive AC1 Amperes	N.O.	N.C.			
115 V hp	230 V hp	200 V hp	230 V hp	460 V hp	575 V hp							
0.5	1	2	2	5	7.5	9	20	1	1	LC1D09	$ 94.	$119.
1	2	3	3	7.5	10	12	25	1	1	LC1D12	119.	149.
1	3	5	5	10	15	18	35	1	1	LC1D18	136.	160.
2	3 5	7.5 10	7.5 10	15 20	20 30	25 32	40 50	1 1	1 1	LC1D25 LC1D32	151. 172.	181. 213.
3	5 7.5	10 15	10 15	30 40	30 40	40 50	60 70	1 1	1 1	LC1D40 LC1D50	218. 234.	275. 291.
5	10	20	20	50	50	65	80	1	1	LC1D65	322.	379.
7.5	15	30	30	60	60	80	110	1	1	LC1D80	363.	420.
...	...	30	40	75	100	115	175	1	1	LC1D115	479.	479.
...	...	40	50	100	125	150	200	1	1	LC1D150	696.	696.

4-pole Contactors with AC and DC Operating Coils

Maximum Current Utilization Categories	Number of Poles		Instantaneous Auxiliary Contacts		Catalog Number ▲■	AC Control Price	DC Control Price
AC-1	N.O.	N.C.	N.O.	N.C.			
20	4	0	1	1	LC1DT20	$ 94.	$119.
	2	2	1	1	LC1D098	94.	119.
25	4	0	1	1	LC1DT25	119.	149.
	2	2	1	1	LC1D128	119.	149.
32	4	0	1	1	LC1DT32	149.	183.
	2	2	1	1	LC1D188	149.	183.
40	4	0	1	1	LC1DT40	193.	240.
	2	2	1	1	LC1D258	193.	240.
60	4	0	1	1	LC1D40004	296.	353.
	2	2	1	1	LC1D40008	296.	353.
80	4	0	0	0	LC1D65004	446.	...
	4	0	0	0	LP1D65004	...	503.
	2	2	0	0	LC1D65008	446.	...
	2	2	0	0	LP1D65008	...	503.
125	4	0	0	0	LC1D80004	489.	...
	4	0	0	0	LP1D80004	...	524.
	2	2	0	0	LC1D80008	489.	...
	2	2	0	0	LP1D80008	...	524.
200	4	0	0	0	LC1D115004	630.	630.

▲ Use voltage codes from the "Voltage Codes" table below to complete the catalog number.
■ Contactor supplied with touch safe cable clamps. For ring terminal configuration add "6" before coil voltage suffix. For spring terminal configuration add "3" before coil voltage suffix. No price adder for these modifications.

Voltage Codes (D-Line Only)▼

Contactor	Hz	24 V	48 V	110 V	120 V	125 V	208 V	220 V	240 V	250 V	440 V	480 V	600 V
AC													
LC1D40–LC1D150 only (see notes)	50	B5	E5	F5	...	...	...	M5	U5	...	...	...	...
	60	B6	E6	F6	G6	...	L6	M6	U6	...	...	Q5	X6♦
All (see notes)	50/60	B7	E7	F7	G7	...	LE7	M7	U7	...	...	T7	X7★
DC (D09–D32, D115 and D150 coils with integral suppression device are fitted as standard)													
D09–D32 Low Consumption	...	BL	EL	FL	...	...	...	ML	...	UL	...	...	...
All	...	BD	ED	FD	...	GD	...	MD	...	UD	RD	...	...

♦ Not available for LC1D115 and LC1D150.
★ Not available for LC1D40–LC1D1500.
▼ Other voltages available. See page 16-17.

Dimensions ..... pages 16-24–16-32
Overload Relays ..... pages 16-19–16-20
Accessories ..... pages 16-8–16-13
Replacement Coils ..... pages 16-15–16-18

For additional information on D-Line contactors, reference Catalog #8502CT9901R5/03.

112 Discount Schedule

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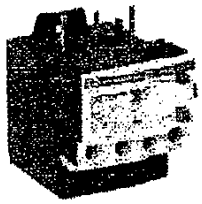
For the most up-to-date information

TeSys™ Overload Relays
D-Line Bimetallic



LRD22

Ambient Compensated bi-metallic overload relays

LRD overload relays are designed for direct mounting to D-line contactors. To mount these overloads separately, select separate mount kits from the table below.

D-Line overload relays

Current Setting Range Amperes	For direct mounting to LC1●●●	Class 10 with Single Phase Sensitivity	Class 10 without Single Phase Sensitivity	Class 20 with Single Phase Sensitivity	Class 20 without Single Phase Sensitivity	Price
.10–.16	D09–D32	LRD01	LR3D01	...	...	
.16–.25	D09–D32	LRD02	LR3D02	...	...	
.25–.40	D09–D32	LRD03	LR3D03	...	...	
.40–.63	D09–D32	LRD04	LR3D04	...	...	
.63–1	D09–D32	LRD05	LR3D05	...	...	$ 60.00
1–1.6	D09–D32	LRD06	LR3D06	...	...	
1.6–2.5	D09–D32	LRD07	LR3D07	...	...	
2.5–4	D09–D32	LRD08	LR3D08	LRD1508	LR3D1508A1	
4–6	D09–D32	LRD10	LR3D10	LRD1510	LR3D1510A1	
5.5–8	D09–D32	LRD12	LR3D12	LRD1512	LR3D1512A1	
7–10	D09–D32	LRD14	LR3D14	LRD1514	LR3D1514A1	
9–13	D12–D32	LRD16	LR3D16	LRD1516	LR3D1516A1	62.00
12–18	D18–D32	LRD21	LR3D21	LRD1521	LR3D1521A1	
16–24	D25–D32	LRD22	LR3D22	LRD1522	LR3D1522A1	
17–25	D25–D32	...	...	...	...	
23–32	D25–D32	LRD32	LR3D32	...	...	
23–28	D25–D32	...	...	LRD1530	LR3D1530A1	73.00
25–32	D25–D32	...	...	LRD1532	LR3D1532A1	
30–38	D32	LRD35	LR3D35	...	...	
17–25	D40–D80	LRD3322	LR3D3322	LR2D3522	LR3D3522	
23–32	D40–D80	LRD3353	LR3D3353	LR2D3553	LR3D3553	
30–40	D40–D80	LRD3355	LR3D3355	LR2D3555	LR3D3555	107.00
37–50	D50–D80	LRD3357	LR3D3357	LR2D3557	LR3D3557	
48–65	D50–D80	LRD3359	LR3D3359	LR2D3559	LR3D3559	
55–70	D65–D80	LRD3361	LR3D3361	LR2D3561	LR3D3561	
63–80	D65–D80	LRD3363	LR3D3363	LR2D3563	LR3D3563	127.00
80–104	D80	LRD3365	...	...	...	
80–104	D115–D150	LRD4365	...	...	...	
95–120	D115–D150	LRD4367	...	...	...	362.00
110–140	D150	LRD4369	...	...	...	

Mounting Kits and Plates

Description	For use with overload relays:	Catalog Number	Price
Separate mounting kits for mounting to 35 mm omega rail or for panel mounting with screws	LRD01–LRD35 and LR3D●●	LAD7B10	$ 8.70
	LRD15●●	LAD7B105	10.40
	LR●D1●●●	LA7D1064	8.70
	LR●D2●●●	LA7D2064	13.10
	LR●D3	LA7D3064	17.50
Mounting plates for screw mounting at 110 mm (4.3") centers	LRD, LR3D01-D32, LR2D15●●	DX1AP25	11.00
	LR2D25●●	DX1AP26	12.00
	LR3D3	LA7D092	16.40

LA7D901

Accessories

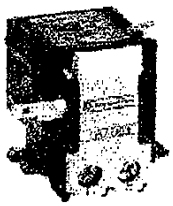
Description	For use with	Standard Packaging	Catalog Number	Price
Pre wiring kit allows direct connection of the N.C. contact of relay LRD01–D32 or LR3D01–D32 to the contactor	LC1D09 through D18	10	LAD7C1	$ 8.70
	LC1D25, D32	10	LAD7C2	8.70
Stop button locking device	All relays except LRD01–D32, LR3D01–D32 and LR9D	10	LA7D01	2.20
Remote stop/tripping or electrical reset♦	LRD01–D32, LR3D01–32	1	LAD703■	43.70
	All relays except LRD01–D32, LR3D01–D31	1	LA7D03■	43.70
Reset by flexible cable 500 mm (19.6 in.)	LRD01–D32	1	LAD7305	100.00

■ Part number to be completed by adding coil voltage code.

Control Circuit Voltages for LA7D03 and LAD703

Volts	12	24	48	110	220/230	380/400	415/440
AC 50/60 Hz	J★	B	E	F	M	Q	N
DC	J	B	E	F	M	...	...

♦ The time that the LA7D03 can remain energized depends on its rest time: 1 s pulse with 9 s rest time; 5 s pulse with 30 s rest time; 10 s pulse with 90 s rest time; maximum pulse duration of 20 s with rest time of 300 s. Consumption on inrush and sealed : < 100 VA
★ Not available for LRD01-D32, LR3D01-D32.



LA7D03

Dimensions..... page 16-30

For additional information, reference Catalog #8502CT9901R5/03.

Relay Sockets
Type N – Class 8501

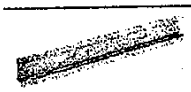
Square D
www.squared.com
FOR CURRENT INFORMATION

- 35mm DIN 3 Track Mount or Direct Panel Mount
- Tubular Sockets available in Easy-to-Wire Single Tier or Space-Saving Double Tier Versions

Sockets

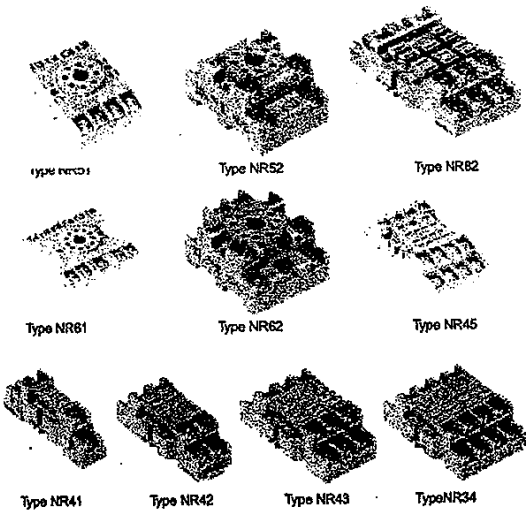
For Use With			Description	Socket Rating	Type	Price	Std. Qty. *
Class 8501 Type	Class 8430 Type	Class 9050 Type					
KP12 KPD12	MPS V24 (240 volts)	JCK11 – 19 JCK31 – 39 JCK51 – 59 JCK60 JCK1 F JCK3 F JCK5 F	8 Pin Tubular Single Tier Screw Terminal	10 Amp 300 Volts	NR51 NR51B	$ 7.90 6.60	1 20
			8 Pin Tubular Double Tier Screw Terminal	10 Amp 300 Volts	NR52 NR52B	7.90 6.60	1 20
KP13 KPD13	.....	JCK21 – 29 JCK41 – 49 JCK70 JCK2F JCK4F	11 Pin Tubular Single Tier Screw Terminal	10 Amp 300 Volts	NR61 NR61B	11.90 10.60	1 20
			11 Pin Tubular Double Tier Screw Terminal	10 Amp 300 Volts	NR62 NR62B	11.90 10.60	1 20
KL KU KX	MPS V29 (480 Volts)	.....	11 Pin Spade Double Tier Screw Terminal	15 Amp 300 Volts *	NR82 NR82B	13.20 11.90	1 20
			11 Pin Spade Chassis Mount Backwire Socket	10 Amp 300 Volts	NR9	2.60	1
RS41 RSD41	.....	.....	5 Pin Spade Double Tier Screw Terminal	10 Amp 300 Volts	NR41	17.20	20
RS42 RSD42	.....	.....	8 Pin Spade Double Tier Screw Terminal	10 Amp 300 Volts	NR42 NR42B	18.50 17.20	1 20
RS43 RSD43	.....	.....	11 Pin Spade Double Tier Screw Terminal	10 Amp 300 Volts	NR43	17.20	20
RS44 RSD44	.....	.....	14 Pin Spade Double Tier Screw Terminal	10 Amp 300 Volts	NR34	17.20	20
RS4 RSD4 RS14 RSD14 RS24 RSD24 RS34 RSD34	.....	.....	14 Pin Spade Double Tier Screw Terminal	7 Amp 300 Volts	NR45 NR45B	18.50 17.20	1 20

* Must be ordered in multiples of the quantity listed. Units provided in standard quantity of one are individually packaged; standard quantity of 20 are bulk packaged.
★ Rated for use with Class 8430 Type MPS at 480 Volts. Rated 10 Amp at 300 volts by CSA.

Kit Description		Class 9999 Type	Price	Std. Qty.*
	**DIN Mounting Track** A 1 meter section of 35mm DIN track aluminum	NT13	$5.90	10
	**Mounting Track-End Clamp** For use with Type NT13 DIN mounting track. Use of end clamps provides security against movement of devices on mounting track.	NT10	1.40	10

* Must be ordered in multiples of the quantity listed.

For additional track and end clamps, see Page 22-14.



Socket Accessories

For Use With	Description	Type	Price	Std.* Qty.
8501 K	Retainer Clip	NH2	$ .66	10
8501 RS4-34, 42 8501 RSD4-34, 42	Retainer Clip	NH3	.66	10
8501 RS41 8501 RSD41	Retainer Clip	NH31	.66	10
8501 RS43 8501 RSD43	Retainer Clip	NH33	.66	10
8501 RS44 8501 RSD44	Retainer Clip	NH34	.66	10
9999 NT13 DIN track	Socket Spacers. Use when relay base is wider than socket base. Width of spacer is .197 inches. Recommend 1 spacer between each Type NR51 and 2 spacers between each Type NR52 or NR62 when used with Class 9050 Type JCK or Class 8430 Type MPS (240 Volt) relays.	NH4	.66	10
8501 NR82 8501 NR45	Socket Connector. Fit between sockets. For collective panel mounting.	NH5	.66	10
8501 NR82 8501 NR45	Socket End Support. Use when panel mounting either individually or collectively.	NH6	.66	10
9050 JCK 8430 MPS (240V)	Restraining Strap.	NH7	5.30	1

* Must be ordered in multiples of the quantity listed.

UL/CSA:

File CCN E66924 SW1V2
File Class LR35144 3211 07

8501 NR45 - pressure wire clamps - 1 or 2 #14 -22 wires.
All other sockets - pressure wire clamps - 1 or 2 #12-22 wires.

How to Order:

To Order Specify:	Catalog Number	
● Class Number ● Type Number	Class	Type
	8501	NR51B

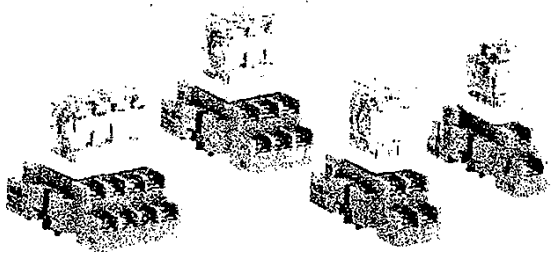
For additional information, reference the G.P. Relay Catalog # 8501CT9201 R10/96 or D-FAX™ # 1251.

CP2 Discount Schedule

3/00

Miniature Plug-In Relays
Class 8501 – Type R

Square D
www.squared.com
FOR CURRENT INFORMATION



- Compact Size
- SPDT through 4PDT
- AC or DC Operated
- Horsepower rated
- 10 Amp Resistive Rating
- Complete Socket Line
- Manual Operator/ Pilot Light Options

UL Contact Ratings

Type	Voltage	Resistive Rating	General Use Rating	Horsepower Rating
RS41	120 Vac	–	–	1/6
	240 Vac	10	7	1/3
RSD41	30 Vdc	10	7	–
RS42	120 Vac	–	–	1/6
	240 Vac	10	7	1/3
RSD42	30 Vdc	10	7	–
RS43	120 Vac	10	7.5	1/6
	240 Vac	7.5	6.5	1/3
RSD43	30 Vdc	10	–	–
RS44	120 Vac	10	7.5	–
	240 Vac	7.5	5	–
RSD44	28 Vdc	10	–	–

Application Data

Class 8501 Type...		RS41	RSD41	RS42	RSD42	RS43	RSD43	RS44	RSD44
Operating Data	Pick-Up Time	20 ms Maximum							
	Drop-Out Time	20 ms Maximum							
	Operating Temperature Range	-25°C to +50°C (-13°F to +122°F)							
Coil	Duty Cycle	Continuous							
	Voltage Range	AC coils +10%, -15% of nominal DC coils +10%, -20% of nominal							
	AC Coils	1.2 VA inrush, 1.0 VA sealed	–	2.0 VA inrush, 1.2 VA sealed	–	2.8 VA inrush, 1.7 VA sealed	–	3.2 VA inrush, 2.0 VA sealed	–
	DC Coils	–	0.8 watts	–	0.9 watts	–	1.5 watts	–	1.5 watts
UL	File CCN	–						–	
CSA	File CCN	E78351 NLDX2						E78427 NLDX2	
CSA	File Class	LR35144 3211 04						LR35144 3211 04	

Voltage Codes

Voltage	6 Vac	12 Vac	24 Vac	120 Vac	240 Vac	6 Vdc	12 Vdc	24 Vdc	110 Vdc
Voltage Code	V35	V36	V14	V20	V24	V50	V51	V53	V60

10 Amps	Input Voltage	Options	Type	Price Each	Std. Pack▲
SPDT	AC 50/60 Hz	None	RS41*	$19.00	20
	DC	None	RSD41*	19.00	20
Silver Cadmium Oxide Contacts					

10 Amps	Input Voltage	Options	Type	Price Each	Std. Pack▲
DPDT	AC 50/60 Hz	None	RS42*	$22.50	10
		Pilot Light	RS42P14*	27.70	10
		Manual Operator and Pilot Light	RS42M1P14*	29.10	10
	DC	None	RSD42*	22.50	10
		Pilot Light	RSD42P14*	27.70	10
		Manual Operator and Pilot Light	RSD42M1P14*	29.10	10
Silver Cadmium Oxide Contacts					

10 Amps	Input Voltage	Options	Type	Price Each	Std. Pack▲
3PDT	AC 50/60 Hz	None	RS43*	$25.30	10
		Pilot Light	RS43P14*	30.60	10
		Manual Operator and Pilot Light	RS43M1P14*	32.00	10
	DC	None	RSD43*	25.30	10
Silver Cadmium Oxide Contacts					

10 Amps	Input Voltage	Options	Type	Price Each	Std. Pack▲
4PDT	AC 50/60 Hz	None	RS44*	$28.50	10
		Pilot Light	RS44P14*	33.80	10
		Manual Operator and Pilot Light	RS44M1P14*	35.10	10
	DC	None	RSD44*	28.50	10
		Pilot Light	RSD44P14*	33.80	10
Silver Cadmium Oxide Contacts					

▲ Orders MUST specify standard package quantity or multiples of that quantity.

* The relay catalog number must be stocked by Square D in the warehouse or it is not available.

For additional information, reference the G.P. Relay Catalog # 8501CT9201 R10/96 or D-FAX™ # 1251.

CP2 | Discount Schedule

3/00

Hoffman®
A Pentair Company

CONCEPT®

Wall–Mount Enclosure
Gehäuse zur Wandmontage
Boîtier mural
Caja Para Montaje En Pared

Hoffman Enclosures Inc.
2100 Hoffman Way
Anoka, MN 55303–1745
(763) 422–2211
www.hoffmanonline.com

Pentair Electronic Packaging
170 Commerce Drive
Warwick, RI 02886
(401) 732–3770
www.pentair–ep.com

Mexico
Pentair Enclosures, S. de R.L. de C.V.
Federico T. de la Chica No. 8 Piso 4 A
Circuito Comercial Plaza Satélite
Ciudad Satélite,
Naucalpan, México C.P. 53100
011–52–55–5393–8263

Canada
Hoffman–Schroff
111 Grangeway Avenue, Suite 504
Scarborough, Ontario M1H 3E9
(416) 289–2770
1–800–668–2500 (Canada only)

Germany
Schroff GmbH
Langenalber Str. 96–100
75334 Straubenhardt
49 (07082) 794–0 www.schroff.de

Great Britain
Schroff UK Ltd.
Maylands Avenue
Hemel Hempstead, Herts HP2 7DE
44 (01442) 240471 www.schroff.co.uk

Sweden
Schroff Scandinavia AB
Box 2003
12821 Skarpnäck
46 08683 61 00 www.schroff.se

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33 03 88 90 64 90 www.schroff.fr

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39 0331 79 40 03

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#01–68/71 German Centre
25 International Business Park
Singapore 609916
65 5 62–78 90

Japan
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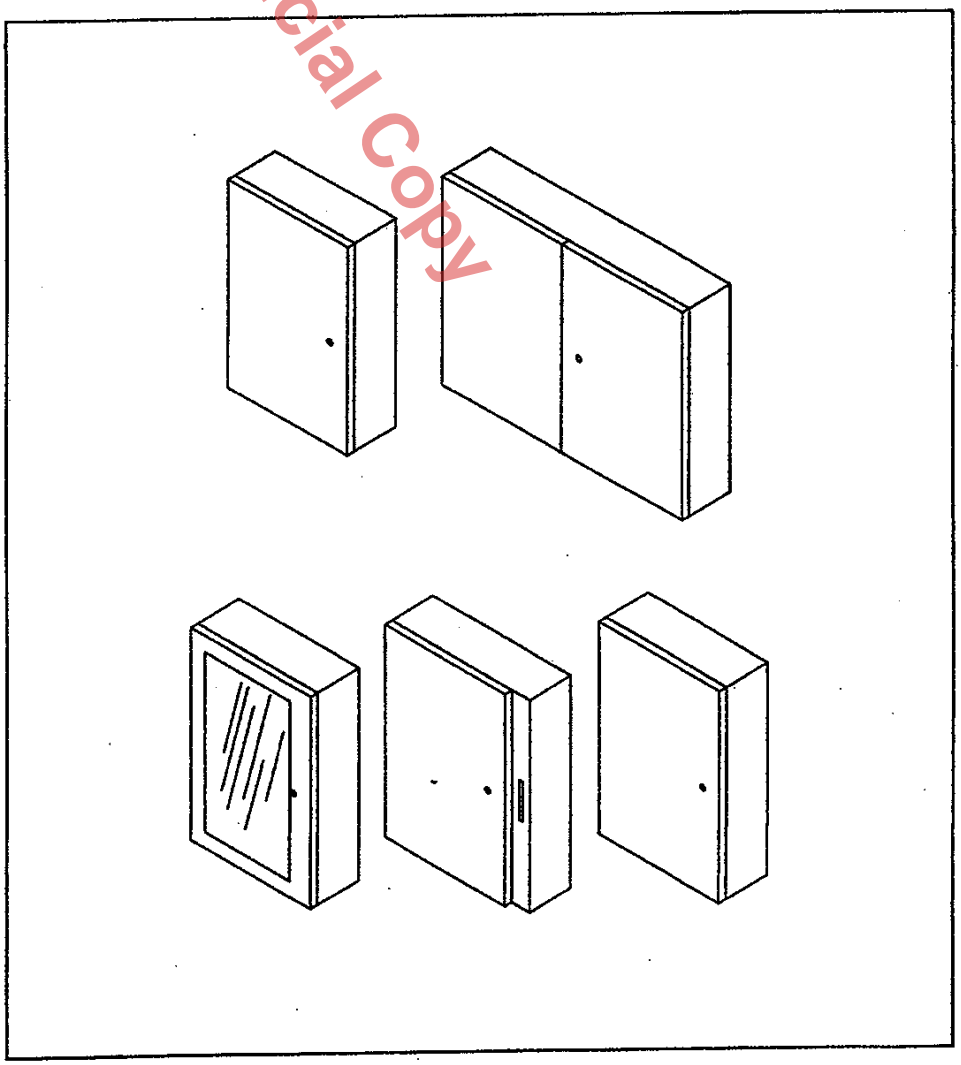
2–5–1 Shinyokohama
Kohoku–Ku, Yokohama shi
Kanagawa 222–0033
81 (045) 476–02 81

Finland
Schroff Scandinavia AB
Peräsimentie 8
03100 Nummela
358 09 222 68 00

Norway
Schroff Scandinavia AB
Bjoernerudveien 24
1266 Oslo
47 022 76 33 60



Rev. D 107520

P/N 64303001

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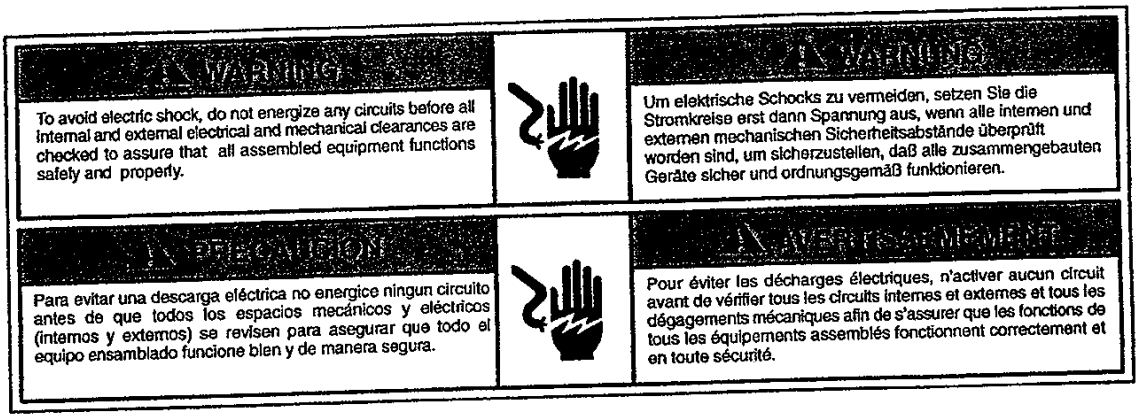

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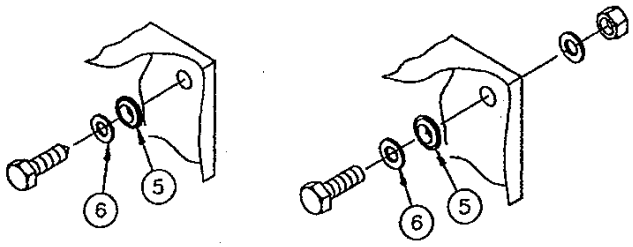
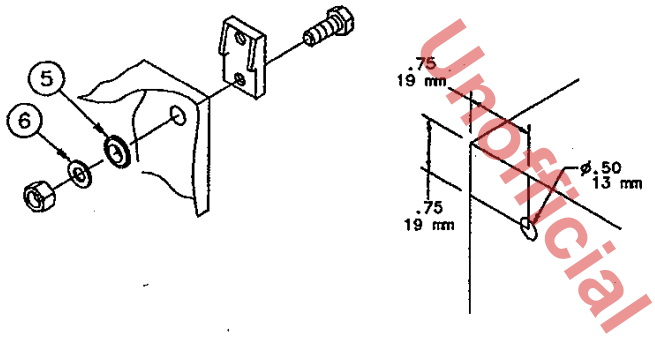
MOUNTING INSTRUCTIONS (optional mounting feet)
MONTAGEANLEITUNG (optionale Montagefüße siehe)
INSTRUCTIONS DE MONTAGE (pattes de montage en option)
INSTRUCCIONES PARA MONTAJE (Pata de Montaje Opcional)





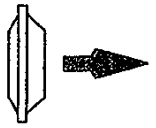
ENGLISH
Mounting holes have been provided in the back of the enclosure for convenient mounting through the enclosure. Attach enclosure to wall or other structure using customer supplied 3/8 inch fasteners, flat washers, and nuts. To insure proper sealing and enclosure protection rating, use the provided sealing washers. Install the sealing washers inside the enclosure with tapered cone against the enclosure and then add the flat washers.

DEUTSCH
Entlüftungslöcher sind in der Rückseite der Einschließung für bequeme Montage durch die Einschließung zur Verfügung gestellt worden. Bringen Sie Einschließung zur Wand an, oder andere Struktur, die Kunden verwendet, lieferte die 3/8–Zoll–Befestiger die flachen Unterlegscheiben und die Nüsse. Um korrekte Dichtung und Einschließung zu versichern Schutzbewertung, benutzen Sie die zur Verfügung gestellten Dichtringe. Bringen Sie die Dichtringe innerhalb der Einschließung mit sich verjüngendem Kegel gegen die Einschließung an und addieren Sie dann die flachen Unterlegscheiben.

FRANÇAIS
Des trous de support ont été donnés dans le dos de la clôture pour le support commode par la clôture. Attachez la clôture au mur ou l'autre structure employant le client a fourni des attaches de 3/8 pouce, des rondelles plates, et des écrous. Pour assurer l'estimation appropriée de protection de cachetage et de clôture, employez les rondelles de cachetage fournies. Installez les rondelles de cachetage à l'intérieur de la clôture avec le cône conique contre la clôture et puis ajoutez les rondelles plates.

ESPAÑOL
Los agujeros de montaje se han proporcionado en la parte posteriora del recinto para el montaje conveniente con el recinto. Una el recinto a la pared o la otra estructura que usaba a cliente proveló los sujetadores de 3/8 pulgada, las arandelas planas, y las tuercas. Para asegurar el grado apropiado de la protección del lacre y del recinto, utilice las arandelas de lacre proporcionadas. Instale las arandelas de lacre dentro del recinto con el cono afilado contra el recinto y después agregue las arandelas planas.

Sealing Washer Detail
Dichtring–Detail
Détail De Rondelle De Cachetage
Detalle De la Arandela De Lacre



Hole Side
Bohrung Seite
Côté De Trou
Lado Del Agujero

ENGLISH
Mounting Feet
UL/CSA Requirement:
- Use of mounting feet mandatory on all type 3,4,4X applications.
- If wall mounting provisions have been omitted, holes must be added per detail above.

The use of the optional mounting feet allows simple mounting with fasteners outside the enclosure.
- Steel Zinc Plated Mounting Foot Kit P/N CMFK
- Stainless Steel Mounting Foot Kit P/N CMFKSS
- Composite Mounting Foot Kit P/N CMTGFT

Kits provide all necessary hardware to install the mounting feet as shown.
(order seperately)

ESPAÑOL
Pie de montaje
Los requisitos del UL/CSA:
- Es obligatorio el uso de pie de montaje en todos los artículos del tipo 3,4,4X.
- Si los orificios para los pies de montaje han sido omitidos, estos deberan ser hechos siguiendo las instrucciones señaladas arriba.

El uso opcional de estos, permite un montaje más sencillo con seguros en el exterior de la caja.
- Juego de pie de mantaje de acero Zinc plateado CMFK
- Juego de pie de montaje de acero inoxidable CMFKSS
- Juego de pie de montaje compuesto CMTGFT

Los kits proporcionan a toda la dotación física necesaria para instalar los pies del montaje según lo mostrado.
(ordenar por separado)

DEUTSCH
Montagefüße
UL/CSA Anforderungen:
- Die Verwendung von Montagefüßen ist für alle Typ 3,4,4X Anwendungen vorgeschrieben.
- Falls die Montagefusskoecher weggelassen wurden, muessen Loecher gemaess obenstehendem Detail hinzugefuegt werden.

Die Verwendung der optionalen Montagefüße erlaubt eine einfache Montage mit Schrauben von außerhalb des Gehäuses.
- Montagefußbausatz, verzinkt, CMFK
- Montagefußbausatz, Edelstahl, CMFKSS
- Montagefußbausatz, Verbund, CMTGFT

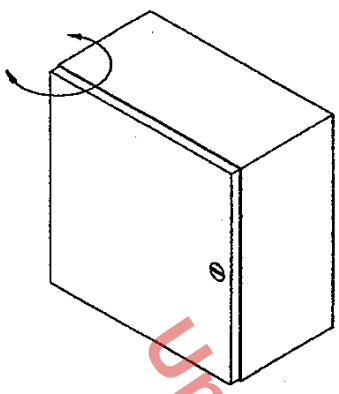
Bausätze beinhalten alle notwendige Hardware um die Montagefüße wie abgebildet zu installieren. *(getrennt bestellen)*

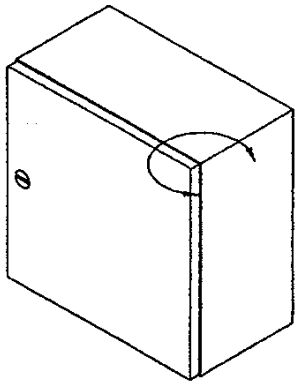
FRANÇAIS
Pattes de Montage
Exigence du UL/CSA
L'utilisation des pattes de montage est mandatoire sur tous les types 3,4,4X applications.
- L'utilisation des pattes de montage optionnelles permet de l'extérieure le simple montage de l'élément avec des attaches.
- Si les trous des pattes de fixation murale on ete omis, des trous doivent etre ajoutes d'apres les instructions ci–dessus.

- Pattes de montage Kit, zinc plaque acier CMFK
- Pattes de montage Kit, acier inoxidable CMFKSS
- Pattes de montage Kit, composite CMTGFT

Les Kits contiennent tous les éléments nécessaires pour installer les pattes de montages comme montrés. *(obtenez separatement)*

REVERSING DOOR HINGES (lower door only)
UMKEHREN DER TÜRSCHARNIERE (nur untere Tür)
INVERSION DES CHARNIÈRES DE PORTES (porte inférieure seulement)
BISAGRAS PARA INTER CAMBIO DE POSICION DE PUERTAS





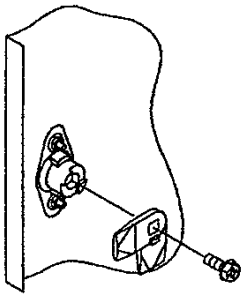
ENGLISH
1) Remove door from body by removing hinge pins.
2) Unscrew hinges from body.
3) Drill Ø.203 (5.16 mm) on opposite enclosure flange at drill point locations.
4) Reinstall hinges and door.
5) Seal the unused hinge holes with customer supplied #10 or M5 screw and silicone sealer.

ESPAÑOL
1)Retire la puerta del cuerpo al mover las bisagras.
2)Desatornille las bisagras del cuerpo.
3)Hacer un hueco con el taladro Ø.203 (5.16mm) en la bisagra del enclaustro opuesto a la ubicación del punto del taladro.
4)Reinstale las bisagras y la puerta.
5)Los orificios de la bisagra que no se usarán se sellarán con el tornillo #10 ó M5 y con el sellador de silicón.

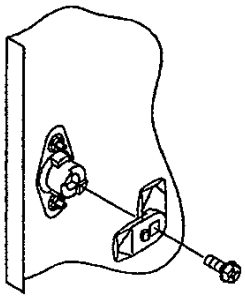
DEUTSCH
1) Entfernen Sie die Scharnierstifte und nehmen Sie die Tür vom Gehäuse ab.
2) Schrauben Sie die Scharniere vom Gehäuse ab.
3) Bohren Sie an der gegenüberliegenden Gehäusewand an den Bohrungspunkten Löcher mit einem Durchmesser von 5,16 mm (Ø .203)
4) Bauen Sie die Scharniere und die Tür wieder ein.
5) Dichten Sie die nicht benutzten Scharnierlöcher mit Schrauben– (Größe #10 oder M5, vom Kunde zu besorgen) und Silikondichtstoff ab.

FRANÇAIS
1) Enlever la porte du corps du meuble en retirant les broches des chamières.
2) Dévisser les chamières du corps du meuble.
3) Percer des trous de 5,16 mm (0,203 po) de diamètre sur le bord opposé du meuble, aux endroits voulus.
4)Réinstaller les chamières et la porte.
5) Boucher les trous de chamière inutilisés avec des vis n° 10 ou M5 et du calfeutrant au silicone, fournis par le client.

REVERSING LATCH DIRECTION
UMKEHREN DER SCHLIESSRICHTUNG
ALLER EN SENS INVERSE LOQUET
INVERSIÓN PICAPORTE DIRECCIÓN



Clockwise to open
Im Uhrzeigersinn öffnen
Ouverture dans le sens horaire
Abrir en dirección a las munecillas del reloj



Counterclockwise to open
Entgegen dem Uhrzeigersinn öffnen
Ouverture dans le sens anti–horaire
Abrir en sentido contrario, a las manecillas del releg

ENGLISH
1) Remove Latch Cam.
2) Invert as shown and reinstall cam.
3) Torque fastener to 4.3Nm (38 in–lbs)

ESPAÑOL
1) Quite la leva del cierre
2) Invierta como se muestra y reinstale la leva
3) Use un torque de 4.3 Nm(38 pulgadas–libras)

DEUTSCH
1) Riegelnocken entfernen.
2) Nocken gemäß Abbildung umdrehen und wieder installieren.
3) Verschluß mit einem Drehmoment von 4,3 Nm festdrehen.

FRANÇAIS
1) Enlever la came du loquet.
2) Inverser comme indiqué et reposer la came.
3) Appliquer à l'attache un couple de 4,3 Nm (38 lb–po.)

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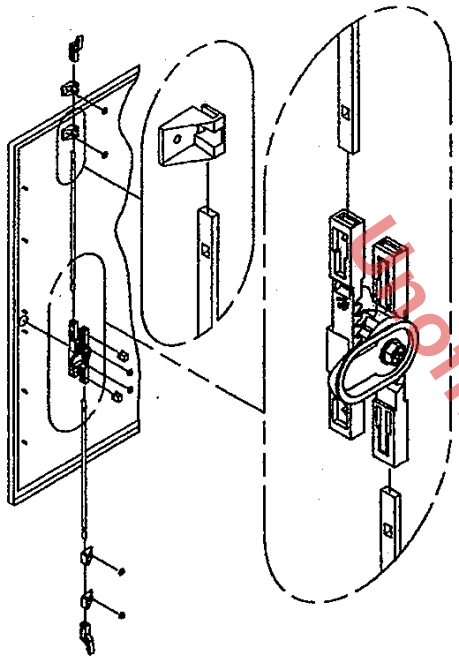
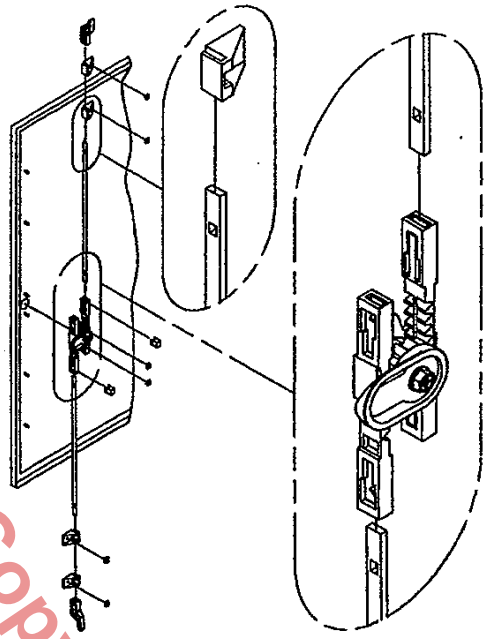
REVERSING MULTIPOINT LATCH DIRECTION (lower door only)
UMKEHREN DER RICHTUNG DES MEHRPUNKTSCHLOSSES (nur untere Tür)
INVERSION DE LA DIRECTION D'UN LOQUET À POINTS MULTIPLES (porte inférieure seulement)
MANIJA MULTIDIRECCIONAL (SOLO PARA PUERTA INFERIOR)



Clockwise to open
Im Uhrzeigersinn öffnen
Ouverture dans le sens horaire
Abrir en dirección a las munecillas del reloj



Counterclockwise to open
Entgegen dem Uhrzeigersinn öffnen
Ouverture dans le sens anti-horaire
Abrir en sentido contrario, a las manecillas del releg

ENGLISH
1) Remove latch system from door.
2) Disengage rods from racks.
3) Remove cam and orient racks as shown.
4) Reinstall cam, torque cam fastener to 38 in-lbs (4.3 Nm).
5) Reposition rod guides.
6) Insert rods in racks.
7) Assemble latch system onto door; torque nuts to 22 in-lbs (2.5 Nm)

ESPAÑOL
1) Retire el sistema de la manija de la puerta.
2) Retire los engranes de la cremallera.
3) Retire la leva y oriente los rieles como se muestra.
4) Vuelva a instalar la leva, la cual debe fijarse a un torque de 38 pulgadas por libras (4.3Nm).
5) Vuelva a poner las guias del engranaje.
6) Inserte los engranes en lacremallera.
7) Ensamble el sistema de la manija dentro de las tuercas de la puerta a un torque de 22 pulgadas por libras (2.5Nm).

DEUTSCH
1) Entfernen Sie das Riegelsystem von der Tür.
2) Nehmen Sie die Stangen von den Halterungen ab.
3) Entfernen Sie den Nocken und richten Sie die Halterungen gemäß den Abbildungen aus.
4) Bauen Sie den Nocken wieder ein und drehen Sie den Nockenverschluß mit einem Drehmoment von 4,3 Nm (38 in-lbs) fest.
5) Stellen Sie die Stangenführungen neu ein.
6) Setzen Sie die Stangen in die Halterungen ein.
7) Bauen Sie das Riegelsystem in die Tür ein. Ziehen Sie die Muttern mit einem Drehmoment von 2,5 Nm fest.

FRANÇAIS
1) Retirer le système du loquet de la porte.
2) Désengager les tiges des crémaillères.
3) Enlever la came et orienter les crémaillères comme indiqué.
4) Réinstaller la came, serrer l'attache de came au couple de 4,3 Nm (38 po-lb).
5) Replacer les guides de tiges.
6) Insérer les tiges dans les crémaillères.
7) Assembler le système du loquet sur la porte, serrer les écrous au couple de 2,5 Nm (22 po-lb).

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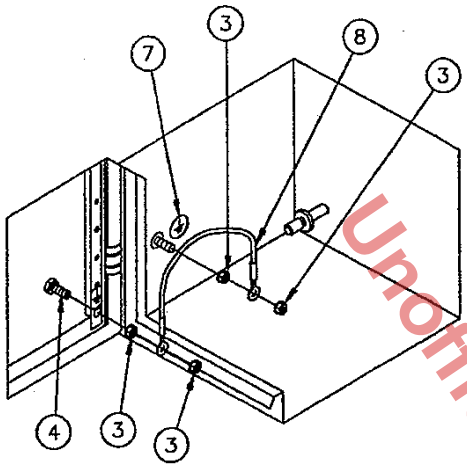
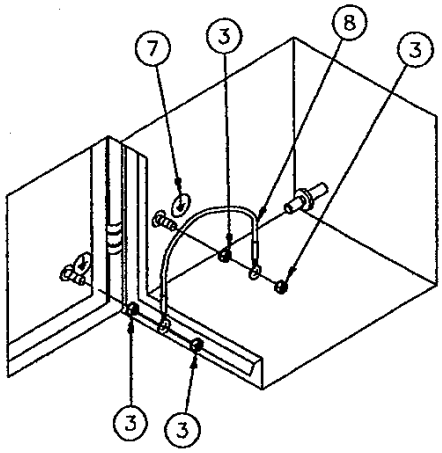
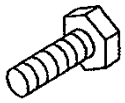
GROUNDING (MILD STEEL)
ERDUNG (STAHL)
MISE À LA TERRE (ACIER MOU)
CABLE A TIERRA (ACERO SWAVE)

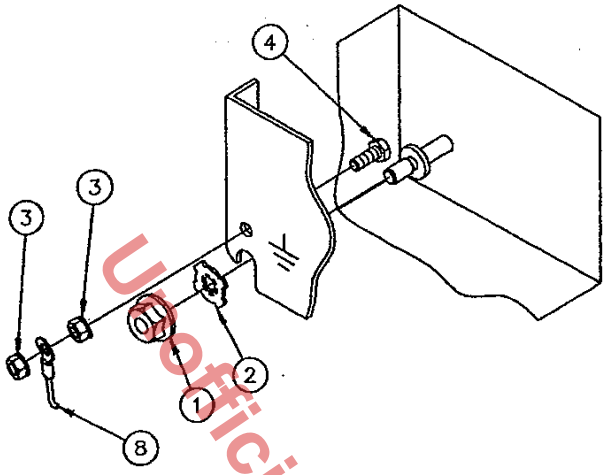


GROUNDING (STAINLESS STEEL)
ERDUNG (EDELSTAHL)
MISE À LA TERRE (ACIER INOXYDABLE)
CABLE A TIERRA (ACERO INOXIDABLE)



1  (4x) (8x)	2  (1x)	3  (6x)	4  (2x)
5  (4x)	6  (4x)	7  (2x)	8  supplied by customer vom Kunden zu besorgen fourni par le client Proporcionado por el cliente

PANEL INSTALLATION / GROUNDING
INSTALLATION DER RÜCKWAND/ ERDUND
INSTALLATION DU PANNEAU / MISE À LA TERRE
INSTALACION DEL PANEL / CABLE A TIERRA



NOTE:

- For proper panel installation, it may be necessary to bend mounting studs slightly to permit the panel to fit in place.

NOTA:

- Para la instalación apropiada, puede que sea necesario doblar ligeramente los pernos para permitir que el panel encaje.

HINWEIS:

- Für eine ordnungsgemäße Installation ist es eventuell erforderlich, die Montagezapfen leicht zu biegen, um die Rückwand genau einzupassen.

REMARQUE:

- Pour l'installation correcte du panneau, il peut être nécessaire de courber légèrement les montants de fixation afin de permettre au panneau de se mettre en place.

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HARDWARE KITS

Included with your Hoffman enclosure is a complete package of hardware for back panel installation. Also provided is all the necessary hardware for grounding the back panel and doors to the enclosure body.

Shown are the proper installation procedures for grounding the doors, covers, and optional panels and mounting the optional side and back panels.

Ground wires (item 8) are available from Hoffman Enclosures. Consult the latest Hoffman Specifiers Guide.

HARDWARE-PAKETE

Für die Installation der Rückwand ist ein komplettes Hardware-Paket im Lieferumfang des Hoffman Gehäuses enthalten. Ferner werden alle Hardware-Bauteile mitgeliefert, die für die Erdung der Rückwand und Türen am Gehäuse erforderlich sind.

Gezeigt werden die passenden Installationsverfahren für die Erdung der Türen, Abdeckungen und optionalen Wände und die Montage der optionalen Seite und Rückwände.

Erdungsdrähte (Pos. 8) sind bei Hoffman Engineering erhältlich. Konsultieren Sie den Hoffman Specifiers Guide.

ACCESORIOS

Estos se incluyen en el enclaustro Hoffman y comprende en paquete con el equipo para la instalación del panel trasero. También se proporciona todo el equipo necesario para hacer tierra de las puertas del panel inferior al cuerpo del enclaustro.

También se muestran los procedimientos de instalación apropiados para hacer tierra en las puertas, cubiertas y paneles opcionales así como el montaje de los paneles laterales opcionales y traseros.

Los cables de tierra (articulo 8) están disponibles en Hoffman Engineering. Consulte la guia de Hoffman quelo especifica.

KITS D'ACCESSOIRES

Un paquet complet d'accessoires pour l'installation du panneau arrière est fourni avec le meuble Hoffman. Est également fourni tout le matériel nécessaire de mise à la terre du panneau et des portes du corps du meuble.

Les illustrations montrent les procédures d'installation correctes de mise à la terre des portes, du dessus ainsi que des panneaux en option et le montage du côté optionnel et des panneaux arrière.

Les fils de mise à la terre (article 8) sont disponibles à Hoffman Engineering. Consulter le guide des identificateurs Hoffman.

REPAINTING INSTRUCTIONS

SUGGESTED PAINTS: The following paints typically provide superior adhesion qualities:

- Two Component Epoxies
- Two Component Polyurethanes
- Lacquers
- Acrylics
- Alkyd Baking Enamels
- Industrial Enamel

SURFACE PREPARATION: Wet wipe all surfaces to be painted with xylene solvent. Allow surfaces to flash dry three to five minutes. If a delay of greater than two hours occurs before painting, wet wipe again.

PAINTING: Apply top coat per paint manufacturer's instructions. Allow adequate cure time between coats.

Allow top coat to cure completely prior to testing paint adhesion. Consult with the paint manufacturer for proper cure time.

ANLEITUNG FÜR DEN NEUANSTRICH

EMPFOHLENE FARBEN: Die folgenden Farben bieten in der Regel ausgezeichnete Haftungseigenschaften:

- Zwei Komponenten Epoxidharze
- Zwei Komponenten Polyesterurethane
- Lacke
- Acryle
- Alkyd–Trockenemaille
- Industrie–Emaille

VORBEREITUNG DER OBERFLÄCHEN: Wischen Sie alle zu streichenden Oberflächen naß mit einer Xylen–Lösung ab. Lassen Sie die Oberflächen kurz drei bis fünf Minuten trocknen. Verzögert sich der Anstrich um mehr als zwei Stunden, wischen Sie die Flächen erneut naß ab.

STREICHEN: Tragen Sie die Beschichtung gemäß den Anweisungen des Farbenherstellers auf. Lassen Sie die Farbe nach jeder aufgetragenen Farbschicht anziehen.

Lassen Sie die oberste Farbschicht vollständig trocknen, bevor Sie die Haftung der Farbe prüfen. Die geeignete Trockenzeit erfahren Sie vom Farbenhersteller

INSTRUCTIONS DE PEINTURE

PRÉPARATION DE LA SURFACE: Nettoyer toutes les surfaces à peindre avec un solvant au xylène. Laisser les surfaces sécher pendant un court moment de trois à cinq minutes. Si plus de deux heures s'écoulent avant de peindre, nettoyer à nouveau.

- xpoxy à deux composants
- Polyuréthannes à deux composants
- Laques
- Acryliques
- Peintures–émail cuites à l'alkyte
- Peintures–émail industrielles

PRÉPARATION DE LA SURFACE : Nettoyer toutes les surfaces à peindre avec un solvant au xylène. Laisser les surfaces sécher pendant un court moment de trois à cinq minutes. Si plus de deux heures s'écoulent avant de peindre, nettoyer à nouveau.

PEINTURE : Appliquer la couche de couverture suivant les instructions du fabricant de la peinture. Laisser sécher entre les couches pendant un temps adéquat.

Laisser la dernière couche sécher complètement avant de tester l'adhésion de la peinture. Demander au fabricant de la peinture le temps de séchage conseillé.

INSTRUCCIONES PARA REPINTADO

PINTURAS SUGERIAS: Las siguientes pinturas son tipicas por proporcionar una calidad superior de adhesión.

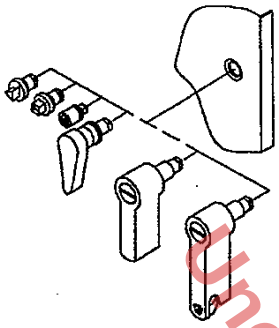
- Epóxicas de dos componentes
- Poliuretano de dos componentes
- Lacas
- Acrilicas
- Con Barniz de horneado Alcalino
- Barniz Industrial

PREPARACION DE SUPERFICIE: Humedezca un trapo con sulvente de xileno y páselo sobre la superficie que va a pintarse. Deje secar la superficie por tres o cinco minutos. Si por alguna razón retrasara el proceso de pintura más de dos horas, humedezca la superficie nuevamente.

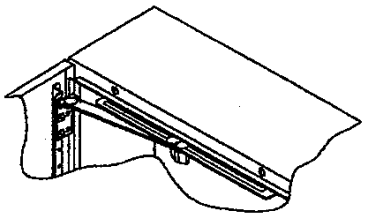
PINTURA: Aplique una capa de pintura por cada capa indicada en el instructivo del fabricante. Dé un tiempo de secado adecuado entre una capa y otra.

Deje que la capa de pintura superior seque por completo antes de realizar cualquier prueba de adhesión de pintura. Consulte el tiempo de secado con la compañia fabricante de la pintura.

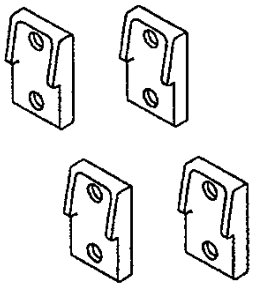
EXTERNAL ACCESSORIES
ZUBEHÖR AUSSEN
ACCESSOIRES EXTERNES
ACCESORIOS EXTERNOS



Latch Accessories
Riegelzubehör
Accessoires pour loquet
Accesorios para Seguro



Door Stop Kit
Türanschlag–Bausatz
Kit de butée de porte
Juego Para Tope de Puerta



Mounting Feet
Montagefüße
Pattes de montage
Pata de Montaje

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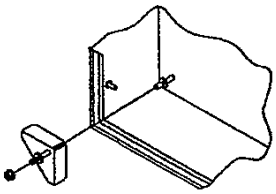
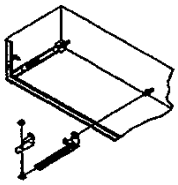
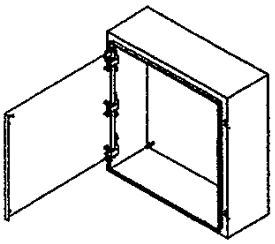
INTERNAL ACCESSORIES
ZUBEHÖR INNEN
ACCESSOIRES INTERNES
ACCESORIOS INTERNOS



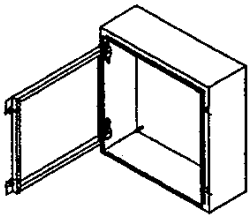
Panel Conversion Kit
Adaptersatz für Montageplatten
Kit de conversion de panneau
Juego Para Panel



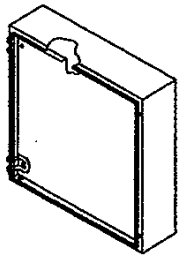
Adjustable Mounting Kit
Verstellbarer Montagebausatz
Kit de montage réglable
Juego Para Montaje Ajustable



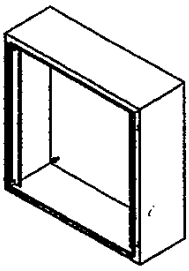
Swing–Out Panel
schwenkbare Montageplatte
Panneau pivotant
Panel de Vaivén



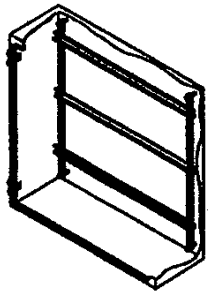
Swing–Out Frame
schwenkbarer Rahmen
Châssis pivotant
Marco Para Panel de Vaivén



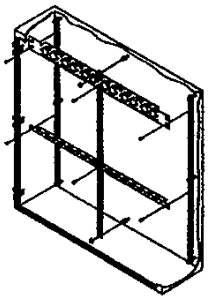
Dead Front Panel
Ungeladenes Frontpanel
Panneau avant inerte
Placa Delantera



Rack Angles
Winkelstücke
Cornières du support
Angulo del Estante



DIN Rail Kit
DIN–Schienensatz
Kit de rail DIN
Juego de Riel DIN



Grid Straps
Gitterverstärkungen
Bandes en grille
sujetador Para Rejillas

GENERAL ACCESSORIES

Temperature Control
Options are available to provide an optimal environment for your controls. Options include louvers, filter fans, heat exchangers, air conditioners, and electric heaters.
Floor Stand Kits
Field or factory installation available on single door enclosures.
Drip Shield Kits
Field or factory installation available on single or double door enclosures.
Electrical Interlocks
Internal safety lockout while the enclosure contents are energized.
Corrosion Inhibitors
Protect interior components from corrosion.
Hole Seals
Used to seal extra conduit openings, pushbutton holes, or cutouts against dust, dirt, oil, and water.
Folding Shelves
Can be used to support instruments and test equipment.
Terminal Kit Assemblies
Provides an easy method to mount terminal blocks.
Pedestals
Provides floor mounting for small to medium size enclosures.
Safety Lockouts
Protect personnel and equipment by enabling multiple padlocks to be installed on a de–energized switch.
Touch–Up Paint
Used to repair the finish of enclosures and panels.
Enclosure Stabilizers
Provides stability to floor mounted enclosures which are not bolted to the floor.
Window Kits
Available for many types of Hoffman enclosures.
Data Pocket Kits
Convenient place for documentation.

ALLGEMEINES ZUBEHÖR

Temperaturregulierung
Zur Optimierung der Umgebung für Ihre Bedienelemente sind Optionen verfügbar. Zu den Optionen gehören Jalousien, Filterventilatoren, Wärmetauscher, Klimaanlagen und elektrische Heizungen.
Standfuß–Bausatz
Vor–Ort– oder Werkinstallation bei Einzeltürgehäusen verfügbar.
Tropfschutz–Bausätze
Vor–Ort– oder Werkinstallation bei Einzel– oder Doppeltürgehäusen verfügbar.
Elektrisches Schloß
Hält die Tür geschlossen, solange Stromkreis im Gehäuse unter Spannung steht.
Korrosionsschutz
Schützt Bauteile im Gehäuse vor Korrosion.
Bohrungsdichtungen
Zur Abdichtung zusätzlicher Rohröffnungen, Druckknopfbohrungen oder Ausschnitte gegen Staub, Schmutz, Öl und Wasser.
Klappregale
Zur Unterbringung von Instrumenten und Testgeräten.
Verteiler Montage Einheit
Erlaubt eine leichte Befestigung von Verteilern.
Sockel
Erlaubt Bodenmontage für kleine und mittelgroße Gehäuse.
Sicherheitsaussperrungen
Ermöglicht den Einbau mehrerer Vorhängeschlösser bei ausgeschaltetem Stromkreis zum Schutz von Personal und Geräten.
Tupflack
Zur Lackreparatur an Gehäusen und Panels.
Stabilisatoren für Gehäuse
Zur Stabilität von Standgehäusen, die nicht am Boden verankert sind.
Fensterbausätze
Für viele Arten von Hoffman Gehäuse erhältlich.
Datentaschen–Bausätze
Nützliche Ablage für Handbücher.

ACCESSORIRES GÉNÉRAL

Contrôle de la température
Des options sont disponibles afin de procurer un environnement optimum à vos contrôles. Ces options comprennent des auvents, ventilateurs à filtre, échangeurs de chaleur, climatiseurs et appareils de chauffage électriques.
Kit de tenue autonome sur le sol
Installation sur place ou en usine disponible sur les éléments à une seule porte.
Kits de dispositifs anti–écoulement
Installation sur place ou en usine disponible sur les éléments à une ou deux portes.
Verrouillages électriques
Verrou de sécurité interne pendant que le contenu de l'élément est sous tension.
Inhibiteurs anti–corrosion
Protection des composants internes contre la corrosion.
Joints d'orifices
Utilisés pour assurer l'étanchéité des passages de conduits supplémentaires, des orifices pour boutons–poussoirs ou des découpages contre la pous sière, la saleté, les produits huileux et l'eau.
Etagères pliantes
Peuvent être utilisées pour supporter des instruments et des équipements d'essais.
Assemblages de borniers
Fournissent une méthode simple de montage des borniers.
Caissons
Offrent une disposition autonome reposant sur le sol pour les éléments de petites à moyennes tailles.
Fermetures de sécurité
Protection du personnel et du matériel en permettant l'installation de cadenas multiples sur un interrupteur hors tension.
Peinture de retouche
Utilisée pour réparer le fini des éléments et panneaux.
Stabilisateurs d'éléments
Procurent la stabilité des éléments reposant à même le sol sans y être boulonnés.
Kits de fenêtres
Disponibles pour ne nombreux éléments Hoffman.
Kits de poches à documents
Endroits pratiques pour toute documentation.

ACCESORIOS GENERALES

Control de Temperatura
Opciones disponibles que proporcionen un ambiente óptimo a sus controles. Estas opciones incluyen : rejillas para ventilación, filtros, abanicos, intercambiadores de calor, aires acondicionados y calentadores eléctricos.
Juegos Para Estantes de Piso
Disponibilidad Para instalación de cajas de una sola puerta , tanto en fábricas como en el campo.
Juego Para Protección de Goteras
Disponibilidad para instalación de cajas de una o dos puertas, tanto en la fábrica como en el campo
Sistema de Cierre Eléctrico
Seguro de protección interna cuando está energizado el contenido de la caja.
Inhibidor de Corrosión
Protege a los componentes de interiores de la corrosión.
Sellos para Orificios
Utilizado para sellar aperturas de conductos para cables, orificios para botones de arranque o protección contra el polvo, suciedad, aceite y agua.
Estantes Plegadizos
Pueden utilizarse como soporte de instrumentos y equipo de prueba.
Juego de Ensamblado para Terminales
Proporciona un método sencillo para montaje de bloques terminales.
Pedestales
Se proporcionan accesorios para montaje en el piso de enclaustros medianos y pequeños
Candado de Seguridad
Protege a la persona y al equipo al proporcionar diversos candados de seguridad al instalarse en un interruptor desenergizado.
Pintura de Retoque
Utilizada para reparar el terminado de cajas y paneles
Estabilizador de Enclaustros (Cajas)
Proporciona estabilidad a los enclaustros montados, los cuales no han sido anclados al piso.
Juego para Ventana
Dispobible para diferentes tipos de cajas Hoffman.
Juego Para Información de Bolsillo
Lugar conveniente para la documentación.

ATTACHMENT B

MECHANICAL PERMIT

City of Lake Forest Park
17425 Ballinger Way NE
Lake Forest Park, WA 98155
(206) 368-5440

Mechanical Permit

Permit Number: M05-1456

Printed: 8/30/2005
Approved: 8/30/2005

Applicant: URS CORPORATION
1501 4TH AVE - SUITE 1400
SEATTLE, WA 98101-1616

Parcel Number: 4019301655
17171 BOTHELL WAY NE
LAKE FOREST PARK, WA 98155

Zoning: TC
Addition: LAKE FOREST PARK ADD
Block: 14 **Lot(s):** 1 THRU 15
Section: 10
Township: 26
Range: 04
Area: 140000

Legal Description:

Owner MADISON MARQUETTE
401 BROADWAY AVE E STE 100
MOUNTLAKE TERRAC, WA 98043

Day: 206-322-1610
Fax:

BUILDER CLEAR CREEK CONTRACTORS
3015 EVERETT AVE NE
EVERETT, WA 98201

Voice: 425.252.5800
Fax:

Local License:

State License: CLEARCI997K1

Conditions:

PERMIT EXPIRES AUG. 30, 2006.

PERMIT TO INSTALL VENTILATION FAN FOR RITE AID STORE, PER APPROVED PLAN.

CALL THE BUILDING DEPT AT 206.368.5440 #128 BEFORE 4 PM TO SCHEDULE AN INSPECTION THE FOLLOWING DAY.

Fees and Receipts:

Number	Description	Amount
	BASIC FEE (MECH) W/O BLDG PERMIT	$90.00
	Ventilation Fan-Single Duct	$10.00
	Fees Total:	**$100.00**
48706		$100.00
	Receipts Total:	**$100.00**

Furnace <100K Btu:
Ventilation Fans:
Mechanical Exhaust Hood:
Furnace >100K Btu:
Suspend/Reces/Floor Htr:
Floor Furnaces:
Incinerators:

City of Lake Forest Park
17425 Ballinger Way NE
Lake Forest Park, WA 98155
(206) 368-5440

Mechanical Permit

Permit Number: M05-1456

Printed: 8/30/2005
Approved: 8/30/2005

Boilers/Compressors:
Air Handling Units:
Cubic Feet per Minute:
Evaporative Coolers:
Documentation: VENTILATION FAN

WHEN SIGNED AND DATED BELOW THIS IS YOUR PERMIT AND RECEIPT.

Permission is hereby given to do the above described work, according to the conditions hereon and according to the approved plans and specifications pertaining thereto, subject to compliance with the City of Lake Forest Park.

This permit covers work to be done on private property ONLY. Any construction on the public domain (curbs, sidewalks, driveways, marquees, etc.) will require separate permission.

This permit becomes null and void if work or construction authorized is not commenced within 180 days, or if construction or work is suspended or abandoned for a period of 180 days at any time after work is commenced.

NOTE: PERMIT LIMIT TWELVE MONTHS (Except DEMOLITIONS which shall be completed in ninety days; MOVED IN BUILDINGS shall be completed in six months).

IT IS UNLAWFUL TO USE OR OCCUPY A BUILDING OR STRUCTURE UNTIL A FINAL INSPECTION HAS BEEN MADE AND APPROVAL OR A CERTIFICATE OF OCCUPANCY HAS BEEN GRANTED. IMC 107.1

Permit Issued 8/30, 2005 By _____
Building Official

FOR INSPECTIONS CALL 206/368-5440. 24 HOURS NOTICE REQUIRED

17425 Ballinger Way NE
Lake Forest Park, WA 98155
Telephone: (206) 368-5440
FAX: (206) 368-6251

MECHANICAL INSPECTION RECORD

NO GAS AFFIDAVIT WILL BE ACCEPTED

Request inspections by 4:00 pm the day prior by calling 206-957-2835 or 206-368-5440 x 128

No construction or noise allowed outside these hours: 7:00 am to 9:00 pm Monday – Friday 8:00 am to 9:00 pm , Saturdays, Sundays and Holidays, LFPMC 8.24.040

Permit Number:	Owner's Name:	Site Address:
M05-1456	LFP ASSOCIATES for RITE AID	17171 BOTHELL WAY NE

REQUIRED INSPECTION	DATE OF INSPECTION	DATE INSPECTION APPROVED	APPROVED BY	COMMENTS
Mechanical groundwork/in-slab				
Mechanical rough in				
Mechanical final				
HW installation				
Gas piping test				

FINAL INSPECTION

FINALED BY:_____ **DATE: FINALED:**_____

G:\FORMS\Mechanical Insp Rec.doc

URS

SITE COPY

RECEIVED
AUG 30 2005
CITY OF
LAKE FOREST PARK

August 29, 2005

Mr. Calvin Thielman
Mechanical Permit
City of Lake Forest Park
17425 Ballinger Way NE
Lake Forest Park, WA 98155

ATTENTION
THESE DOCUMENTS
ARE SUBJECT TO
FIELD INSPECTION
FOR CODE COMPLIANCE

APPROVED
BUILDING PERMIT NO. M05145
TYPE OF CONSTRUCTION VN
OCCUPANCY GROUP B
BUILDING OFFICIAL
DATE OF APPROVAL 8/30/05
CITY OF LAKE FOREST PARK

Subject: Information Regarding Permits for Construction
Sub-Slab Ventilation System
Lake Forest Park Towne Center (Rite Aid Store)
17171 Bothell Way NE, #150
Lake Forest Park, Washington, 98155-5534
URS Project No. 33757930

Dear Mr. Thielman:

URS Corporation is working on behalf of Seattle LFP Associates, LP (Seattle LFP Associates) at their Lake Forest Park Towne Center property located in Lake Forest Park, Washington. URS is designing and installing a sub-slab ventilation system to mitigate potential vapor intrusion within the Rite Aid tenant space. This work is associated with a Washington State Department of Ecology (Ecology) voluntary cleanup action. The ventilation system will include two sub-slab horizontal extraction piping laterals, and aboveground piping and mechanical equipment. The equipment will include an electrically driven blower contained within a pre-constructed enclosure located at the rear of the Rite Aid tenant space. The enclosure foot-print will be much less than 100 square feet.

URS contacted you on August 19, 2005, to discuss the need for permits for this project. It is our understanding that the City of Lake Forest Park will only be requiring a mechanical permit for this project, and that fees will total $100.00. Due to the electrical equipment involved, we will be obtaining an electrical permit for this project from the Washington State Department of Labor and Industries. This letter is intended to confirm our conversation in order to minimize any schedule impacts during construction, which is scheduled to occur during September 2005.

Attached is an application for a mechanical permit, and two drawings that illustrate the proposed sub-slab ventilation system.

Please contact me at (206) 438-2172 if you have any questions.

Sincerely,

URS Corporation

Paul E. Kalina, PE
Senior Civil Engineer

Attachments: Permit Application
Figure 1 - Proposed Ambient Air Mitigation System Plan and Sections
Figure 2 - P&ID/ Equipment Plan and Elevation

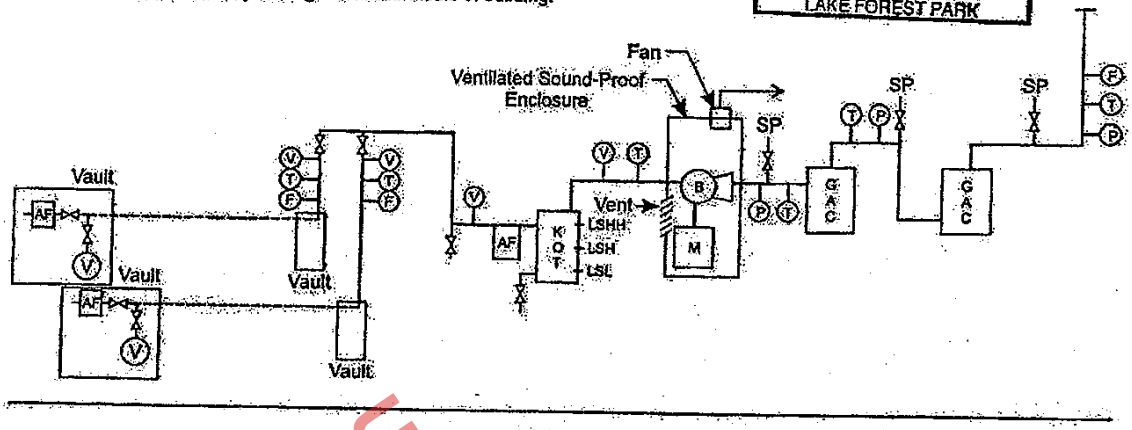
URS Corporation
1501 4th Avenue, Suite 1400
Seattle, WA 98101-1616
Tel: 206.438.2700
Fax: 206.438.2699

I:\WM&RD\Lake Forest Park\2005\Subsurface Slab Ventilation System\Draft LFP Letter 081905.doc

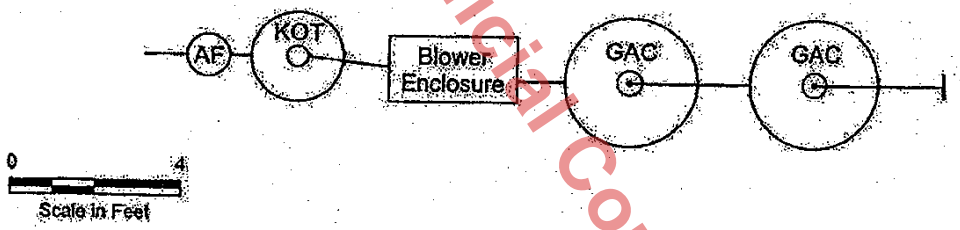
33757930_02.cdr

Background:

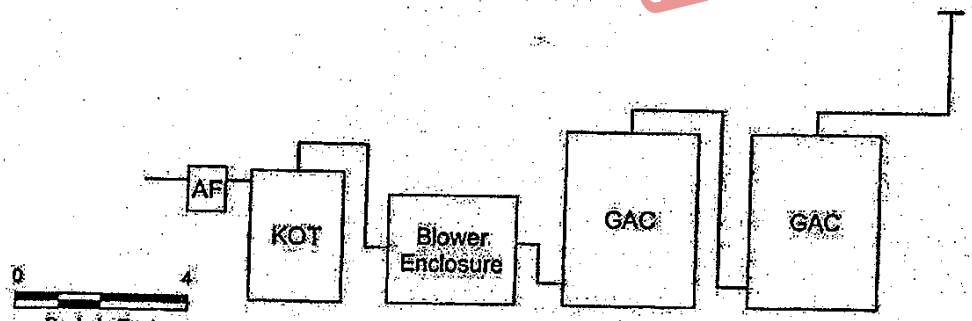
Groundwater approximately 1.5' bgs at north of building.
Groundwater approximately 3.0' bgs at south/middle of building.



P&ID



Plan



Elevation

Legend:

AF	Air filter	T	Temperature indicator
KOT	Knockout tank	V	Vacuum indicator
GAC	Granulated activated carbon unit	P	Pressure indicator
SP	Sampling port	F	Flow indicator
		LS	Level switch

Job No. 33757930

Figure 2
Proposed Ambient Air Mitigation System P&ID/Equipment Plan and Elevation

URS

Former Magic Cleaners
Lake Forest Park, Washington

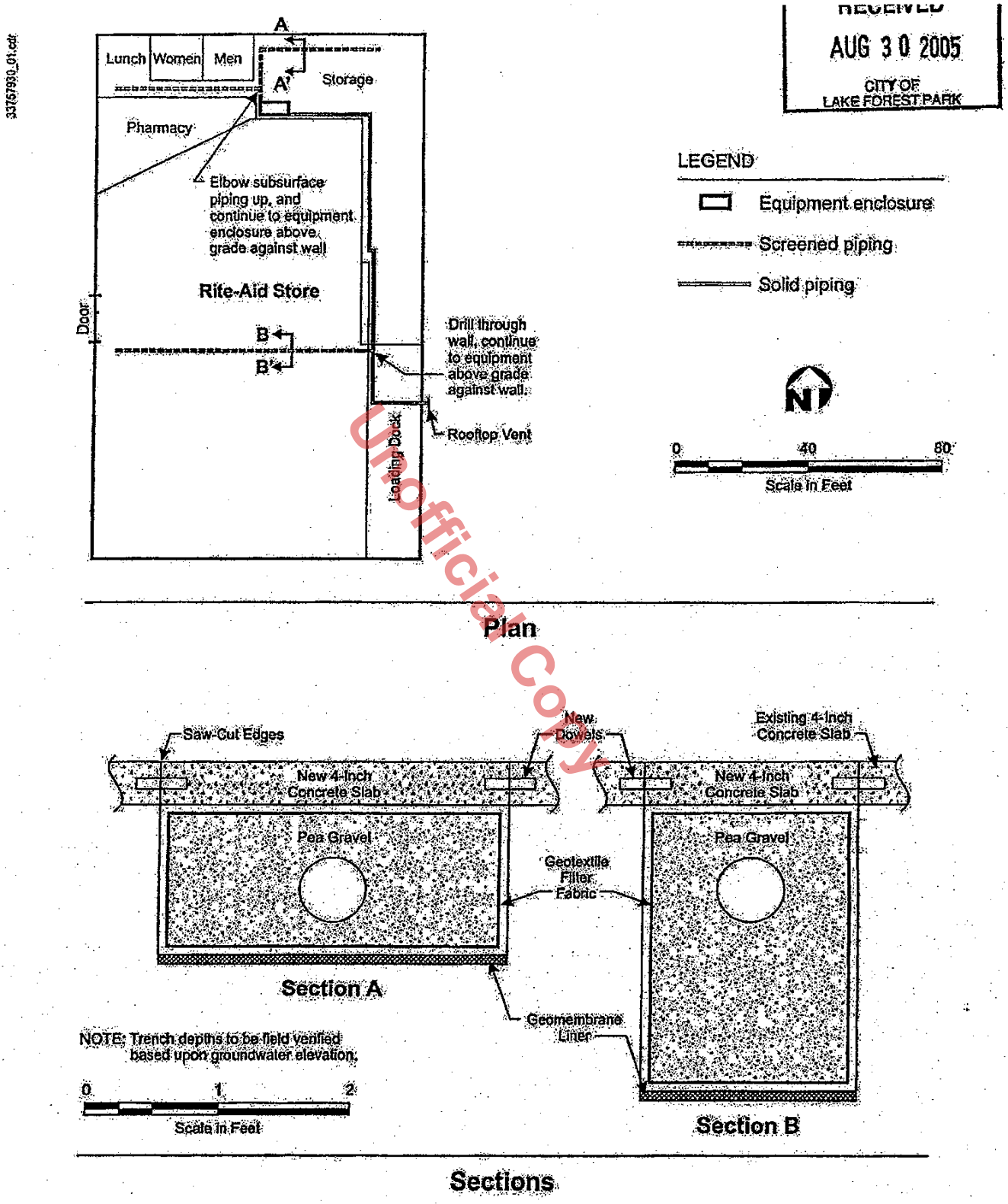


Figure 1

Proposed Ambient Air Mitigation System Plan and Sections

Job No. 33757930

URS

Former Magic Cleaners
Lake Forest Park, Washington

ATTACHMENT C

PERFORMANCE MONITORING PLAN

1.0 INTRODUCTION

This Performance Monitoring Plan (PMP) describes monitoring of the SSVS, including gauge measurement recording, extracted vapor sampling, and reporting. An overall monitoring schedule for the site is shown in Table 1-1.

2.0 SUB-SLAB VENTILATION SYSTEM MONITORING

In order to track the removal of VOCs from the subsurface and system performance, it is necessary to monitor the system on a periodic basis. The following sections describe the procedures that will be followed to track the removal of VOCs, ensure that permit conditions are met, and track system performance.

2.1 Process Monitoring

2.1.1 Process Information

Process information (including system flow rates, temperatures, vacuums, pressures, etc.) will be collected on a monthly basis as part of routine system operation and maintenance (O&M) activities. Table 2-1 details process information that will be collected.

Process information will be tabulated and reviewed on a regular basis to ensure proper operation of the system and assist in the optimization of the system. In addition, the information will be used to minimize operational and maintenance costs and to track VOC removal rates. Process information will be tabulated and submitted in annual reports.

2.1.2 System Operation

The SSVS will be monitored periodically by site personnel, who will notify O&M personnel in the event of a system shutdown. The cause of each system shutdown will be recorded to assist in the troubleshooting and optimization of the system. System operation data will be tabulated and submitted with annual reports.

2.2 Vapor Monitoring

Vapor samples will be collected and analyzed during the initial 3 months of operation (Table 2-2) to track the removal of VOCs in the extracted vapors and ensure compliance with site air permit conditions. Untreated vapor samples will be collected once a month during system operation. In compliance with standard air permit requirements, treated (post-carbon) vapor samples will also be collected on a monthly basis (for first three months and then, as required by the Puget Sound Clean Air Agency (PSCAA). Vapor samples will be analyzed by North Creek Analytical, Inc. of Bothell, Washington. The vapor sample identification conventions are provided in Table 2-3.

3.0 REPORTING

Annual reports will be generated summarizing the operation of the SSVS. The reports, at a minimum, will include:

- Summary of system operation, including an operating history, system utilization, and quantity of vapors treated;
- Vapor sampling results, including a contaminant concentration versus time graph;
- Treated vapor results
- Estimated quantity of contaminant removed in vapors, including total contaminant removal versus time graphs;
- A project recovery summary

Table 1-1

Overall Monitoring & Reporting Program

Former Magic Cleaners, Lake Forest Park, Washington

	First Week	Monthly	Quarterly	Semiannual	Yearly
PROCESS INFORMATION					
Start-Up Information	✓				
VAPOR SAMPLING					
Untreated Vapors		✓*			
Treated Vapors		✓*			
Extraction Trenches					
REPORTING					
PSCAA Permit					✓ (retain data)
Status Report					✓
Ecology VCP					

*Sampled during first 3 months of operations, if below PSCAA levels, monthly sampling will be suspended per PSCAA approval

Table 2-1

Summary of Process Information

Former Magic Cleaners, Lake Forest Park, Washington

URS **DATA COLLECTION FORM**

Project Information Page 1 of _____

Project Name:	Former Magic Cleaners	Location:	Lake Forest Park, Washington
Project/Task No.:		Weather:	
Date:		Personnel	

Observations

	Location	Label	Unit	Measurement	Time	Comments / Notes
1	Blower	B1	on / off			
2	Blower Fan	BF1	on / off			
3	ST - Air Filter	AF1	condition			
4	ST-Dilution	BV1	% open			
5	ST-End Vac	V1	in H20			
6	ST-Flow	F1	scfm			
7	ST-Temp	T1	deg F			
8	ST-Man Vac	V2	in H20			
9	ST-SP	SP1	ppmv			
10	ST-Throttle	BV2	% open			
11	NT-Air Filter	AF2	condition			
12	NT-Dilution	BV3	% open			
13	NT-End Vac	V3	in H20			
14	NT-Flow	F2	scfm			
15	NT-Temp	T2	deg F			
16	NT-Man Vac	V4	in H20			
17	NT-SP	SP2	ppmv			
18	NT-Throttle	BV4	% open			
19	Manifold-Vac	V5	in H20			
20	KOT-Dilution	GV1	% open			
21	KOT-Dil Flow	DF1	lfpm			
22	KOT-Vac	V6	in H20			
23	KOT-Temp	T3	deg F			
24	B1 Pressure	P1	in H20			
25	B1 SP	SP3	ppmv			
26	B1 Temp	T4	deg F			
27	C1 Temp	T5	deg F			
28	C1 Pressure	P2	in H20			
29	C1 SP	SP4	ppmv			
30	C2 Pressure	P3	in H20			
31	C2 SP	SP5	ppmv			
32	C2 Temp	T6	deg F			
33	Flow Out	F3	scfm			
34	KOT-Air Filter	AF3	condition			
35	KOT-Liq Lvl	LL1	in H2O			
36	Stack Liq Lvl	LL2	in H2O			

Comments / Site Activities

Table 2-2

Analytical Sampling Schedule

Former Magic Cleaners, Lake Forest Park, Washington

	Extracted Vapors			
Sample Location	Untreated Vapor (C-IN)	Treated Vapor (C-MID)	Treated Vapor (C-OUT)	Extraction Trenches
Analytical Method	HVOCs (EPA 8260B)	HVOCs (EPA 8260 B)	HVOCs (EPA 8260 B)	HVOCs (EPA 8260 B)
1 / 2006	✔	✔	✔	TBD
2 / 2006	✔	✔	✔	
3 / 2006	✔	✔	✔	
4 / 2006			TBD	
5 / 2006			TBD	
6 / 2006			TBD	
7 / 2006			TBD	
8 / 2006			TBD	
9 / 2006			TBD	
10 / 2006			TBD	
11 / 2006			TBD	
12 / 2006			TBD	
1 / 2007			TBD	
2 / 2007			TBD	
3 / 2007			TBD	

TBD = To Be Determined

Table 2-3

Vapor Sampling Identification Convention
Belshaw Bros., Seattle, WA

Sample Name	Sample Location	Sample Identification
Untreated Vapor	Inlet to Primary Carbon Vessel	SSVS C-IN mmddyyyy
Intermediate Vapor Carbon	Between Vapor Carbon Vessel	SSVS C-MID mmddyy
Treated Vapor	Outlet of Secondary Carbon Vessel	SSVS C-OUT mmddyy
South Extraction Trench	Extraction Trench Piping at SSVS Manifold	SSVS ST mmddyy
North Extraction Trench	Extraction Trench Piping at SSVS Maniforl	SSVS NT mmddyy

Notes:

Dd = day
mm = month
yy = year

EXHIBIT C-2

TITLE COMMITMENT

See attached

Form WA-5 (6/76)
Commitment Face Page

File No.: NCS-205089-NY

COMMITMENT FOR TITLE INSURANCE

Issued by

FIRST AMERICAN TITLE INSURANCE COMPANY

First American Title Insurance Company, herein called the Company, for valuable consideration, hereby commits to issue its policy or policies of title insurance, as identified in Schedule A, in favor of the proposed Insured named in Schedule A, as owner or mortgagor of the estate or interest covered hereby in the land described or referred to in Schedule A, upon payment of the premiums and charges therefor; all subject to the provisions of Schedules A and B and to the Conditions and Stipulations hereof.

This Commitment shall be effective only when the identity of the proposed Insured and the amount of the policy or policies committed for have been inserted in Schedule A hereof by the Company, either at the time of the issuance of the Commitment or by subsequent endorsement.

This Commitment if preliminary to the issuance of such policy or policies of title insurance and all liability and obligations hereunder shall cease and terminate six (6) months after the effective date hereof or when the policy or policies committed for shall issue, whichever first occurs, provided that the failure to issue such policy or policies is not the fault of the Company. This Commitment shall not be valid or binding until countersigned by an authorized officer or agent.

IN WITNESS WHEREOF, the Company has caused this commitment to be signed and sealed, to become valid when countersigned by an authorized officer or agent of the Company, all in accordance with its By-Laws. This Commitment is effective as of the date shown in Schedule A as "Effective Date."

First American Title Insurance Company

By: _____ President

Attest: _____ Secretary

By: _____ Countersigned

Form WA-5 (6/76)
Commitment

File No.: NCS-205089-NY
Page No. 1

First American Title Insurance Company of New York
633 Third Avenue, New York, NY 10017
(800)437-1234 - FAX (212)922-0881

To: **GE Asset Management Inc**
3003 Summer Street

Stamford, CT 06905-4316

Attn: **Leanne Dunn, Esq**

File No.: **NCS-205089-NY**
Your Ref No.: **Lake Forest Park Town Center**

SECOND REPORT
SCHEDULE A

1. Commitment Date: February 17, 2006 at 7:30 A.M.

2. Policy or Policies to be issued:

	AMOUNT	PREMIUM	TAX
Extended Owner's Coverage	$ To Follow	$ To Follow	$ To Follow

Proposed Insured:
MSREF/Seneca Tree House, L.L.C., a Delaware Limited Liability Company

Extended Mortgagee's Coverage	$ To Follow	$ To Follow	$ To Follow

Proposed Insured:

3. The estate or interest in the land described on Page 2 herein is **Fee Simple**, and title thereto is at the effective date hereof vested in:

Lake Forest Park Associates, a Washington Joint Venture Partnership

4. The land referred to in this Commitment is described as follows:

The land referred to in this report is described in Exhibit "A" attached hereto.

EXHIBIT 'A'

LEGAL DESCRIPTION:

NEW LOT 2 OF CITY OF LAKE FOREST PARK SHORT PLAT NO. SP99-79, RECORDED MARCH 7, 2000 UNDER RECORDING NO. 20000307900002, IN KING COUNTY, WASHINGTON.

SCHEDULE B - SECTION 1
REQUIREMENTS

The following are the Requirements to be complied with:

Item (A) Payment to or for the account of the Grantors or Mortgagors of the full consideration for the estate or interest to be insured.

Item (B) Proper instrument(s) creating the estate or interest to be insured must be executed and duly filed for record.

Item (C) Pay us the premiums, fees and charges for the policy.

Item (D) You must tell us in writing the name of anyone not referred to in this Commitment who will get an interest in the land or who will make a loan on the land. We may then make additional requirements or exceptions

SCHEDULE B - SECTION 2
GENERAL EXCEPTIONS

The Policy or Policies to be issued will contain Exceptions to the following unless the same are disposed of to the satisfaction of the Company.

A. Taxes or assessments which are not shown as existing liens by the records of any taxing authority that levies taxes or assessments on real property or by the public records.

B. Any facts, rights, interest, or claims which are not shown by the public records but which could be ascertained by an inspection of said land or by making inquiry of person in possession thereof.

C. Easements, claims of easement or encumbrances which are not shown by the public records.

D. Discrepancies, conflicts in boundary lines, shortage in area, encroachments, or any other facts which a correct survey would disclose, and which are not shown by public records.

E. (1) Unpatented mining claims; (2) reservations or exceptions in patents or in acts authorizing the issuance thereof; (3) Water rights, claims or title to water; whether or not the matters excepted under (1), (2) or (3) are shown by the public records; (4) Indian Tribal Codes or Regulations, Indian Treaty or Aboriginal Rights, including easements or equitable servitudes.

F. Any lien, or right to a lien, for services, labor, materials or medical assistance theretofore or hereafter furnished, imposed by law and not shown by the public records.

G. Any service, installation, connection, maintenance, construction, tap or reimbursement charges/costs for sewer, water, garbage or electricity.

H. Defects, liens, encumbrances, adverse claims or other matters, if any, created, first appearing in the public records or attaching subsequent to the effective date hereof but prior to the date the proposed insured acquires of record for value the estate or interest or mortgages thereon covered by this Commitment.

SCHEDULE B - SECTION 2
(continued)
SPECIAL EXCEPTIONS

1. Lien of the Real Estate Excise Sales Tax and Surcharge upon any sale of said premises, if unpaid. As of the date herein, the excise tax rate for the **City of Lake Forest Park** is at **1.78**%.
Levy/Area Code: 1255

For all transactions recorded on or after July 1, 2005:
- **A fee of $10.00 will be charged on all exempt transactions;**
- **A fee of $5.00 will be charged on all taxable transactions in addition to the excise tax due.**

2. Covenants, conditions, restrictions and/or easements:
Recorded: February 19, 1913
Recording No.: 853810 (Volume 821, Page 603)

3. Right to make necessary slopes for cuts or fills upon said premises for State Highway No. 2 as granted by deed recorded June 3, 1938 under recording no. 2998835 (Volume 1790, Page 320).

4. Right to make necessary slopes for cuts or fills upon said premises for Ballinger Way as granted by deed recorded March 22, 1961 under recording no. 5264360.

5. Right to make necessary slopes for cuts or fills upon said premises for Ballinger Way and Bothell Way Northeast as granted by deed recorded March 22, 1961 under recording no. 5264361.

6. Sewer Service Agreement and the terms and conditions thereof:
Between: Lake City Sewer District
And: Lake Forest Park, Inc.
Recorded: June 7, 1963
Recording No.: 5593757

7. Easement, including terms and provisions contained therein:
Recording Information: July 26, 1963 under Recording No. 5615390
In Favor of: The Town of Lake Forest Park, a Municipal Corporation
For: Ingress and egress
Affects: The Northerly portion of said premises

8. A lease dated August 2, 1963, executed by Forest Park, Inc. as lessor and Albertson's Inc. as lessee, for a term of 20 years recorded August 12, 1963 as Recording No. 5622581 of Official Records.

9. Release of Damage Agreement and the terms and conditions thereof:
Between: Forest Park, Inc.
And: City of Seattle
Recorded: June 17, 1964
Recording No.: 5749596

10. Side sewer easement, including terms and provisions contained therein:

Location:	Along the line as constructed
Width:	6 feet
Recording No.:	5792145 recorded on September 29, 1964

11. Easement, including terms and provisions contained therein:

Recording Information:	February 25, 1977 under Recording No. 7702250242
In Favor of:	State of Washington
For:	Traffic control equipment
Affects:	The Southerly portion of said premises

12. Lease made by Joshua Green Corporation, a Delaware Corporation, lessor, to Far West Services, Inc., a California Corporation, lessee, for a term of 25 years, and the covenants and conditions as therein contained, as disclosed by Memorandum of Lease dated October 9, 1979, and recorded November 5, 1979 as document no. 7911050798.

Said lease, among other things provides for an option to renew for 3 periods of 5 years each.

13. Restrictions, conditions, dedications, notes, easements and provisions, if any, as contained and/or delineated on the face of the Short Subdivision No. 20 recorded September 24, 1980 under Recording No. 8009240309, in King County, Washington.

14. Easement, including terms and provisions contained therein:

Recording Information:	January 31, 1983 under Recording No. 8301310050
In Favor of:	City of Lake Forest Park, a Municipal Corporation
For:	Ingress and egress
Affects:	The Northerly portion of said premises

Said easement relocates portions of that easement previously established by instrument recorded July 26, 1963 under Recording No. 5615390.

15. The terms and provisions contained in the document entitled "Concomitant Agreement" recorded December 29, 1988 as Recording No. 8812291216 of Official Records. By and between City of Lake Forest Park and Birtcher McDonald Properties and Boettcher Western Properties II, Ltd., a Colorado Limited Partnership.

16. Lease made by Lake Forest Park Associates, a Joint Venture of Birtcher McDonald Properties and Boettcher Western Properties II Ltd., lessor, to Pay'N Save Drug Stores, Incorporated, a California Corporation, lessee, for a term of 5 years, and the covenants and conditions as therein contained, as disclosed by Memorandum of Lease dated May 18, 1989, and recorded August 31, 1989 as document no. 8908310594.

Said lease, among other things provides for an option to renew for a period of Four (4) successive periods of Five (5) years each after the expiration of the initial term.

17. The terms and provisions contained in the document entitled "Contract for Developer Extension" recorded October 26, 1989 as Recording No. 8910260380 of Official Records. By and between City of Lake Forest Park and Nor Wes Construction Inc.

18. The terms and provisions contained in the document entitled "Agreement and Easement for Sidewalk" recorded October 26, 1989 as Recording No. 8910260381 of Official Records. By and between Lake Forest Park Associates, a Washington Joint Venture and The City of Lake Forest Park, a Municipality.

19. Terms, covenants, conditions and restrictions as contained in recorded Lot Line Adjustment (Boundary Line Revision) L-89-109 :

Recorded:	October 27, 1989
Recording Information:	8910271129

20. Easement, including terms and provisions contained therein:

Recording Information:	June 15, 1990 under Recording No. 9006151759
In Favor of:	King County Fire Protection District No. 16, a Municipal Corporation
For:	Ingress and egress
Affects:	Southwesterly portion of said premises

21. Easement, including terms and provisions contained therein:

Recording Information:	June 15, 1990 under Recording No. 9006151760
In Favor of:	Washington Natural Gas Company
For:	Gas pipeline or pipelines
Affects:	Refer to said instrument for the exact location

22. Restrictions, conditions, dedications, notes, easements and provisions, if any, as contained and/or delineated on the face of the Short Plat No. 90-45 recorded August 22, 1990 under Recording No. 9008220271, in King County, Washington.

Document(s) declaring modifications thereof recorded July 11, 1990 as Recording No. 9007110936 of Official Records.

23. The terms and provisions contained in the document entitled "Environmental Agreement" recorded October 10, 1990 as Recording No. 9010101584 of Official Records. By and between Chevron U.S.A. Inc., a Pennsylvania Corporation and Lake Forest Park Associates, a Washington General Partnership.

24. Easement, including terms and provisions contained therein:

Recording Information:	December 18, 1990 under Recording No. 9012181106
In Favor of:	City of Seattle
For:	Electric system
Affects:	The Westerly 30 feet and a 10 foot wide strip on Southwesterly portion of said premises

25. Terms, covenants, conditions and restrictions as contained in recorded Lot Line Adjustment (Boundary Line Revision) L98-152 :

Recorded:	October 27, 1998
Recording Information:	9810279006

Notice of Approval Recorded October 27, 1998 under Recording No. 9810271793.

26. The terms and provisions contained in the document entitled "Reciprocal Parking Agreement" recorded July 28, 1999 as Recording No. 19990728001956 of Official Records. By and between Lake Forest Park Associates, a Washington Partnership and Skipper's, Inc., a Washington Corporation.

27. Restrictions, conditions, dedications, notes, easements and provisions, if any, as contained and/or delineated on the face of the Short Plat No. SP-99-79 recorded March 7, 2000 under Recording No. 20000307900002, in King County, Washington.

Approval of said subdivision was recorded March 7, 2000 under Recording No. 20000307000950.

28. The terms and provisions contained in the document entitled "Reciprocal Easement Agreement" recorded March 30, 2000 as Recording Nos. 20000330001299 and 20000330001306 of Official Records. By and between FP, LLC, a Washington Limited Liability Company and Lake Forest Park Association, a Washington General Partnership.

29. Covenants, conditions, restrictions and/or easements:

Recorded:	March 2, 2004
Recording No.:	20040302001196

30. Terms, conditions, provisions and stipulations of the Joint Venture Agreement of **Lake Forest Park Associates, a Washington Joint Venture Partnership**. A copy of the current agreement and any amendments must be submitted prior to closing. Any conveyance or encumbrance of the Joint Venture property must be executed by all of the Joint Venturer.

31. This item has been intentionally deleted.

32. Unrecorded leaseholds, if any, rights of vendors and security agreement on personal property and rights of tenants, and secured parties to remove trade fixtures at the expiration of the term.

33. General Taxes for the year 2006.

Tax Account No.:	401930-1655-01
Amount Billed:	$ 261,133.76
Amount Paid:	$ 0.00
Amount Due:	$ 261,133.76
Assessed Land Value:	$ 11,472,100.00
Assessed Improvement Value:	$ 9,040,300.00

34. General Taxes for the year 2006.

Tax Account No.:	401930-1656-00
Amount Billed:	$ 8,534.33
Amount Paid:	$ 0.00
Amount Due:	$ 8,534.33
Assessed Land Value:	$ 318,800.00
Assessed Improvement Value:	$ 381,900.00

(As to Lot B of Short Subdivision No. 20, recorded September 24, 1980 under Recording No. 8009240309, which lies within New Lot 2 described in Exhibit "A" of Schedule A)

35. Covenants, conditions, restrictions and/or easements:
Recorded: February 6, 2006
Recording No.: 20060206002755

36. Right, title and interest of McElroy George & Associates Inc. as to the herein described property as disclosed by the King County Tax Roll. We find no record of the party(ies) having an interest in the premises.

37. Evidence of the authority of the individual(s) to execute the forthcoming document for MSREF/Seneca Tree House, L.L.C., a Delaware Limited Liability Company, copies of the current operating agreement should be submitted prior to closing.

38. A Certificate of Good Standing from the State of Delaware for MSREF/Seneca Tree House, L.L.C., a Delaware Limited Liability Company, should be submitted prior to closing.

INFORMATIONAL NOTES

A. Effective January 1, 1997, and pursuant to amendment of Washington State Statutes relating to standardization of recorded documents, the following format and content requirements must be met. Failure to comply may result in rejection of the document by the recorder.

B. Any sketch attached hereto is done so as a courtesy only and is not part of any title commitment or policy. It is furnished solely for the purpose of assisting in locating the premises and First American expressly disclaims any liability which may result from reliance made upon it.

C. The description can be abbreviated as suggested below if necessary to meet standardization requirements. The full text of the description must appear in the document(s) to be insured.

New Lot 2, SP No. SP99-79, Rec. 20000307900002

APN: 401930-1655-01
APN: 401930-1656-00

Property Address: **17171 & 17181 Bothell Way NE., Lake Forest Park, WA 98155**

D. According to the application for title insurance, title is to vest in MSREF/Seneca Tree House, L.L.C., a Delaware Limited Liability Company.

Examination of the records discloses no matters pending against said party(ies).

E. A fee will be charged upon the cancellation of this Commitment pursuant to the Washington State Insurance Code and the filed Rate Schedule of the Company.

END OF SCHEDULE B

cc: TBD

First American Title Insurance Company of New York

COMMITMENT
Conditions and Stipulations

1. The term "mortgage" when used herein shall include deed of trust, trust deed, or other security instrument.

2. If the proposed Insured has or acquires actual knowledge of a defect, lien, encumbrance, adverse claim or other matter affecting the estate or interest or mortgage thereon covered by this Commitment, other than those shown in Schedule B hereof, and shall fail to disclose such knowledge to the Company in writing, the Company shall be relieved from liability for any loss or damage resulting from any act or reliance hereon to the extent the Company is prejudiced by failure to so disclose such knowledge. If the proposed Insured shall disclosure such knowledge to the Company, or if the Company otherwise acquires actual knowledge of any such defect, lien, encumbrance, adverse claim or other matter, the Company at its option, may amend Schedule B of this Commitment accordingly, but such amendment shall not relieve the Company from liability previously incurred pursuant to paragraph 3 of these Conditions and Stipulations.

3. Liability of the Company under this Commitment shall be only to the named proposed Insured and such parties included under the definition of Insured in the form of Policy or Policies committed for, and only for actual loss incurred in reliance hereon in undertaking in good faith (a) to comply with the requirements hereof, or (b) to eliminate exceptions shown in Schedule B, or (c) to acquire or create the estate or interest or mortgage thereon covered by this Commitment. In no event shall such liability exceed the amount stated in Schedule A for the Policy or Policies committed for and such liability is subject to the Insuring provisions, exclusion from coverage, and the Conditions and Stipulations of the form of Policy or Policies committed for in favor of the proposed Insured which are hereby incorporated by references, and are made a part of this Commitment except as expressly modified herein.

4. Any claim of loss or damage, whether or not based on negligence, and which arises out of the status of the title to the estate or interest or the lien of the Insured mortgage covered hereby or any action asserting such claim, shall be restricted to the provisions and Conditions and Stipulations of this Commitment.

The First American Corporation

First American Title Insurance Company of New York

PRIVACY POLICY

We Are Committed to Safeguarding Customer Information

In order to better serve your needs now and in the future, we may ask you to provide us with certain information. We understand that you may be concerned about what we will do with such information particularly any personal or financial information. We agree that you have a right to know how we will utilize the personal information you provide to us. Therefore, together with our parent company, The First American Corporation, we have adopted this Privacy Policy to govern the use and handling of your personal information.

Applicability

This Privacy Policy governs our use of the information which you provide to us. It does not govern the manner in which we may use information we have obtained from any other source, such as information obtained from a public record or from another person or entity. First American has also adopted broader guidelines that govern our use of personal information regardless of its source. First American calls these guidelines its Fair Information Values, a copy of which can be found on our website at www.firstam.com.

Types of Information

Depending upon which of our services you are utilizing, the types of nonpublic personal information that we may collect include:

- Information we receive from you on applications, forms and in other communications to us, whether in writing, in person, by telephone or any other means;
- Information about your transactions with us, our affiliated companies, or others; and
- Information we receive from a consumer reporting agency.

Use of Information

We request information from you for our own legitimate business purposes and not for the benefit of any nonaffiliated party. Therefore, we will not release your information to nonaffiliated parties except: (1) as necessary for us to provide the product or service you have requested of us; or (2) as permitted by law. We may, however, store such information indefinitely, including the period after which any customer relationship has ceased. Such information may be used for any internal purpose, such as quality control efforts or customer analysis. We may also provide all of the types of nonpublic personal information listed above to one or more of our affiliated companies. Such affiliated companies include financial service providers, such as title insurers, property and casualty insurers, and trust and investment advisory companies, or companies involved in real estate services, such as appraisal companies, home warranty companies, and escrow companies. Furthermore, we may also provide all the information we collect, as described above, to companies that perform marketing services on our behalf, on behalf of our affiliated companies, or to other financial institutions with whom we or our affiliated companies have joint marketing agreements.

Former Customers

Even if you are no longer our customer, our Privacy Policy will continue to apply to you.

Confidentiality and Security

We will use our best efforts to ensure that no unauthorized parties have access to any of your information. We restrict access to nonpublic personal information about you to those individuals and entities who need to know that information to provide products or services to you. We will use our best efforts to train and oversee our employees and agents to ensure that your information will be handled responsibly and in accordance with this Privacy Policy and First American's Fair Information Values. We currently maintain physical, electronic, and procedural safeguards that comply with federal regulations to guard your nonpublic personal information.