OPERATION, MAINTENANCE AND MONITORING PLAN

Former Huck Manufacturing Facility, Kingston, New York

NYSDEC Site No. V00171-3

March 5, 2015

OPERATION, MAINTENANCE AND MONITORING PLAN

Former Huck Manufacturing Facility, Kingston, New York
NYSDEC Site No. V00171-3

March 5, 2015

Client

Federal-Mogul Corporation

Consultant

WSP USA Corp
50 Lakefront Blvd, Suite 111, Buffalo, NY14202
+1-716-362-9196

WSP Contacts

Brian Silfer
Brian.Silfer@WSPGroup.com

Todd Musterait, P.E., ENV SP, LEED Green Assoc.
Todd.Musterait@WSPGroup.com

Daniel Liwicki
Daniel.Liwicki@WSPGroup.com

Table of Contents

Figures

Appendices

1 Introduction

WSP, on behalf of the Federal-Mogul Corporation has prepared this Operation, Maintenance and Monitoring (OM&M) Plan to describe the procedures for inspecting, maintaining, and monitoring the interim remedial measure (IRM) at the Former Huck Manufacturing Facility (site) in Kingston, New York (Figure 1). This OM&M Plan has been prepared in accordance with the requirements and procedures detailed in the Interim Remedial Measure Work Plan for Air Sparing and Soil Vapor Extraction System Design and Installation, which was approved by the New York State Department of Environmental Conservation (NYSDEC) in correspondence, dated September 3, 2013. This OM&M Plan is included as Appendix E of the construction completion report (CCR) titled Construction Completion Report, Air Sparging and Soil Vapor Extraction System (CCR), dated February 27, 2015.

1.1 Purpose

The purpose of the OM&M Plan is to describe the procedures to inspect, maintain, and monitor the IRM, which became operational on April 19, 2014. The primary objective of the IRM is to reduce the volatile organic compound (VOC) mass in groundwater in two areas of the site that exhibit the highest aqueous VOC concentrations, while addressing VOCs potentially present in vadose zone soils within these areas. The two target areas include the Former Degreaser Area and Former Metal Finish and Chemical Storage Area (Figure 2). The system also addresses VOCs in vadose zone soils south and west of the former manufacturing building.

1.2 Site Description

The former Huck manufacturing facility is located at 85 Grand Street in Kingston, New York, and consists of two buildings occupying 105,000-square feet on 4.5-acres (Figures 1 and 2). The remainder of the site consists of asphalt parking areas, access roads, and a small grass-covered area near the southeast corner of the former manufacturing building. A chain-link fence controls access to the western portion of the facility. The property is owned by Allways Moving and Storage, which uses the facility for indoor self-storage and leases portions of the onsite buildings to other entities.

The property is in a mixed light industrial, commercial, and residential area. Tenbroeck Avenue borders the site to the northeast. Northeast of Tenbroeck Avenue are mixed residential and commercial properties. Grand Street and a residential neighborhood border the site to the southeast. West of the site are CSX Transportation, Inc., railroad tracks and further west are light industrial and commercial properties.

2 Project Background

In March 2004, a soil vapor extraction (SVE) system was installed primarily along the eastern and southern property lines as an IRM to address VOCs in soil east of the former manufacturing building from 1 to 3-feet below ground surface and to prevent the offsite migration of VOCs in soil gas. Treatment of soils in the eastern parking lot is ongoing.

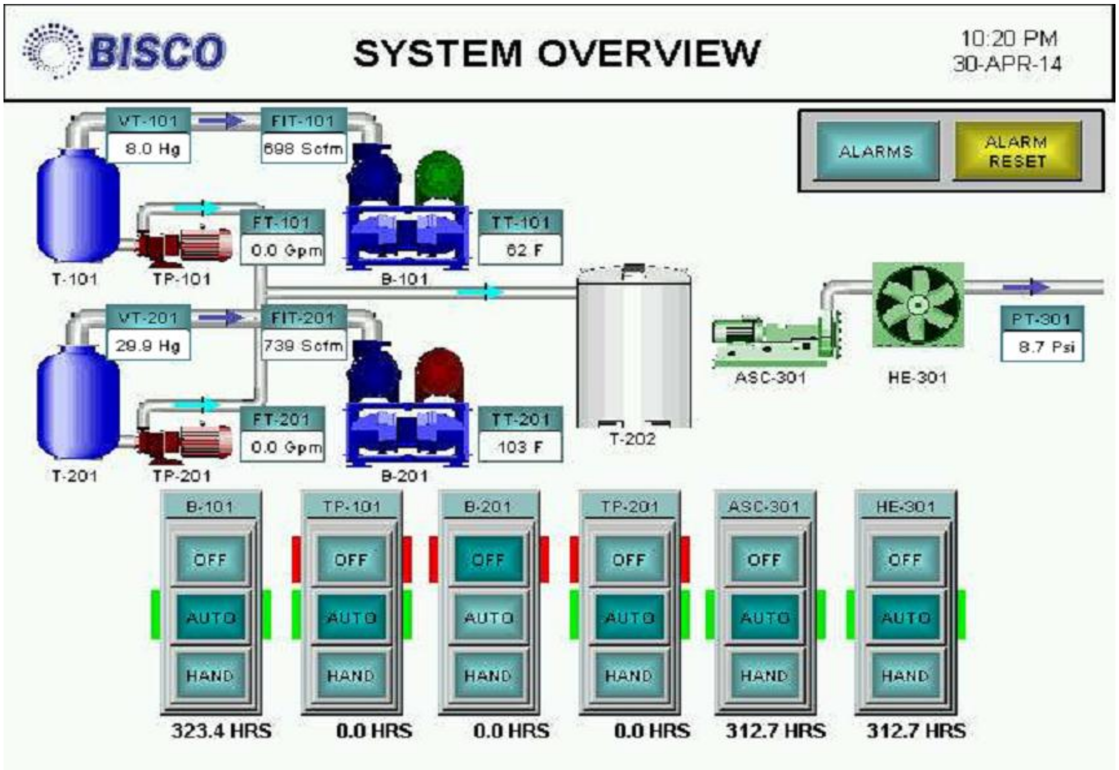
In April 2014, construction was completed on an IRM that consists of an air sparging (AS) component designed to target VOC-affected groundwater and a SVE component designed to remove VOCs from the vadose zone, as well as collect VOCs partitioned from the groundwater due to AS operation. The IRM is further described in the following sections.

3 IRM System Description

The IRM system consists of 12 SVE wells and 9 AS wells divided into two cycle groups to provide for cycled operation of the system (Appendix A; Sheets 1-9). The AS and SVE cycle groups are each connected to a dedicated manifold by a network of subsurface (trenched) and overhead conveyance piping. The manifolds allow for compressed air flow from the AS header piping and soil gas flow to the SVE header piping, respectively. The AS header enters from the Manifold Room into the SVE Treatment Room and connects to the AS compressor skid (Appendix A; Sheet 6). The two SVE cycle groups join to a common header at a three-way control valve in the Manifold Room. The SVE header pipe runs through the west wall of the Manifold Room and ties into the inlet pipe to SVE blower B-101 in the SVE Treatment Room, prior to the inlet air filter. The AS and SVE wells comprising each cycle group are presented below:

Cycle Group 1			**Cycle Group 2**		
Area	***SVE Wells***	***AS Wells***	***Area***	***SVE Wells***	***AS Wells***
Area 1	SV-1	AS-1	**Area 3**	SV-8	AS-8
	SV-2	AS-2	**Area 4**	SV-12	AS-9
	SV-3	AS-3	**Area 5**	SV-9	
	SV-4	AS-4		SV-10	
		AS-5		SV-11	
Area 2	SV-5	AS-6	**Area 6**	SV-7	
	SV-6	AS-7			

The programmable logic controller (PLC) has an electronic interface that controls SVE blower B-101, transfer pump TP-101, air compressor ASC-301, and AS heat exchanger HE-301. The PLC interface is presented in the figure below:



PLC and Master Control Panel Interface

4 Initial Startup and System Commissioning

IRM startup and system commissioning was conducted from April 17 through 19, 2014, as detailed in the CCR. Operability and functionality testing completed during startup and commissioning is described below:

- Inspected and tested the electrical system including PLC master control, system alarms, flow transmitters, vacuum gauges, temperature gauges, pressure gauges, emergency stop, thermostat, overhead lighting, etc.
- Inspected and tested the mechanical system including SVE blower B-101, transfer pump TP-101, air compressor ASC-301, and heat exchanger HE-301, including associated floats, starter coils, and motors.
- Balanced air flow to SVE Cycle Group 1 and Cycle Group 2 at the SVE manifold.
- Balanced air flow from the ASC-301 compressor skid to each of the AS wells at the AS manifold.
- Monitored influent VOC concentrations from each cycle group using a photoionization detector (PID), including the individual SVE well branches and the combined flow into SVE blower B-101. The monitoring was conducted at 1 hour intervals for the first 8 hours of operation and again at the end of the 24-hour startup period.
- Monitored vacuum, temperature, pressure, and air flow in each SVE branch.
- Collected vapor samples from the influent to SVE blower B-101 at 2, 4, 8, and 24 hours after initiating startup activities for each cycle group.
- Collected effluent vapor samples at the beginning and end of the startup period for each cycle group.

A detailed description of startup and commissioning activities is presented in Section 4 of the CCR. Influent and effluent vapor samples were collected using evacuated 1-liter Entech Instruments, Inc., canisters and analyzed for VOCs by U.S. Environmental Protection Agency (EPA) Method TO-15. Effluent samples were collected to demonstrate compliance with the NYSDEC's Air Guide 1.

5 Operation, Maintenance, and Monitoring

Following completion of the IRM startup and commissioning activities on April 19, 2014, the system was considered operational. Presented below is a description of the OM&M activities to be performed with respect to the IRM.

5.1 Monthly OM&M Performance Monitoring and Cycling

Monthly OM&M performance monitoring and cycling of the AS/SVE cycle groups will be completed by WSP or its subcontractor (OM&M personnel). Performance monitoring will include, at a minimum, the following procedures to identify variations from operational baselines, which may be due to system malfunctions, changes in subsurface conditions, or the development of cracks in the concrete used to cap the trenches or the surrounding asphalt or concrete surfaces.

Upon arrival at the site, SVE blower B-101 and AS compressor ASC-301 should be in operation. OM&M personnel will verify and record that the equipment is operating on sheet 1 of the OM&M Field Log Template (Appendix B). OM&M personnel will verify the position of the AS control valves and the SVE control valve (three-way valve), located in the Manifold Room. IRM performance monitoring measurements and instrument readings of the cycle group in operation will be recorded on sheet 1 of the OM&M Log:

SVE Branch Readings (SV-1 through SV-12; Manifold Room):

- Temperature (TI)
- Vacuum (VI)
- Differential Pressure (DP-FS)

AS Header Readings (Manifold Room)

- Temperature (TI)
- Pressure (PI)

AS Branch Readings (AS-1 through AS-9; Manifold Room)

- Pressure (PI)
- Flow Rate (FS)

SVE Readings (SVE blower B-101; SVE Treatment Room)

- Inlet Vacuum – Before Filter (VI)
- Inlet Vacuum – After Filter (VI)
- Vacuum – After Air/Water (A/W) Separator (VI-101)
- Vacuum – Inlet to Blower Filter (VI)
- Vacuum – Inlet Blower (VI-102)
- Differential Pressure (PI-101)
- Effluent Temperature (TI-101)

AS Skid Readings (SVE Treatment Room)

- Air Inlet Vacuum (VI-301)
- Discharge (hot) Air Pressure (PI-301)

- Discharge (hot) Air Temperature (TI-301)
- Discharge (warm) Air Pressure (PI-302)
- Discharge (warm) Air Temperature (TI-302)
- Discharge (warm) Air Differential Pressure (flow, FI-301)

PLC/Control Panel Readings (SVE Treatment Room)

- Influent Vacuum (VT-101)
- Influent Air Flow Rate (FIT-101)
- Effluent Air Temperature (TT-101)
- Air Sparge Pressure (PT-301)
- Hour Meter Readings (B-101, TP-101, B-201, TP-201, ASC-301, HE-301)

A PID equipped with a 10.6 eV lamp should be used for all applicable OM&M tasks. A PID calibration certificate must be retained for each monthly cycling of the IRM. OM&M personnel will collect a Tedlar bag sample from the SVE blower B-101 influent and effluent and measure the total VOC concentration in each sample using a PID. A Tedlar bag sample will be collected from each of the operating SVE branches (Manifold Room) to measure the total VOC concentration from each branch. The general procedure for collecting instantaneous PID influent and effluent readings is described below.

SVE blower B-101 Influent Monitoring Procedure

- Ensure the date and time on the PID is correct.
- Use 1/4-inch inside-diameter vinyl tubing to connect the front of the hand-pump to the stopcock located on the air and water separator for SVE blower B-101. The tubing shall be installed firmly over the intake of the hand-pump and the barbed fitting located on the stop cock.
- Connect a Tedlar bag to the top of the hand-pump.
- Open valve on Tedlar bag, open the stopcock, and fill the Tedlar bag.
- Close the valve on the Tedlar bag, remove it from the hand pump, and connect the Tedlar bag to the PID.
- *<u>DO NOT SQUEEZE THE TEDLAR BAG.</u>* Squeezing the Tedlar bag and forcing air into the PID may result in an inaccurate reading.
- Allow the PID to draw in at least ½ of the air contained in the Tedlar bag.
- Record the maximum concentration measured by the PID for each Tedlar bag.
- Remove the Tedlar bag from the PID.
  - Discharge the remaining air in the Tedlar bag before filling if for the next measurement.
  - Repeat the above steps for each measurement needed.

SVE blower B-101 Effluent Monitoring Procedure

- Ensure the date and time on the PID is correct.
- Use 1/4-inch inside-diameter vinyl tubing to connect the PID to the SVE blower B-101 effluent sampling port. The tubing shall be installed firmly over the end of the PID and the barbed fitting located on the effluent sample port.
- Having excessive pressure/flow through the PID may affect the accuracy of the measurements. When connecting the PID to the effluent sample port, make sure the value is almost fully closed (i.e. the air coming out of the tubing should be barely felt on the back of your hand).

- Open valve on Tedlar bag, open the stopcock, and fill the Tedlar bag.
- Close the valve on the Tedlar bag, remove it from the stopcock, and connect the Tedlar bag to the PID.
- *DO NOT SQUEEZE THE TEDLAR BAG.* Squeezing the Tedlar bag and forcing air into the PID may result in an inaccurate reading.
- Allow the PID to draw in at least ½ of the air contained in the Tedlar bag.
- Record the maximum concentration measured by the PID for each Tedlar bag.
- Remove the Tedlar bag from the PID.
- Discharge all of the remaining air in the Tedlar bag before filling it for the next measurement.
- Repeat the above steps for each measurement needed.

When restarting the AS/SVE system, the gate valve on Line 3 of the 2004 IRM system located in the SVE Treatment Room must be closed. The three-way valve on the SVE header pipe in the Manifold Room must be opened for operation of the desired cycle group. During routine monthly site visits, the operating cycle group will be switched to the cycle group that was previously inactive. For example, if AS/SVE Cycle Group 1 was operating at the commencement of the monthly visit, AS/SVE Cycle Group 2 shall be put into operation at the completion of the monthly site visit. Once the cycle group has been changed, page 4 of the OM&M Log should be completed.

In the SVE Treatment Room, restart SVE blower B-101, transfer pump TP-101, air compressor ASC-301, and heat exchanger HE-301 by pushing the "AUTO" button on the control panel for each component. The OM&M personnel should then immediately begin recording instrument readings, and collecting influent/effluent samples as described previously within this section. On completion of these activities, the monthly cycling of the IRM is complete.

5.2 Preventative Maintenance

OM&M personnel will perform the following routine preventative maintenance on the IRM system components prior to initiating the IRM cycling activities described in the previous section.

- Replace oil and add grease in Roots™ SVE blower B-101, if necessary, based on hours of operation and manufacturer specifications (Appendix C).
- Transfer water (if present) from the air/water separator tanks to the onsite 400-gallon transfer tank. The volume of water in the transfer tank should not exceed 200 gallons. If necessary, OM&M personnel will transfer excess water to 55-gallon closed-top steel drums (see below).
- Transfer excess water from the transfer tank to new or reconditioned U.S. Department of Transportation - authorized closed-top 55-gallon steel drums. The drums must be free of hazardous chemicals or petroleum residues. All waste must be labeled with non-hazardous waste labels immediately following the containerization of any amount of condensate. The label should include the date that waste was first placed in the drum and a description of its contents.
- Check the V-belt on the Roots™ SVE blower B-101 and adjust as needed. If necessary, replace the belt.
- Inspect and clean SVE blower B-101 particulate filters. If necessary, replace the filters.
- Replace auxiliary IRM equipment that is not working properly (e.g., valves and gauges).

5.3 Carbon Replacement

OM&M personnel will procure, manage, and oversee subcontractor services for spent carbon removal and replacement with virgin, vapor phase granular activated carbon. Carbon replacement will be conducted, as necessary, based on effluent monitoring results.

5.4 IRM System Sampling

Influent and effluent vapor samples will be collected for analysis of trichloroethene, tretrachloroethene, and cis-1,2-dichloroethene using EPA Method TO-15. The samples will be collected bi-weekly for the first 2 months of operation, quarterly for the remainder of the first year of operation, and semi-annually thereafter. This sampling schedule assumes continuous operation of the IRM. If the system becomes inoperable during a cycle scheduled for sampling, the collection of samples may be postponed until the next cycle if it is determined that VOC levels will not reach asymptotic concentrations by the end of the cycle. WSP will notify the NYSDEC of any changes to the sampling schedule.

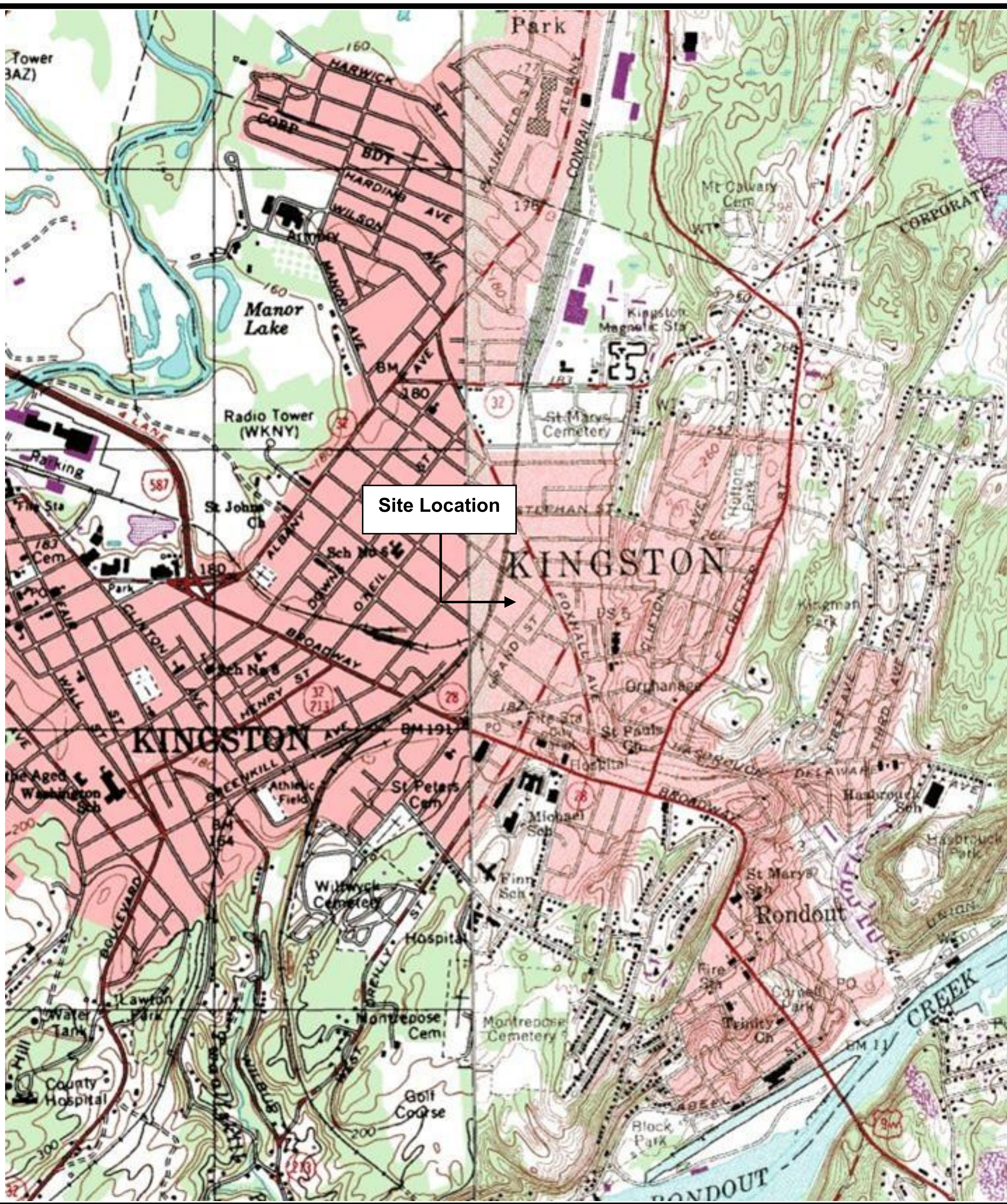
5.5 Subsurface Vacuum Monitoring

Subsurface vacuum measurements will be collected from monitoring points MP-1 through MP-9. (Appendix A; Sheet 2). The vacuum monitoring should be performed on a quarterly basis, at a minimum, to ensure design criteria are being met and confirm subsurface vacuum influence.

6 Acronyms and Abbreviations

AS	Air Sparging
CCR	Construction Completion Report
EPA	Environmental Protection Agency
IRM	Interim Remedial Measure
NYSDEC	New York State Department of Environmental Conservation
OM&M	Operation, Maintenance, and Monitoring
PID	Photoionization Detector
PLC	Programmable Logic Controller
SVE	Soil Vapor Extraction
VOCs	Volatile Organic Compounds

Figures



REFERENCE:
7.5 MINUTE SERIES TOPOGRAPHIC QUADRANGLE
KINGSTON EAST, NEW YORK
PHOTOREVISED 1980 SCALE 1:24,000

N

0 1000 2000 4000
SCALE, FEET

WSP

WSP USA Corp.
2360 Sweet Home Road, Suite 3
Amherst, New York 14228
(716) 691-5232

FIGURE 1

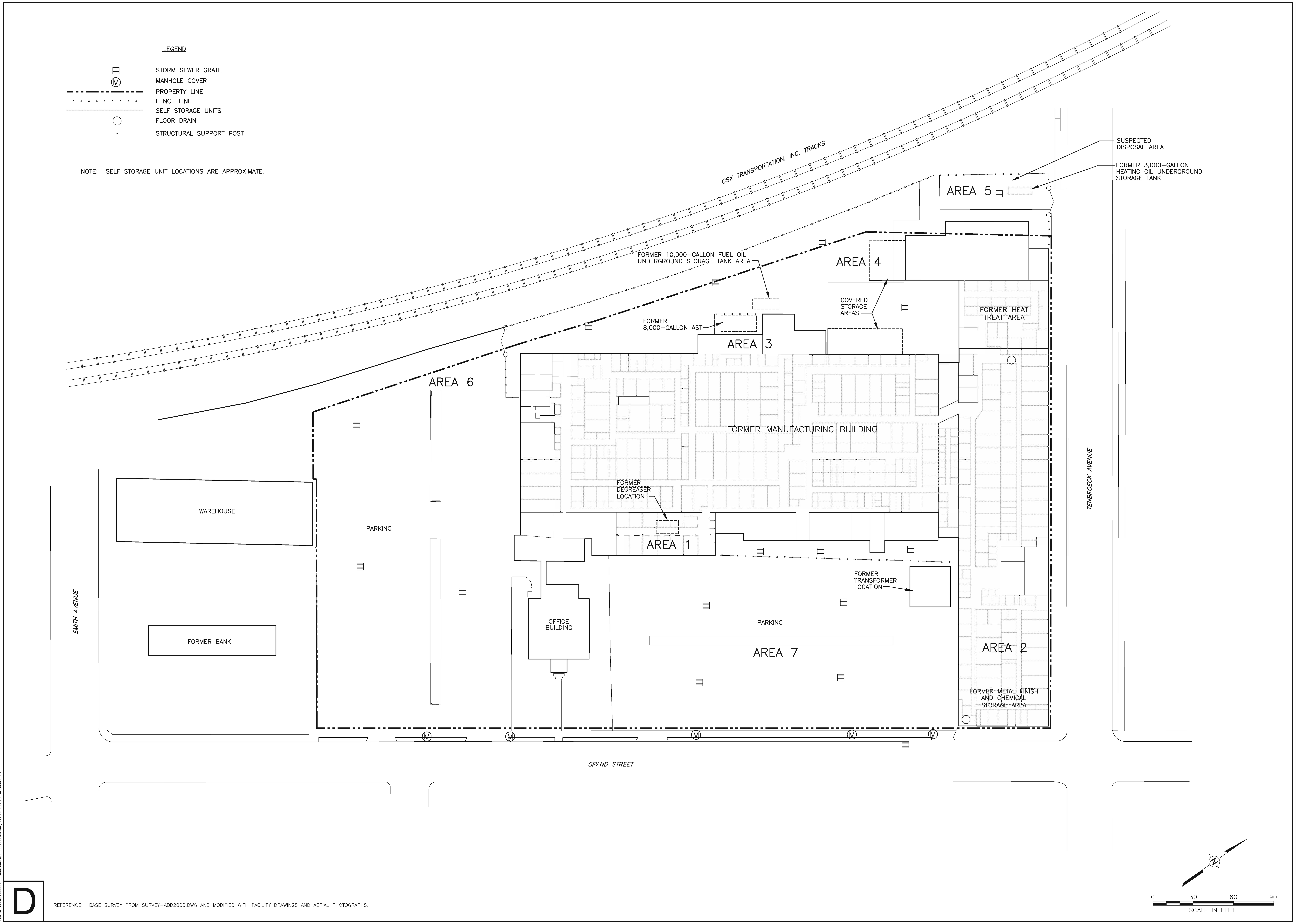
SITE LOCATION MAP

HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK

PREPARED FOR

FEDERAL-MOGUL CORPORATION
SOUTHFIELD, MICHIGAN

DWG Name:
Checked:
Approved:
Drawn By:
A



REVISIONS

REV	DESCRIPTION

DRAWN BY EGC
CHECKED SBP 08/23/2012
APPROVED KDS 08/23/2012

SITE LAYOUT

FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK

PREPARED FOR
FEDERAL-MOGUL CORPORATION
SOUTHFIELD, MICHIGAN

WSP

WSP USA Corp.
5 Sullivan Street
Cazenovia, New York 13035
(315) 655-3900
www.wspgroup.com/usa

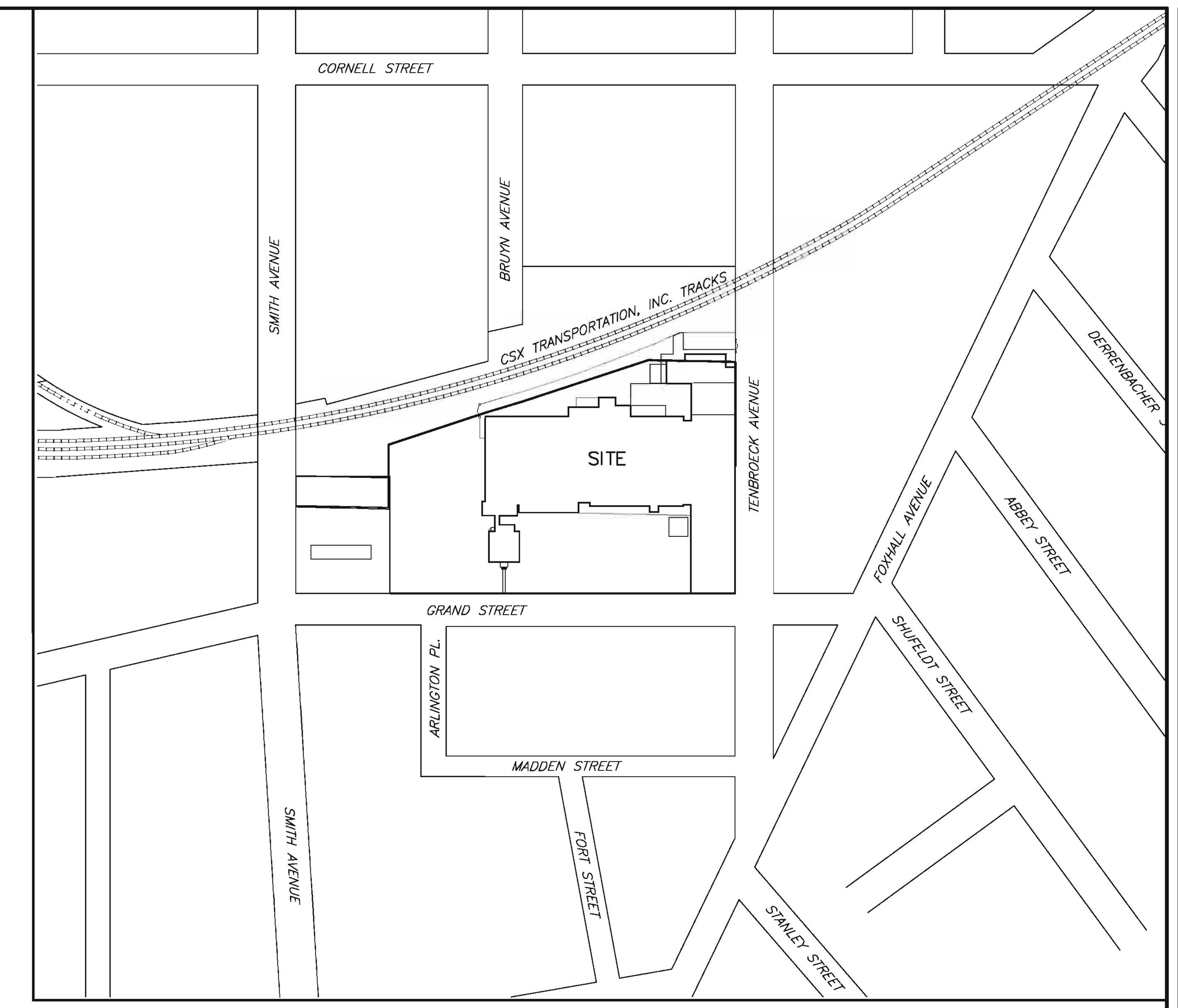
FIGURE 2

Drawing Number
00005609-047

Appendix A – As-Built Drawing Package

INDEX OF DRAWINGS

DRAWING NUMBER	SHEET NUMBER	DESCRIPTION
00005609-064	1	TITLE SHEET
00005609-065	2	IRM SITE PLAN
00005609-066	3	PROCESS AND INSTRUMENTATION DIAGRAM
00005609-068	4	WELL LOCATIONS AND PIPING ROUTES - CYCLE GROUP 1
00005609-067	5	WELL LOCATIONS AND PIPING ROUTES - CYCLE GROUP 2
00005609-069	6	SOIL VAPOR EXTRACTION AND AIR SPARGING EQUIPMENT LAYOUT AND MANIFOLD CONNECTION LAYOUT
00005609-070	7	SOIL VAPOR EXTRACTION AND AIR SPARGING MANIFOLD DETAILS
00005609-071	8	AIR SPARGING WELLHEAD COMPLETION DETAILS
00005609-072	9	SOIL VAPOR EXTRACTION WELLHEAD COMPLETION AND PIPE HANGER DETAILS



LOCATION MAP
SCALE: 1"=200'

INTERIM REMEDIAL MEASURE
AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM

AS-BUILT DRAWING PACKAGE

FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK

PREPARED FOR

FEDERAL-MOGUL CORPORATION

D

REVISIONS

REV	DESCRIPTION	
1	Revised: Chkd:	Appr.:
2	Revised: Chkd:	Appr.:
3	Revised: Chkd:	Appr.:

SEAL

DATE

DRAWN BY	EGC	
CHECKED	DL	2/3/2015
APPROVED	TMM	2/24/2015

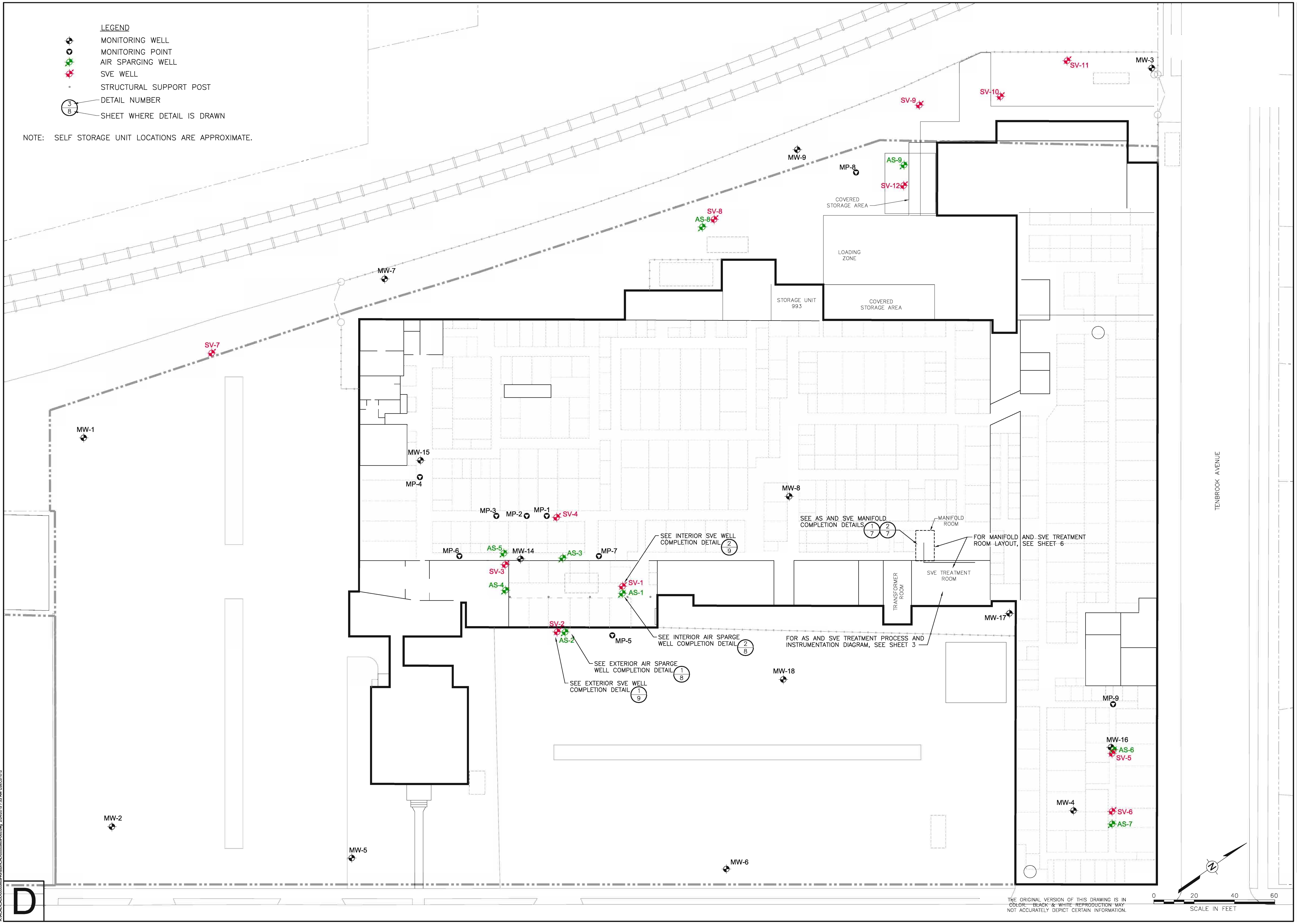
TITLE SHEET

AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK
PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP USA Corp.
11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

SHEET 1

Drawing Number
00005609-064



REVISIONS

REV	DESCRIPTION
1	Revised: Chkd: Appr.:
2	Revised: Chkd: Appr.:
3	Revised: Chkd: Appr.:

SEAL

DATE

DRAWN BY	EGC	
CHECKED	PL	2/3/2015
APPROVED	TMM	2/24/2015

PROPERTY OF WSP USA CORP.
IMPORTANT: THIS DRAWING PRINT IS LOANED FOR MUTUAL ASSISTANCE AND AS SUCH IS SUBJECT TO RECALL AT ANY TIME. INFORMATION CONTAINED HEREON IS NOT TO BE DISCLOSED OR REPRODUCED IN ANY FORM FOR THE BENEFIT OF PARTIES OTHER THAN NECESSARY SUBCONTRACTORS AND SUPPLIERS WITHOUT THE WRITTEN CONSENT OF WSP USA CORP.

NOTICE: THIS DRAWING HAS BEEN PREPARED UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, IT IS A VIOLATION OF STATE LAW FOR ANY PERSONS, UNLESS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT IN ANY WAY.

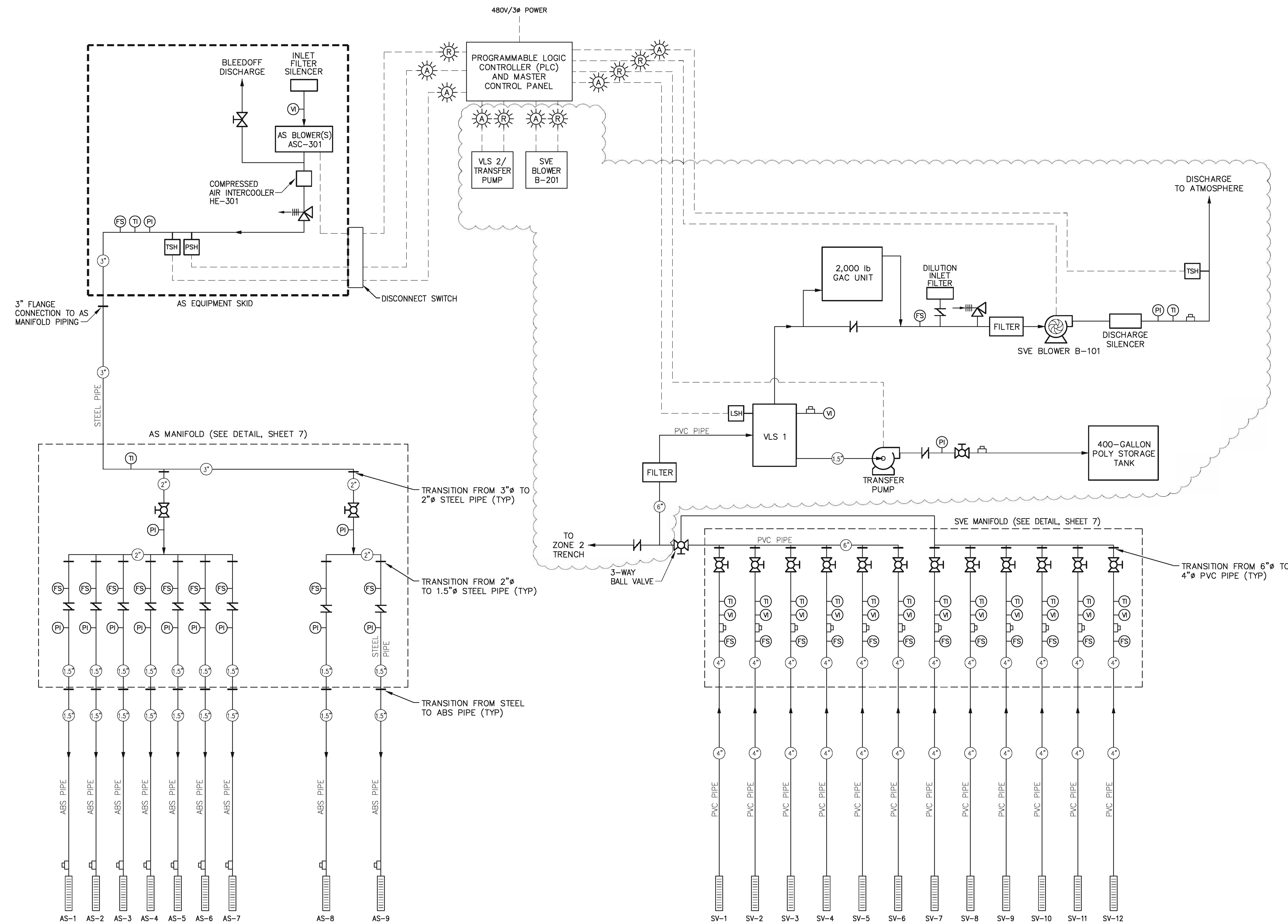
IRM SITE PLAN

AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK
PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP USA Corp.
5 Sullivan Street
Cazenovia, New York 13035
(315) 655-3900
www.wspgroup.com/usa

SHEET 2

Drawing Number
00005609-065



MASTER CONTROL PANEL

1. THE MASTER CONTROL PANEL AND PROGRAMMABLE LOGIC CONTROLLER SUPPLIED BY BISCO ENVIRONMENTAL PROVIDES THE FOLLOWING ALARM FUNCTIONALITY:
   a. ALARM 1 – HIGH LEVEL ALARM IN VLS 1 WILL CAUSE SVE BLOWER B-101 TO SHUTDOWN. THIS ALARM WILL ALSO TRIGGER THE AS BLOWER TO SHUTDOWN.
   b. ALARM 2 – HIGH TEMPERATURE ALARM IN SVE BLOWER B-101 DISCHARGE PIPING WILL CAUSE SVE BLOWER B-101 TO SHUTDOWN. THIS ALARM WILL ALSO TRIGGER THE AS BLOWER TO SHUTDOWN.
   c. ALARM 5 – HIGH PRESSURE ALARM IN THE AS DISCHARGE HEADER WILL CAUSE THE AS BLOWER TO SHUTDOWN. SVE SYSTEMS WILL NOT BE AFFECTED BY THIS ALARM
   d. ALARM 6 – HIGH TEMPERATURE ALARM IN THE AS DISCHARGE HEADER WILL CAUSE THE AS BLOWER TO SHUT DOWN. SVE SYSTEMS WILL NOT BE AFFECTED BY THIS ALARM
   e. ALARM 7 – SPARE
   f. REMOTE EMERGENCY STOP (MOUNTED IN AS EQUIPMENT ROOM)
   g. SPARE – HAND/OFF/AUTO SWITCH WITH RUN INDICATOR LIGHT
2. THE CONTROL PANEL INCLUDES THE FOLLOWING PHYSICAL CONTROLS:
   a. SVE BLOWER 1 – HAND/OFF/AUTO SWITCH WITH RUN INDICATOR LIGHT
   b. AS BLOWER – HAND/OFF/AUTO SWITCH WITH RUN INDICATOR LIGHT
   c. VLS 1 TRANSFER PUMP – HAND/OFF/AUTO SWITCH WITH RUN INDICATOR LIGHT
   d. VLS 2 TRANSFER PUMP – HAND/OFF/AUTO SWITCH WITH RUN INDICATOR LIGHT
   e. ALARM 1 THROUGH ALARM 7 – INDICATOR LIGHTS
   f. EMERGENCY STOP (ALL SYSTEMS STOP)
3. THE CONTROL PANEL AND SYSTEM SOFTWARE PROVIDES THE FOLLOWING CAPABILITIES:
   a. WIRELESS (WI-FI) CONNECTIVITY
   b. REMOTE STARTING AND STOPPING OF ANY EQUIPMENT WHEN POSITIONED IN "AUTO"
   c. ONSITE PROGRAMMABLE USER INTERFACE WITH KEYPAD OR TOUCH SCREEN

LEGEND

- CONVEYANCE PIPING AND DIRECTION OF FLOW
- CONTROL CIRCUIT
- FS – FLOW SENSOR WITH DIFFERENTIAL PRESSURE GAGE
- PI – PRESSURE INDICATOR
- TI – TEMPERATURE INDICATOR
- VI – VACUUM INDICATOR
- PSH – PRESSURE SWITCH HIGH
- TSH – TEMPERATURE SWITCH HIGH
- LSH – LIQUID SENSOR HIGH
- SAMPLE PORT WITH STOPCOCK
- BUTTERFLY VALVE
- BALL VALVE
- GATE VALVE
- VACUUM RELIEF VALVE
- PRESSURE RELIEVE VALVE
- VLS – VAPOR LIQUID SEPARATOR
- GAC – GRANULAR ACTIVATED CARBON
- R – RUN INDICATOR
- A – ALARM CONDITION INDICATOR
- PREVIOUSLY EXISTING EQUIPMENT AT SVE TREATMENT ROOM

REVISIONS

REV	DESCRIPTION

Revised: Chkd: Appr:

SEAL

DATE

DRAWN BY	EGC	
CHECKED	DL	2/3/2015
APPROVED	TMM	2/24/2015

PROCESS AND INSTRUMENTATION DIAGRAM

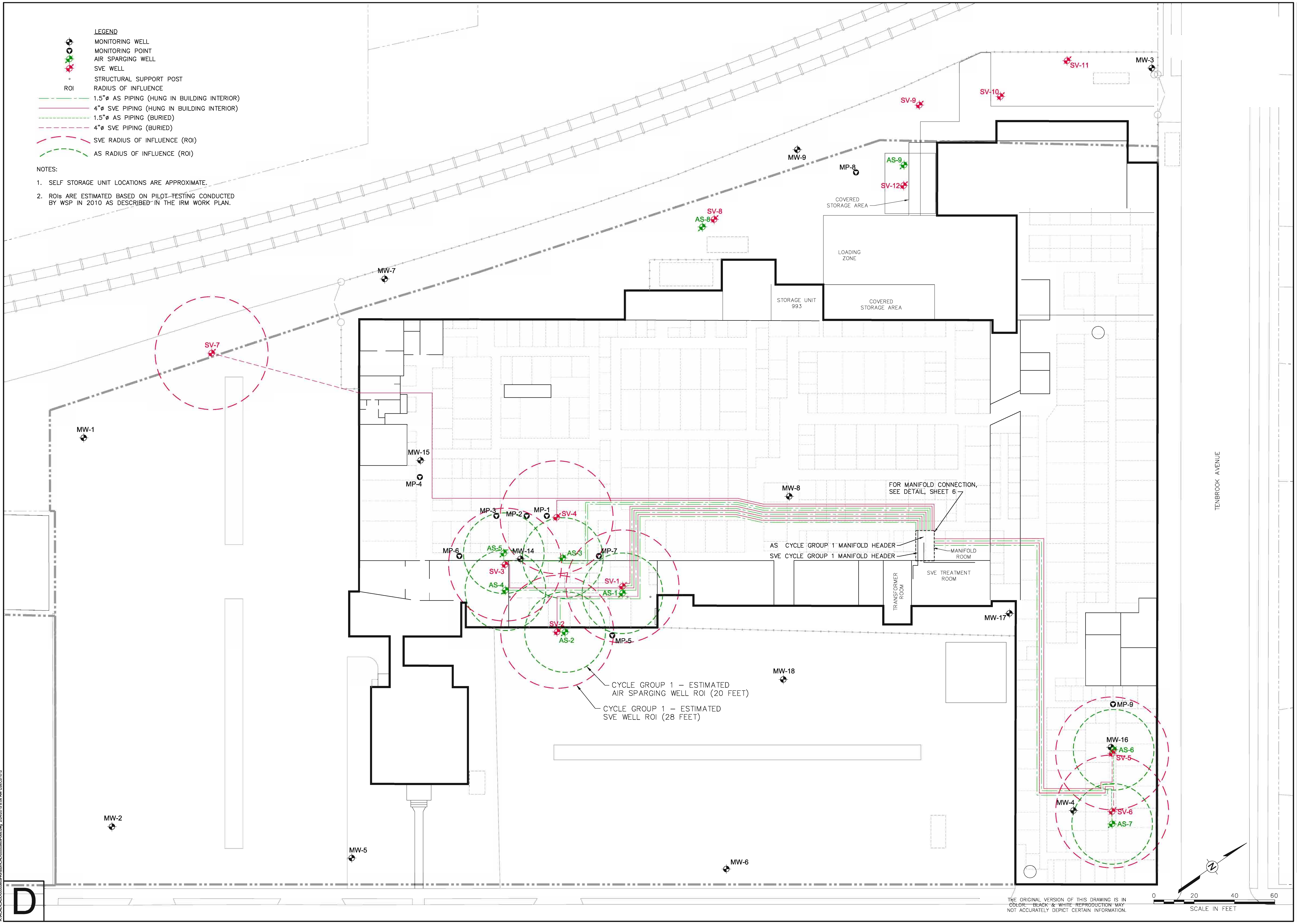
AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK
PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP USA Corp.
11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

SHEET 3

Drawing Number
00005609-066

D



NOTES:

1. SELF STORAGE UNIT LOCATIONS ARE APPROXIMATE.
2. ROIs ARE ESTIMATED BASED ON PILOT TESTING CONDUCTED BY WSP IN 2010 AS DESCRIBED IN THE IRM WORK PLAN.

REVISIONS

REV	DESCRIPTION

SEAL

DATE

DRAWN BY EGC
CHECKED DL 1/19/2016
APPROVED TMM 2/24/2016

PROPERTY OF WSP USA CORP. IMPORTANT: THIS DRAWING PRINT IS LOANED FOR MUTUAL ASSISTANCE AND AS SUCH IS SUBJECT TO RECALL AT ANY TIME. INFORMATION CONTAINED HEREON IS NOT TO BE DISCLOSED OR REPRODUCED IN ANY FORM FOR THE BENEFIT OF PARTIES OTHER THAN NECESSARY SUBCONTRACTORS AND SUPPLIERS WITHOUT THE WRITTEN CONSENT OF WSP USA CORP.

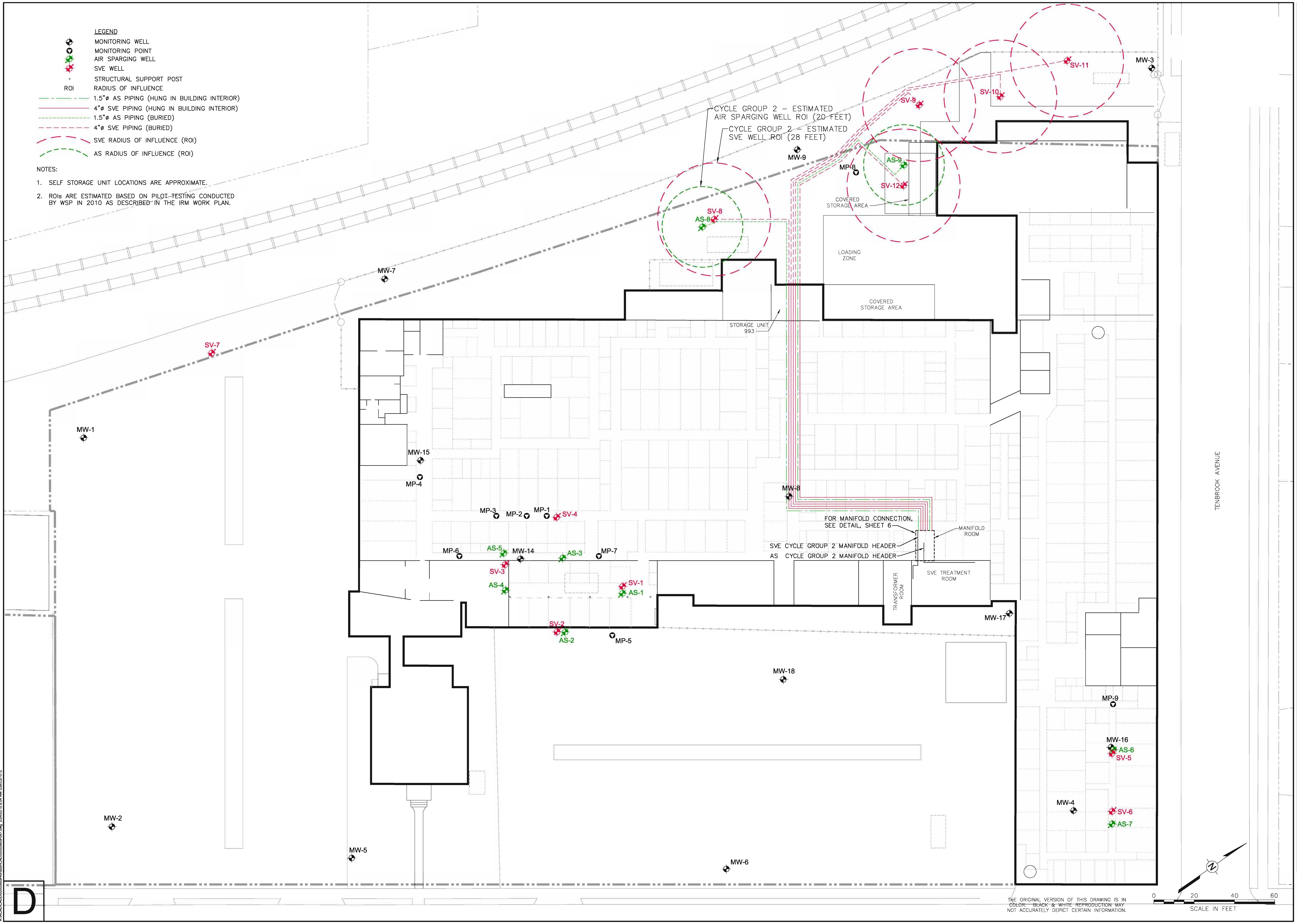
NOTICE: THIS DRAWING HAS BEEN PREPARED UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. IT IS A VIOLATION OF STATE LAW FOR ANY PERSONS, UNLESS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT IN ANY WAY.

WELL LOCATIONS AND PIPING ROUTES – CYCLE GROUP 1
AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK
PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP USA Corp.
5 Sullivan Street
Cazenovia, New York 13035
(315) 655-3900
www.wspgroup.com/usa

SHEET 4

Drawing Number
00005609-068



REVISIONS

REV	DESCRIPTION

DRAWN BY	EGC	
CHECKED	DL	1/19/2015
APPROVED	TMM	2/24/2015

SEAL

DATE

WELL LOCATIONS AND PIPING ROUTES – CYCLE GROUP 2

AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK

PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP USA Corp.
5 Sullivan Street
Cazenovia, New York 13035
(315) 655-3900
www.wspgroup.com/usa

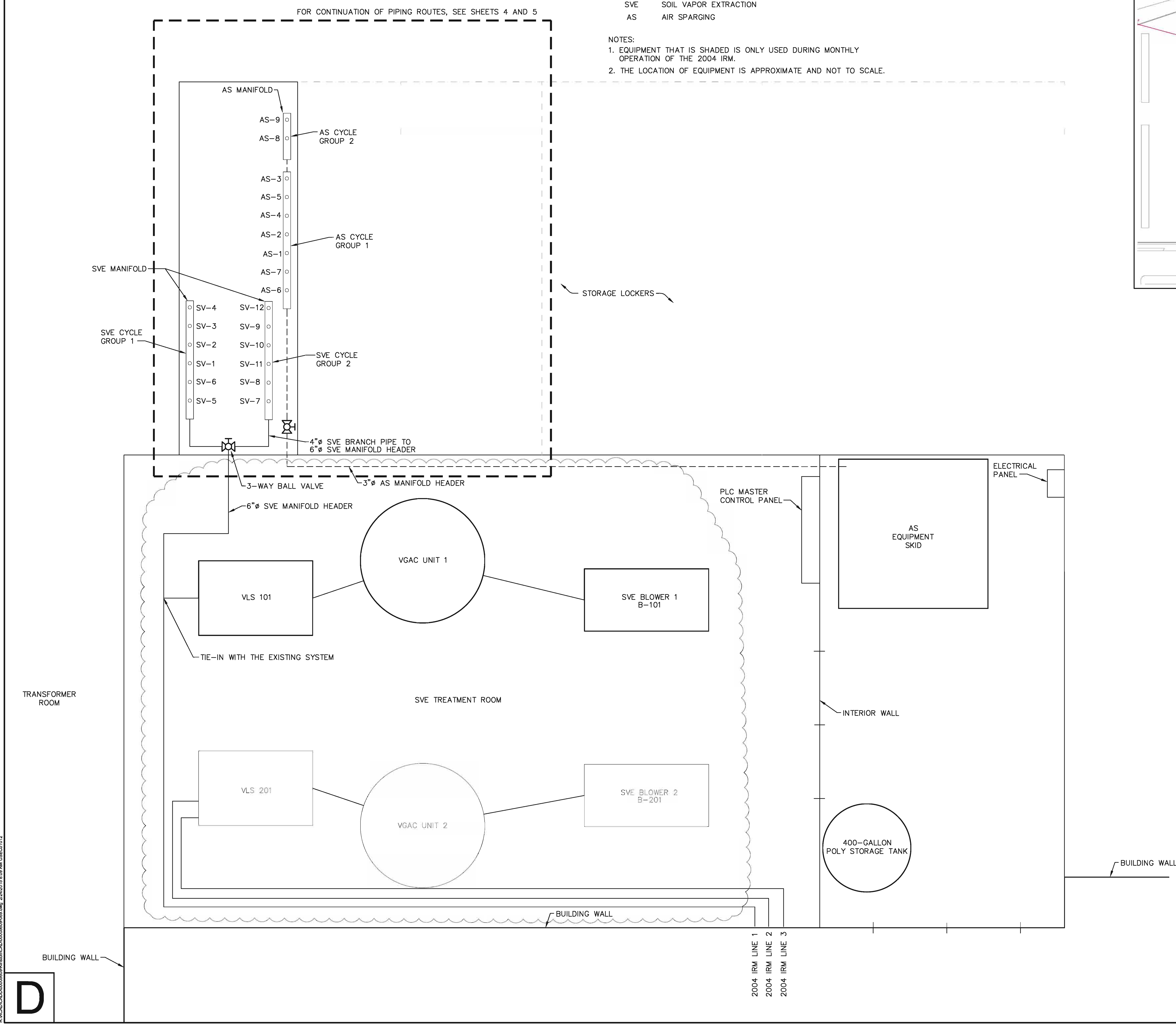
SHEET 5

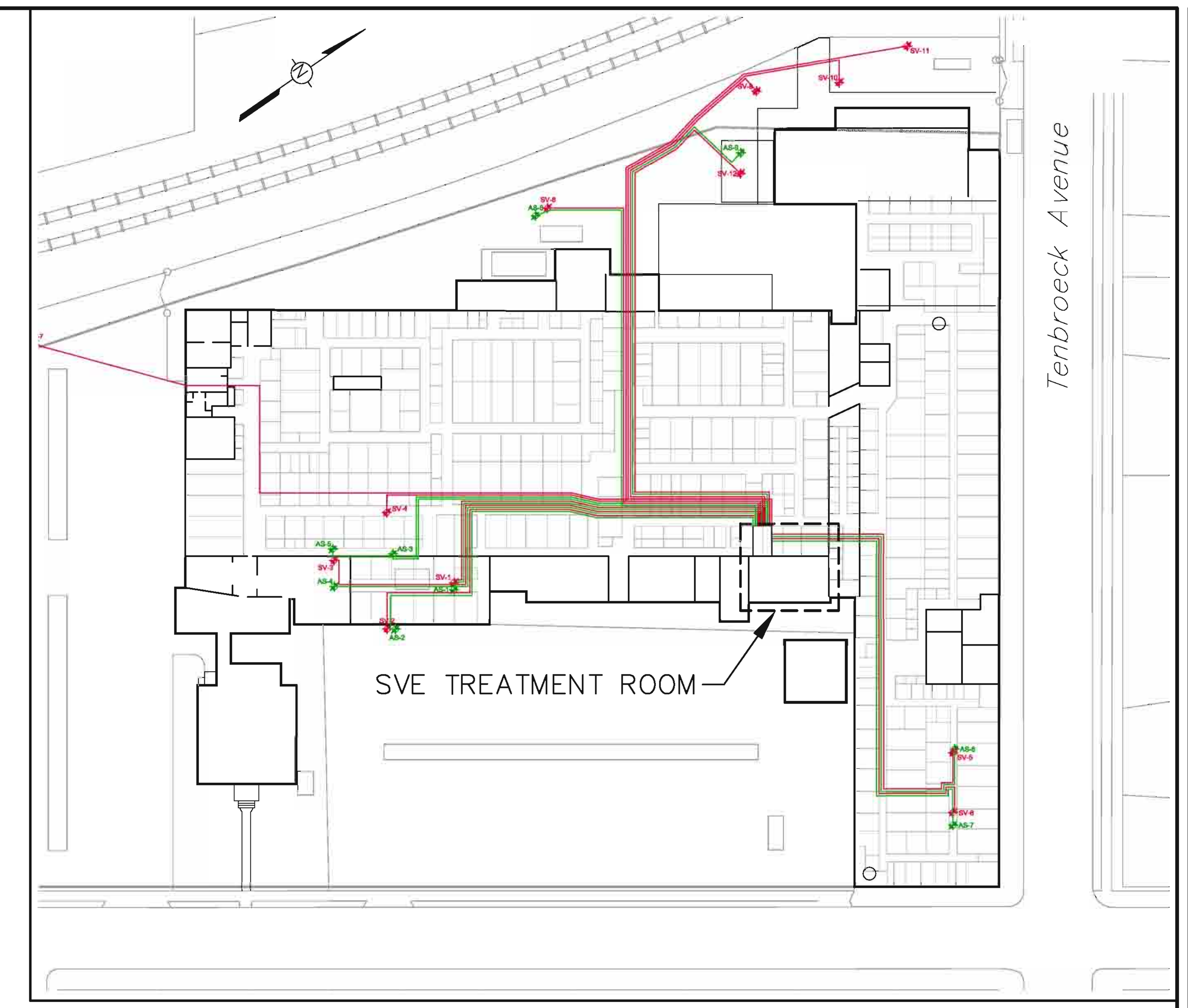
Drawing Number
00005609-067

LEGEND

- 1.5" DIAMETER AS PIPING (HUNG IN BUILDING INTERIOR)
- 4" DIAMETER SVE PIPING (HUNG IN BUILDING INTERIOR)
- EXISTING EQUIPMENT
- BALL VALVE
- VLS VAPOR LIQUID SEPARATOR
- VGAC VAPOR PHASE GRANULAR ACTIVATED CARBON
- SVE SOIL VAPOR EXTRACTION
- AS AIR SPARGING

NOTES:
1. EQUIPMENT THAT IS SHADED IS ONLY USED DURING MONTHLY OPERATION OF THE 2004 IRM.
2. THE LOCATION OF EQUIPMENT IS APPROXIMATE AND NOT TO SCALE.





LOCATION MAP
SCALE: 1"=60'

REVISIONS

REV	DESCRIPTION

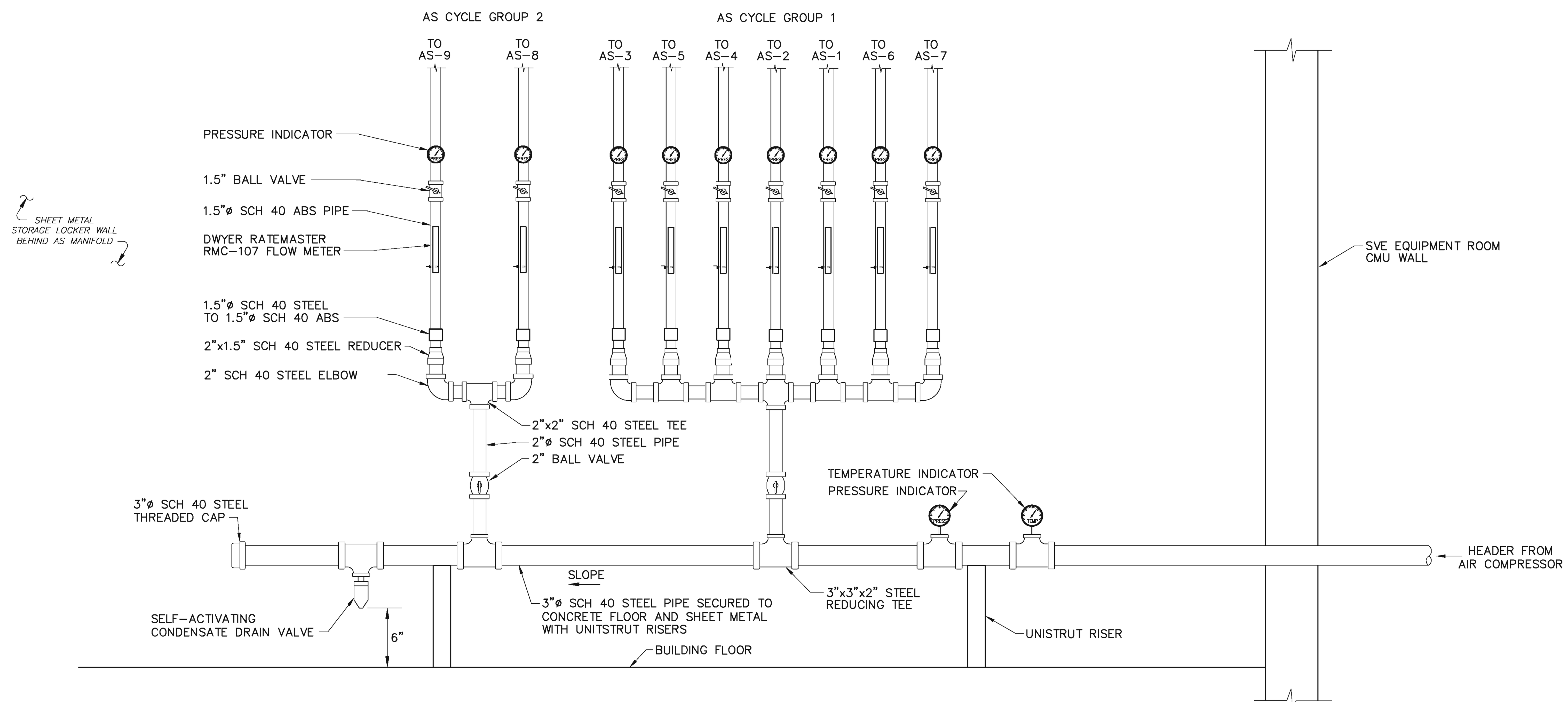
DRAWN BY EGC
CHECKED DL 2/9/2016
APPROVED TMM 2/24/2016

SOIL VAPOR EXTRACTION AND AIR SPARGING EQUIPMENT LAYOUT AND MANIFOLD CONNECTION LAYOUT
AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK
PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP
WSP USA Corp.
11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

SHEET 6

Drawing Number
00005609-069



(2/2) AIR SPARGING MANIFOLD DETAIL
NOT TO SCALE

LABELING:

1. PRINTED LABEL ON EACH SVE PIPELINE AT THE SVE MANIFOLD IDENTIFYING THE TERMINATION SVE WELL:

   SOIL VAPOR – SVE WELL ##

2. PRINTED LABEL ON EACH SVE PIPELINE AT EVERY 50 FT INTERVAL IDENTIFYING THE PIPE CONTENTS AND THE TERMINATION SVE WELL AS FOLLOWS:

   SOIL VAPOR – SVE WELL ##
   CONTACT WSP USA CORP AT (315) 655-3900
   FOR EMERGENCIES OR ADDITIONAL INFORMATION.

3. PRINTED LABEL ON EACH AS PIPELINE AT THE AS MANIFOLD IDENTIFYING THE TERMINATION AS WELL:

   PRESSURIZED AIR – AS WELL ##

4. PRINTED LABEL ON EACH AS PILELINE AT EVERY 50 FT INTERVAL IDENTIFYING THE PIPE CONTENTS AND THE TERMINATION AS WELL AS FOLLOWS:

   PRESSURIZED AIR – AS WELL ##
   CONTACT WSP USA CORP AT (315) 655-3900
   FOR EMERGENCIES OR ADDITIONAL INFORMATION.

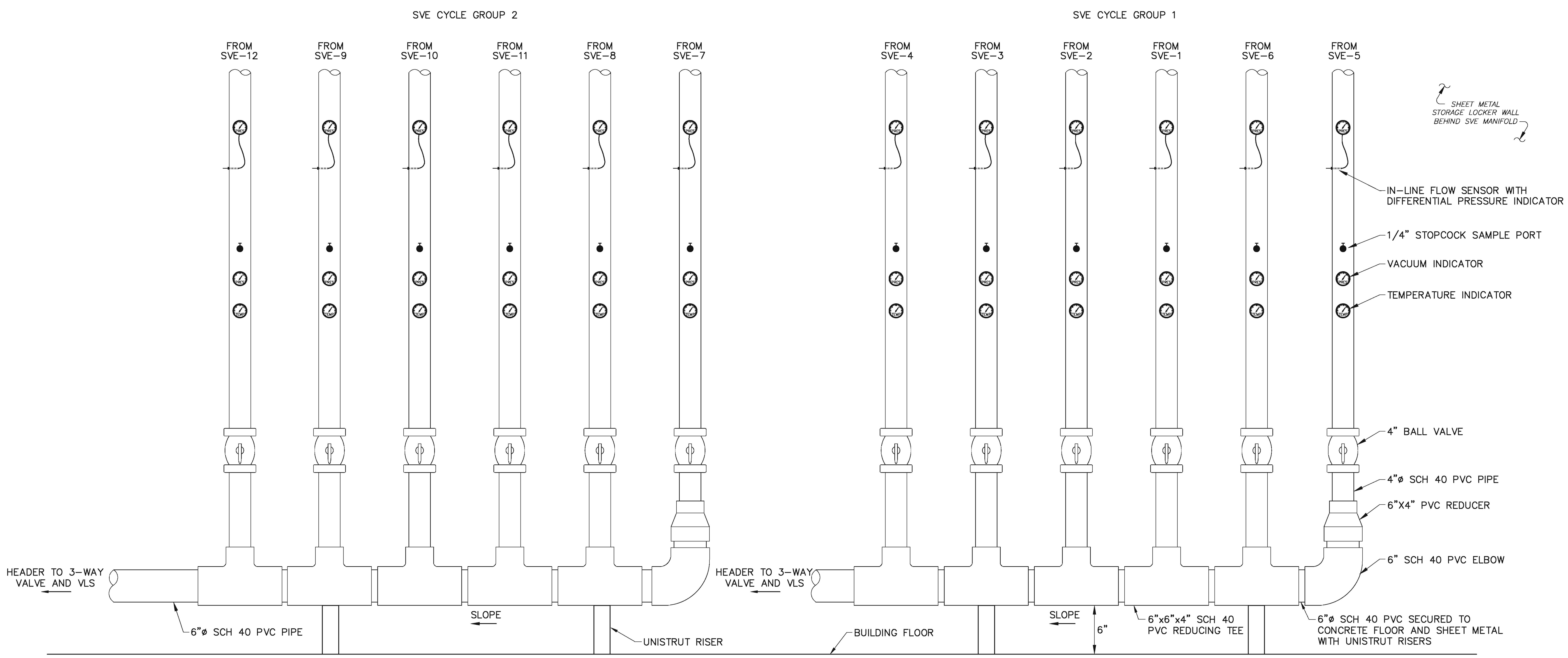
5. PRINTED LABEL TO EACH CIRCUIT PANEL POWERING THE CONTROL PANEL AND EQUIPMENT STATES:

   ENVIRONMENTAL EQUIPMENT – DO NOT TURN OFF
   REMEDIATION SYSTEM IN OPERATION
   CONTACT WSP USA CORP AT (315) 655-3900
   FOR ADDITIONAL INFORMATION
   AND PERMISSION TO POWER DOWN

LEGEND

(1/2) DETAIL NUMBER / SHEET REFERENCED FROM

NOTE:
ALL STEEL, PVC, AND ABS PIPE AND FITTINGS ARE SCHEDULE 40.



(1/2) SOIL VAPOR EXTRACTION MANIFOLD DETAIL
NOT TO SCALE

D

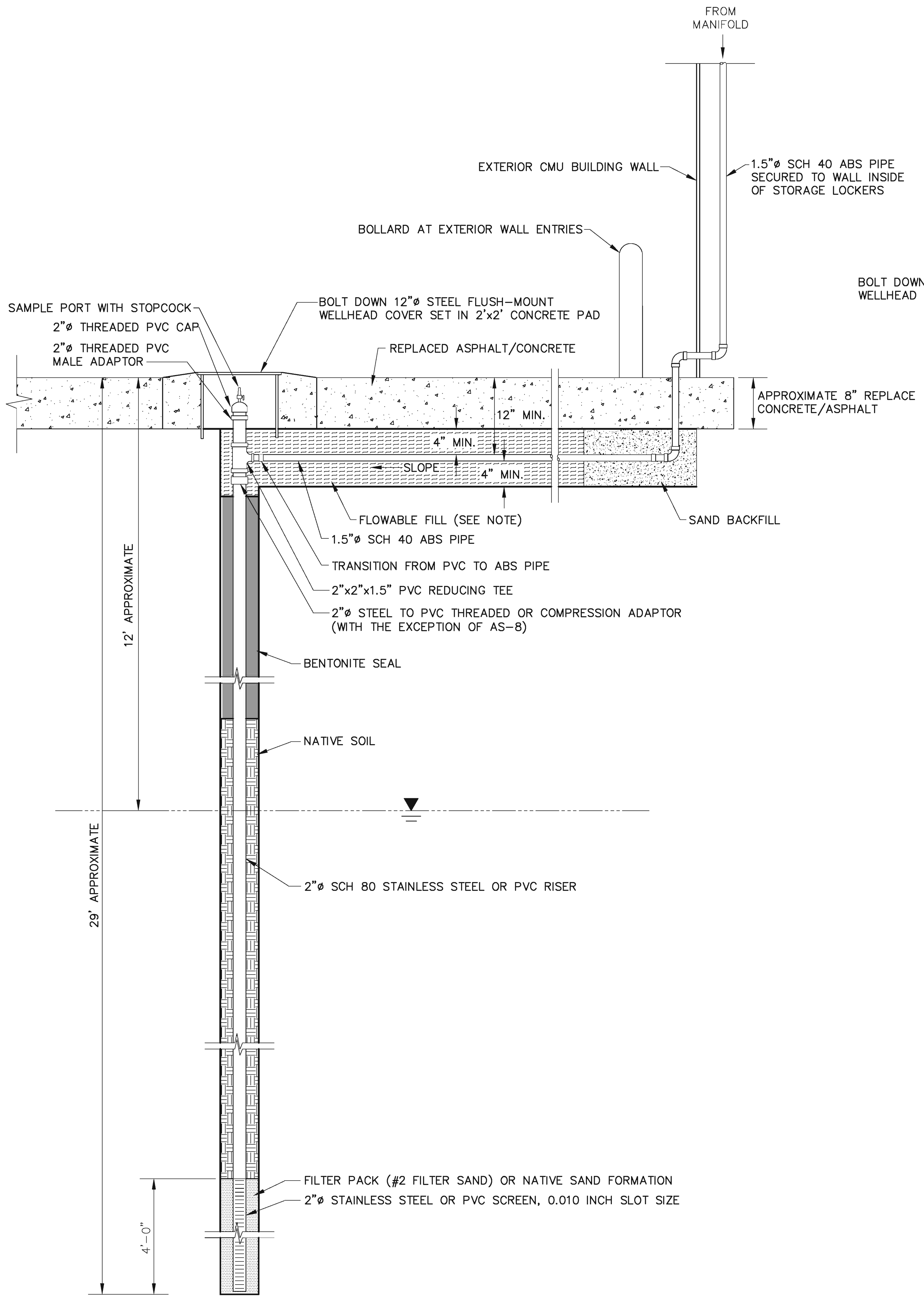
REVISIONS
REV | DESCRIPTION

DRAWN BY EGC
CHECKED DL 2/9/2015
APPROVED TMM 2/24/2015

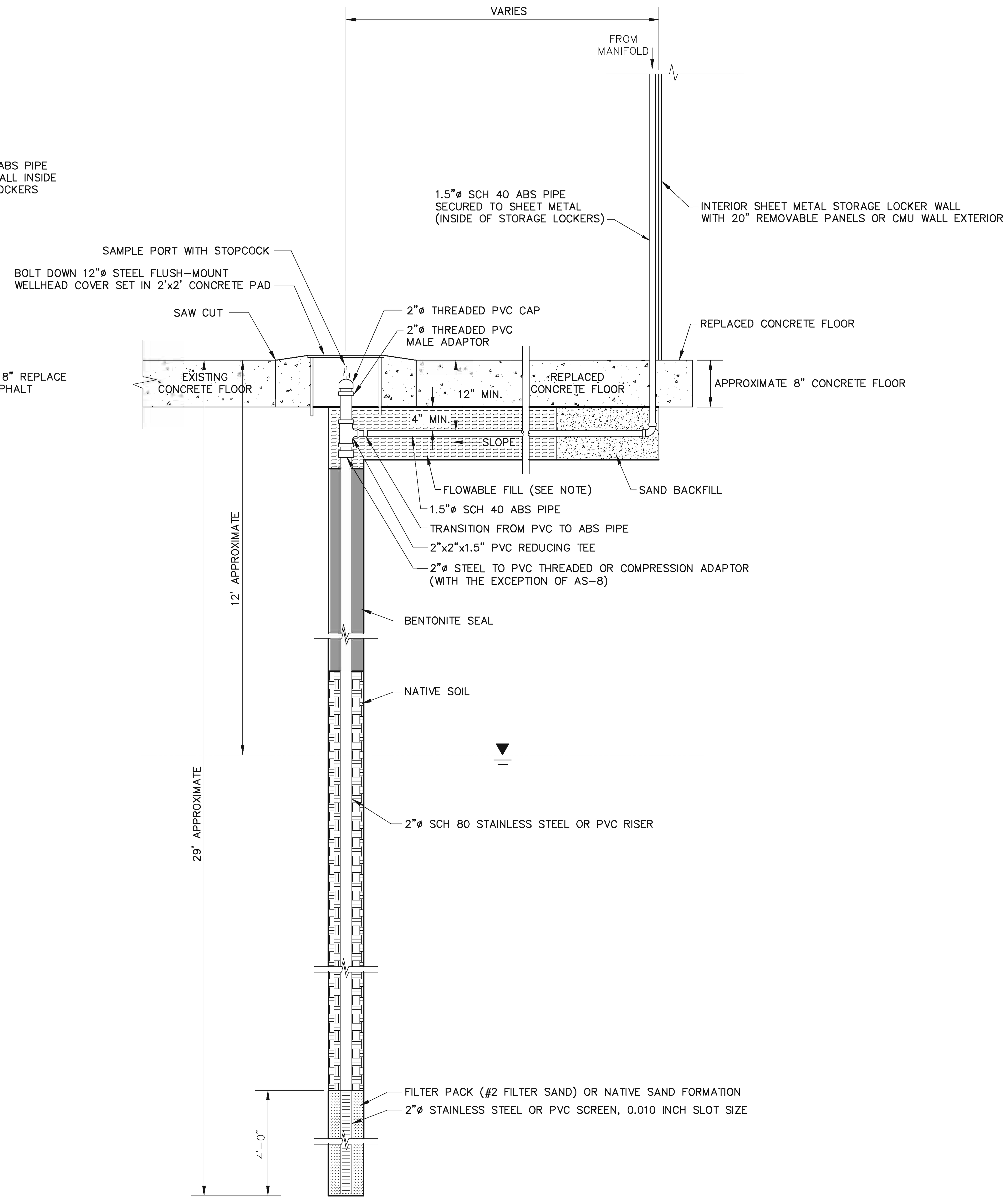
SOIL VAPOR EXTRACTION AND AIR SPARGING MANIFOLD DETAILS
AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK
PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP USA Corp.
11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

SHEET 7
Drawing Number
00005609-070



1/2 TYPICAL EXTERIOR AIR SPARGING WELL DETAIL (IN ASPHALT/CONCRETE)
SCALE: 1"=1'-0"



2/2 TYPICAL INTERIOR AIR SPARGING WELL DETAIL
SCALE: 1"=1'-0"

LEGEND

1/2 — DETAIL NUMBER / SHEET REFERENCED FROM

NOTE:
FLOWABLE FILL INSTALLED IN CONVEYANCE TRENCH WITHIN 28 FEET OF EACH SVE WELL. FLOWABLE FILL INSTALLED IN CONVEYANCE TRENCH WITHIN 20 FEET OF EACH AS WELL.

AS Wells AS-1 through AS-9 Well Construction

Well	Interior/Exterior Location	Completion Date	Construction	TD (ft bgs) (b)	Installation Method	Borehole Diameter (inches)	Screen Length (feet)	Annular Seal	Annular Seal Interval (ft bgs)	Filter pack	Filter Pack Interval (ft bgs)	Note
AS-1	Interior	10/7/2013	Stainless steel	29	DD	2.25	4	Granular Bentonite "dry grout"	1-20	Native sand formation	20-29	(d)
AS-2	Exterior	10/1/2013	Stainless steel	29	HSA	8.25	4	hydrated bentonite chips & bentonite-cement grout	20.8-24	#2 Filter Sand	24-29	
AS-3	Interior	10/4/2013	Stainless steel	28	DD	2.25	4	Granular Bentonite "dry grout"	1-8	Native sand formation	8-28	(d)
AS-4	Interior	10/8/2013	Stainless steel	28.5	DD	2.25	4	Granular Bentonite "dry grout"	1-8	Native sand formation	8-28.5	(d)
AS-5	Interior	10/3/2013	Stainless steel	28	DD	2.25	4	Granular Bentonite "dry grout"	1-8	Native sand formation	8-28	(d)
AS-6	Interior	10/9/2013	Stainless steel	28.5	DD	2.25	4	Granular Bentonite "dry grout"	1-8	Native sand formation	8-28.5	(d)
AS-7	Interior	10/8/2013	Stainless steel	28.5	DD	2.25	4	Granular Bentonite "dry grout"	1-8	Native sand formation	8-28.5	(d)
AS-8	Exterior	10/1/2013	PVC	29	HSA	8.25	4	hydrated bentonite chips & bentonite-cement grout	21-24	#2 Filter Sand	24-29	
AS-9	Exterior	10/4/2013	Stainless steel	28.5	HSA	8.25	4	hydrated bentonite chips & bentonite-cement grout	20-23.5	#2 Filter Sand	23.5-28.5	

a/ ft bgs = feet below ground surface; TD = total depth; PVC = polyvinyl chloride; DD = direct drive; HSA = Hollow Stem Augers
b/ Total depths omit 0.5-foot-long drive point at bottom of stainless-steel wells.
c/ Annular seal depths in air sparge wells installed using HSA are for bentonite seal only. Grout seals extend to surface.
d/ Depth intervals of annular seals and natural filter material are approximate in direct-drive wells due to the nature of installation.

D

REVISIONS

REV	DESCRIPTION
	Revised: Chkd: Appr:
	Revised: Chkd: Appr:
	Revised: Chkd: Appr:

SEAL

DATE

DRAWN BY EGC
CHECKED DL 2/3/2015
APPROVED TMM 2/24/2015

AIR SPARGING WELLHEAD COMPLETION DETAILS

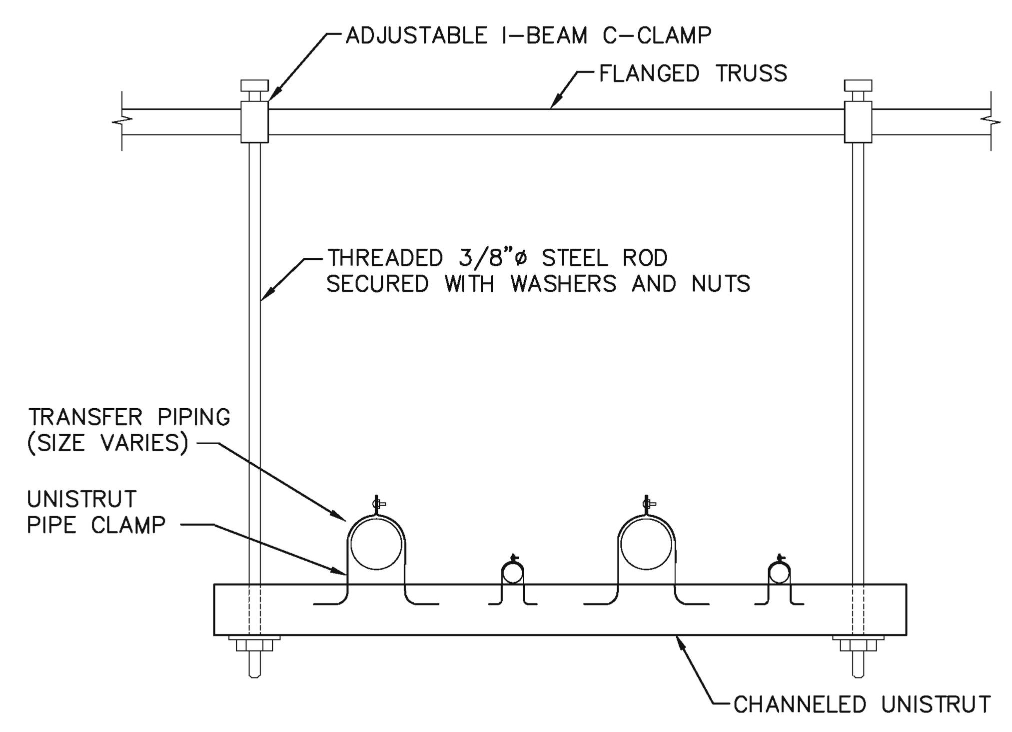
AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK

PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP USA Corp.
11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

SHEET 8

Drawing Number
00005609-071



TYPICAL PIPE HANGER DETAIL
NOT TO SCALE

LEGEND

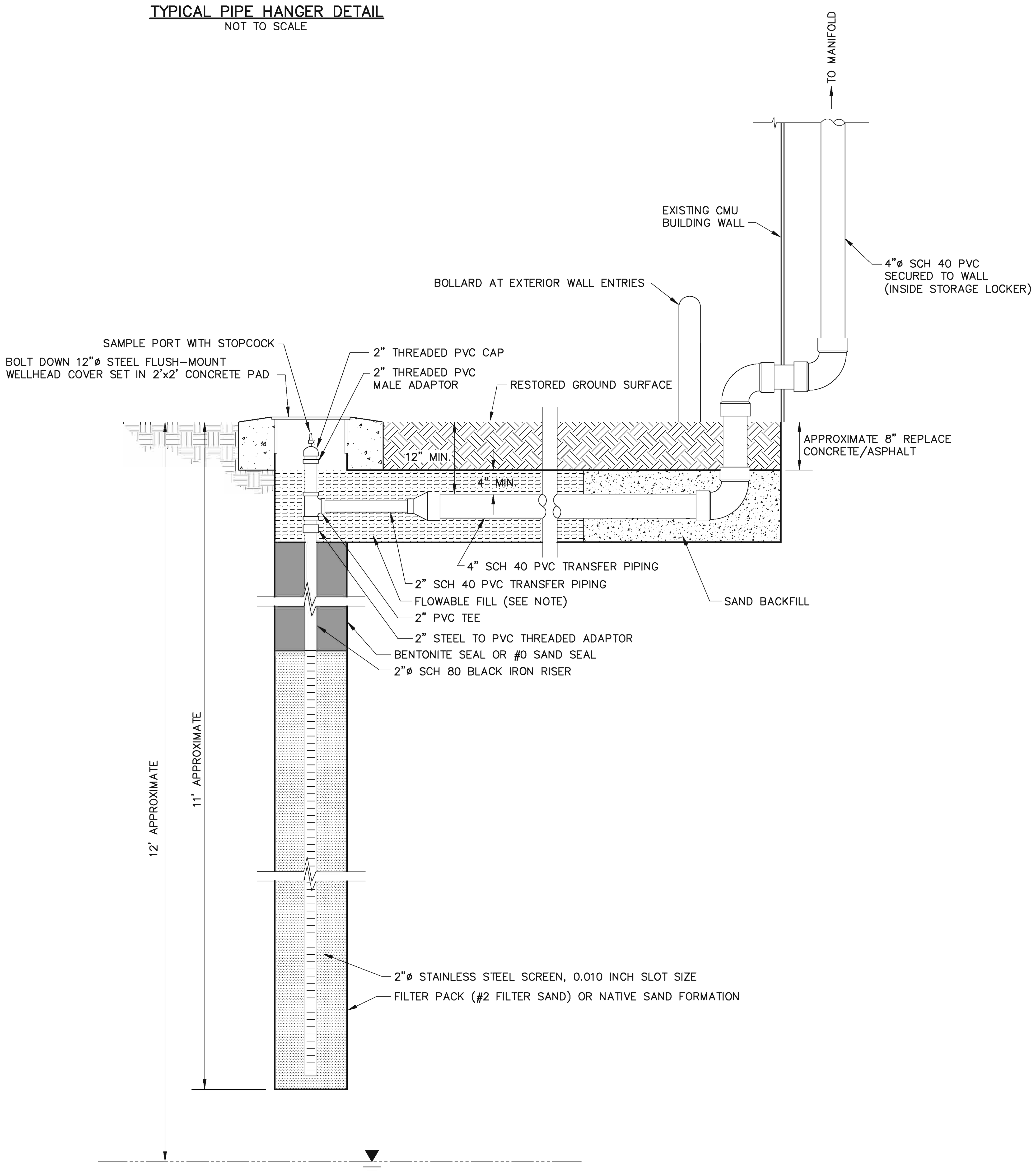
1/2 — DETAIL NUMBER / SHEET REFERENCED FROM

NOTE:
FLOWABLE FILL INSTALLED IN CONVEYANCE TRENCH WITHIN 28 FEET OF EACH SVE WELL. FLOWABLE FILL INSTALLED IN CONVEYANCE TRENCH WITHIN 20 FEET OF EACH AS WELL.

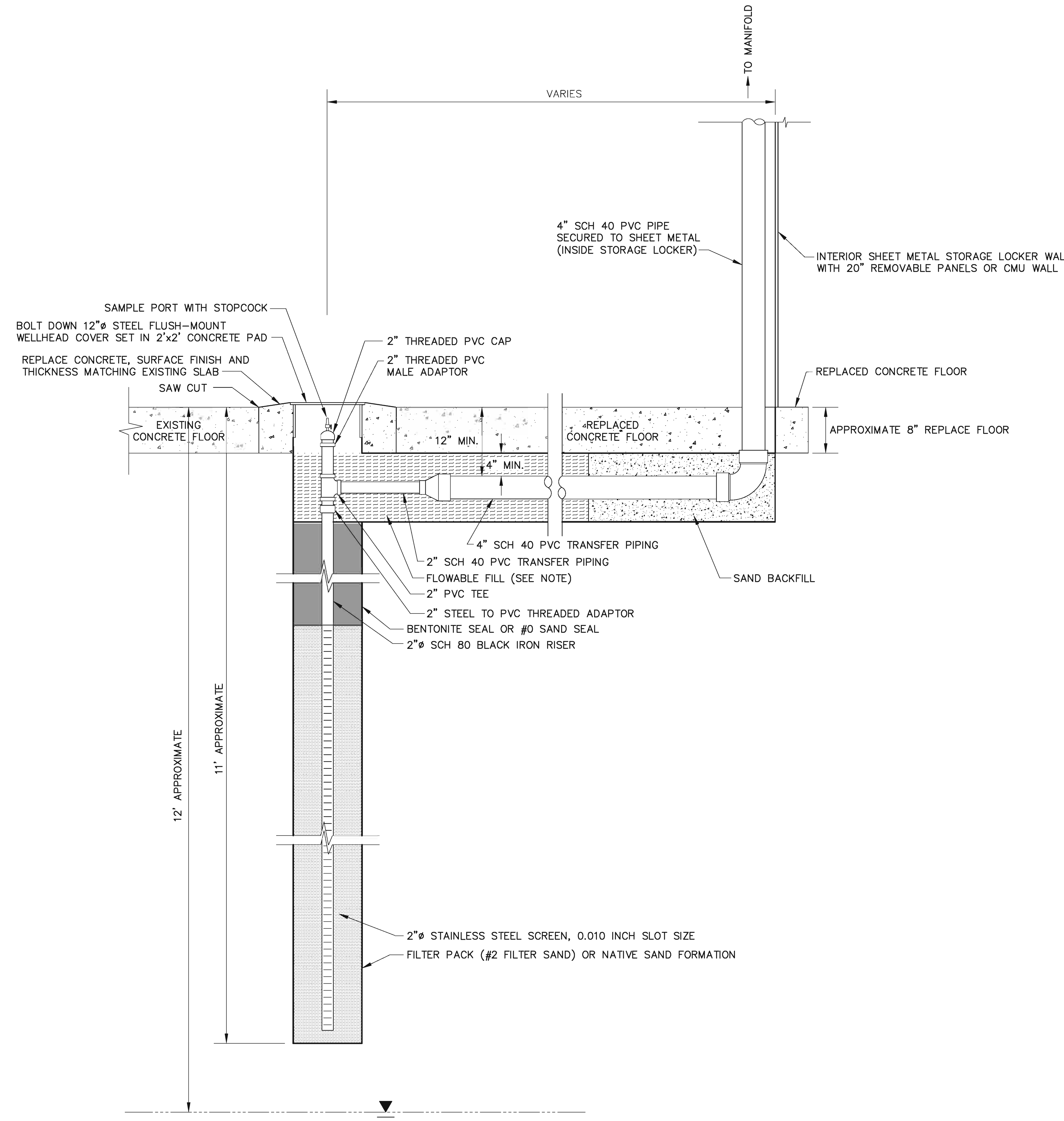
SVE Wells SV-1 through SV-12 Well Construction

Well	Interior/Exterior Location	Completion Date	Construction	TD (ft bgs) (b)	Installation Method	Borehole Diameter (inches)	Screen Length (feet)	Annular Seal	Annular Seal Interval (ft bgs)	Filter pack	Filter Pack Interval (ft bgs)	Note
SV-1	Interior	10/3/2013	Stainless steel	11	DD	2.25	8	#0 Sand Seal	1-2	Native sand formation	2-11	(d)
SV-2	Exterior	10/1/2013	Stainless steel	11	HSA	8.25	8	hydrated bentonite chips	1.5-2.5	#2 Filter Sand	2.5-11	
SV-3	Interior	10/8/2013	Stainless steel	11	DD	2.25	8	#0 Sand	1-2	Native sand formation	2-11	(d)
SV-5	Interior	10/1/2013	Stainless steel	12	DD	2.25	8	#0 Sand	1-2	Native sand formation	2-11	(d)
SV-6	Interior	10/2/2013	Stainless steel	11	DD	2.25	8	#0 Sand	1-2	Native sand formation	2-11	(d)
SV-7	Exterior	10/2/2013	Stainless steel	11	HSA	8.25	8	hydrated bentonite chips	1.5-2.5	#2 Filter Sand	2.5-11	
SV-8	Exterior	10/2/2013	Stainless steel	11	HSA	8.25	8	hydrated bentonite chips	1.5-2.5	#2 Filter Sand	2.5-11	
SV-9	Exterior	10/3/2013	Stainless steel	11	HSA	8.25	8	hydrated bentonite chips	1.5-2.5	#2 Filter Sand	2.5-11	
SV-10	Exterior	10/3/2013	Stainless steel	11	HSA	8.25	8	hydrated bentonite chips	1.5-2.5	#2 Filter Sand	2.5-11	
SV-11	Exterior	10/2/2013	Stainless steel	11	HSA	8.25	8	hydrated bentonite chips	1.5-2.5	#2 Filter Sand	2.5-11	
SV-12	Exterior	10/4/2013	Stainless steel	11	HSA	8.25	8	hydrated bentonite chips	1.5-2.5	#2 Filter Sand	2.5-11	

a/ ft bgs = feet below ground surface; TD = total depth; PVC = polyvinyl chloride; DD = direct drive; HSA = Hollow Stem Augers
b/ Total depths omit 0.5-foot-long drive point at bottom of stainless-steel wells.
c/ Annular seal depths in air sparge wells installed using HSA are for bentonite seal only. Grout seals extend to surface.
d/ Depth intervals of annular seals and natural filter material are approximate in direct-drive wells due to the nature of installation.



1/2 TYPICAL EXTERIOR SOIL VAPOR EXTRACTION WELL COMPLETION DETAIL
SCALE: 1"=1'-0"



2/2 TYPICAL INTERIOR SOIL VAPOR EXTRACTION WELL COMPLETION DETAIL
SCALE: 1"=1'-0"

D

REVISIONS
REV | DESCRIPTION

SEAL

DATE

DRAWN BY EGC
CHECKED DL 1/13/2015
APPROVED TMM 2/24/2015

SOIL VAPOR EXTRACTION WELLHEAD COMPLETION AND PIPE HANGER DETAILS
AS-BUILT DRAWING PACKAGE
FORMER HUCK MANUFACTURING FACILITY
KINGSTON, NEW YORK
PREPARED FOR
FEDERAL-MOGUL CORPORATION

WSP USA Corp.
11190 Sunrise Valley Drive, Suite 300
Reston, Virginia 20191
(703) 709-6500
www.wspgroup.com/usa

SHEET 9
Drawing Number
00005609-072

Appendix B – OM&M Field Log Template

Operational ChecklistFederal-MogulKingston, NY

Date: ____________________ **Inspector (print):** ____________________

Arrival Time: ____________________ **Inspector (sign):** ____________________

Departure Time: ____________________ **Weather Conditions:** ____________________

Reason for Visit (check all that apply):

Monthly O&M ☐ Response to alarm ☐

Other ☐ (If Checked, Explain in Detail):

Pulse Day One

TREATMENT SYSTEM OPERATIONAL CHECKLIST

Zone 1	Reading	Units	Notes
Inlet Vacuum - Before Inlet Filter		in. H_2O	
Inlet Vacuum - After Inlet Filter		in. H_2O	
Vacuum - Effluent Separator		in. H_2O	
Vacuum - Inlet to Blower Filter		in. H_2O	
Vacuum - Inlet Blower		inHg	
Differential Pressure		in. H_2O	
Effluent Temperature		°F	

Task 2 - Inspect/Replace Absorbent in MW-14	
Please note the condition of the absorbent in MW-14 (i.e. the amount of staining)	
Was the absorbent in MW-14 removed?	
If so, was it replaced?	

Zone 2	Reading	Units	Notes
Inlet Vacuum - Before Inlet Filter		in. H_2O	
Inlet Vacuum - After Inlet Filter		in. H_2O	
Vacuum - Effluent Separator		in. H_2O	
Vacuum - Inlet to Blower Filter		in. H_2O	
Vacuum - Inlet Blower		inHg	
Differential Pressure		in. H_2O	
Effluent Temperature		°F	

Total Gallons in Poly Storage Tank = 100 gallons

Electricity Meter:		
	Startup	kwh
	Shutdown	kwh

System Pulse Time:		Date	Time
	Startup		
	Shutdown		

Were SVE Trench Leaks Observed? (yes/n ____________________

Is the 85 Grand Street Mitigation Fan Operational? (yes/no): ____________________

Zone 1 Influent PID Reading		
Time	Duration into Pulse (min)	PID (ppb)

Zone 2 Influent PID Readings		
Time	Duration into Pulse (min)	PID (ppb)

Notable Observations:

System Maintenance

Equipment

Reason for Maintenance

Description of Maintenance Action

Federal-Mogul
Kingston, NY

Date: ______________________ **Inspector (print):** ______________________
Arrival Time: ______________________ **Inspector (sign):** ______________________
Departure Time: ______________________ **Weather Conditions:** ______________________

Reason for Visit (check all that apply):

Monthly O&M ☐ Response to alarm ☐
Other ☐ (Explain) ______________________

B-101 ☐ ON ☐ OFF ASC-301 ☐ ON ☐ OFF AS/SVE Valve Positions ☐ Cycle Group 1 ☐ Cycle Group 2

AS/SVE SYSTEM CYCLING AND OPERATIONAL CHECKLIST

Maniifold Room

Operating SVE Cycle Group 1 / 2 Readings					Operating AS Cycle Group 1 / 2 Readings			
SVE Branch	**Temp (°C)**	**Vacuum (in WC)**	**∆P (in H_20)**	**PID (ppb)**	**AS Branch**	**Temp (°F)**	**Flow (scfh)**	**Pres. (psi)**
SVE-5					AS Header		-	
SVE-6								
SVE-1								
SVE-2								
SVE-3								
SVE-4								

SVE Room

SVE Blower (B-101)	Reading	Units	Notes
Inlet Vacuum - Before Inlet Filter		in. H_2O	
Inlet Vacuum - After Inlet Filter		in. H_2O	
Vacuum - Effluent Separator		in. H_2O	
Vacuum - Inlet to Blower Filter		in. H_2O	
Vacuum - Inlet Blower		inHg	
Differential Pressure		in. H_2O	
Effluent Temperature		°F	
Influent Air Sample PID		ppb	
Effluent Air Sample PID		ppb	

AS Compressor Room

Air Sparge Skid (ASC-301)	Reading	Units	Notes
Air Inlet Vacuum (VI-301)		in. H_2O	
Discharge (hot) Air Pressure (PI-301)		psi	
Discharge (hot) Air Temperature (TI-301)		°F	
Discharge (warm) Air Pressure (PI-302)		psi	
Discharge (warm) Air Temperature (TI-302)		°F	
Discharge (warm) Air Differ. Pressure (FI-301)		in. H_2O	

SVE Room

PLC/Control Panel Readings	Reading	Units
SVE Influent Vacuum (VT-101)		in Hg
SVE Influent Air Flow Rate (FIT-101)		cfm
SVE Effluent Air Temperature (TT-101)		°F
AS Discharge Pressure (PT-301)		psi

Hour Meter Logs		
B-101		hours
TP-101		hours
B-201		hours
TP-201		hours
ASC-301		hours
HE-301		hours

Operational ChecklistFederal-MogulKingston, NY

Date: ____________________ **Inspector (print):** ____________________

Arrival Time: ____________________ **Inspector (sign):** ____________________

Departure Time: ____________________ **Weather Conditions:** ____________________

Reason for Visit (check all that apply):

Monthly O&M ☐ Response to alarm ☐

Other ☐ (If Checked, Explain in Detail):

TREATMENT SYSTEM OPERATIONAL CHECKLIST

Zone 1	Reading	Units	Notes
Inlet Vacuum - Before Inlet Filter		in. H_2O	
Inlet Vacuum - After Inlet Filter		in. H_2O	
Vacuum - Effluent Separator		in. H_2O	
Vacuum - Inlet to Blower Filter		in. H_2O	
Vacuum - Inlet Blower		inHg	
Differential Pressure		in. H_2O	
Effluent Temperature		°F	

Zone 2	Reading	Units	Notes
Inlet Vacuum - Before Inlet Filter		in. H_2O	
Inlet Vacuum - After Inlet Filter		in. H_2O	
Vacuum - Effluent Separator		in. H_2O	
Vacuum - Inlet to Blower Filter		in. H_2O	
Vacuum - Inlet Blower		inHg	
Differential Pressure		in. H_2O	
Effluent Temperature		°F	

Task 2 - Inspect/Replace Absorbent in MW-14	
Please note the condition of the absorbent in MW-14 (i.e. the amount of staining)	
Was the absorbent in MW-14 removed?	
If so, was it replaced?	

Total Gallons in Poly Storage Tank = ____________ gallons

Electricity Meter:			
	Startup		kwh
	Shutdown		kwh

System Pulse Time:		Date	Time
	Startup		
	Shutdown		

Were SVE Trench Leaks Observed? (yes/no No

Is the 85 Grand Street Mitigation Fan Operational? (yes/no): Yes

Zone 1 Influent PID Reading		
Time	Duration into Pulse (min)	PID (ppb)

Zone 2 Influent PID Readings		
Time	Duration into Pulse (min)	PID (ppb)

Notable Observations:

System Maintenance
Equipment

Reason for Maintenance

Description of Maintenance Action

Appendix B - OM&M Field Log Template

Federal-Mogul
Kingston, NY

Date: ______________________ **Inspector (print):** ______________________

Arrival Time: ______________________ **Inspector (sign):** ______________________

Departure Time: ______________________ **Weather Conditions:** ______________________

Reason for Visit (check all that apply):

Monthly O&M ☐ Response to alarm ☐

Other ☐ (Explain) Pulse Day 2

B-101 ☐ ON ☐ OFF ASC-301 ☐ ON ☐ OFF AS/SVE Valve Positions ☐ Cycle Group 1 ☐ Cycle Group 2

AS/SVE SYSTEM CYCLING AND OPERATIONAL CHECKLIST

Maniifold Room

Operating SVE Cycle Group 1 / 2 Readings					**Operating AS Cycle Group 1 / 2 Readings**			
SVE Branch	**Temp (°C)**	**Vacuum (in WC)**	**ΔP (in H_20)**	**PID (ppb)**	**AS Branch**	**Temp (°F)**	**Flow (scfh)**	**Pres. (psi)**
SVE-9					AS Header		-	
SVE-10					AS-9			
SVE-11					AS-8			
SVE-8					AS-			
SVE-7					AS-			
SVE-					AS-			
					AS-			
					AS-			

SVE Room

SVE Blower (B-101)	**Reading**	**Units**	**Notes**
Inlet Vacuum - Before Inlet Filter		in. H_2O	
Inlet Vacuum - After Inlet Filter		in. H_2O	
Vacuum - Effluent Separator		in. H_2O	
Vacuum - Inlet to Blower Filter		in. H_2O	
Vacuum - Inlet Blower		inHg	
Differential Pressure		in. H_2O	
Effluent Temperature		°F	
Influent Air Sample PID		ppb	
Effluent Air Sample PID		ppb	

AS Compressor Room

Air Sparge Skid (ASC-301)	**Reading**	**Units**	**Notes**
Air Inlet Vacuum (VI-301)		in. H_2O	
Discharge (hot) Air Pressure (PI-301)		psi	
Discharge (hot) Air Temperature (TI-301)		°F	
Discharge (warm) Air Pressure (PI-302)		psi	
Discharge (warm) Air Temperature (TI-302)		°F	
Discharge (warm) Air Differ. Pressure (FI-301)		in. H_2O	

SVE Room

PLC/Control Panel Readings	**Reading**	**Units**	**Hour Meter Logs**		
SVE Influent Vacuum (VT-101)		in Hg	B-101		hours
SVE Influent Air Flow Rate (FIT-101)		cfm	TP-101		hours
SVE Effluent Air Temperature (TT-101)		°F	B-201		hours
AS Discharge Pressure (PT-301)		psi	TP-201		hours
			ASC-301		hours
			HE-301		hours

O Log

Federal-Mogul
Kingston, NY

Date: ____________ **Inspector (print):** ____________

Arrival Time: ____________ **Inspector (sign):** ____________

Departure Time: ____________ **Weather Conditions:** ____________

Reason for Visit (check all that apply):

Bi-Weekly O&M ☐ Response to alarm ☐

Other ☐ (Explain)

B-101 ☐ ON ☐ OFF ASC-301 ☐ ON ☐ OFF AS/SVE Valve Positions ☐ Cycle Group 1 ☐ Cycle Group 2

AS/SVE SYSTEM Bi-WEEKLY MONITORING CHECKLIST

Manifold Room

Operating SVE Cycle Group 1				Operating SVE Cycle Group 2 Readings			
SVE Branch	**Temp (°F)**	**Vacuum (inHg)**	**ΔP (in H_20)**	**AS Branch**	**Temp (°F)**	**Flow (scfh)**	**Pres. (psi)**
SVE-				AS Header			
SVE-				AS-3			
SVE-				AS-5			
SVE-				AS-4			
SVE-				AS-2			
SVE-				AS-1			
				AS-7			
				AS-6			

SVE Room

SVE Blower (B-101)	Reading	Units	Notes
Inlet Vacuum - Before Inlet Filter		in. H_2O	
Inlet Vacuum - After Inlet Filter		in. H_2O	
Vacuum - Effluent Separator		in. H_2O	
Vacuum - Inlet to Blower Filter		in. H_2O	
Vacuum - Inlet Blower		inHg	
Differential Pressure		in. H_2O	
Effluent Temperature		°F	

B-101 Influent PID Reading		
Time	Duration into Pulse (min)	PID (ppm)
	0	
	10	
	20	
	30	
	40	
	50	
	60	

B-101 Effluent PID Readings		
Time	Duration into Pulse (min)	PID (ppm)
	0	
	10	
	20	
	30	
	40	
	50	
	60	

Task 2 - Inspect/Replace Absorbent in SV-12
Condition of the absorbent in SV-12(i.e. the amount of staining)
Was the absorbent removed and replaced

AS Compressor Room

Air Sparge Skid (ASC-301)	Reading	Units	Notes
Air Inlet Vacuum (VI-301)		in. H_2O	
Discharge (hot) Air Pressure (PI-301)		psi	
Discharge (hot) Air Temperature (TI-301)		°F	
Discharge (warm) Air Pressure (PI-302)		psi	
Discharge (warm) Air Temperature (TI-302)		°F	
Discharge (warm) Air Differ. Pressure (FI-301)		in. H_2O	
Effluent Temperature		°F	

SVE Room

PLC/Control Panel Readings	Reading	Units
SVE Influent Vacuum (VT-101)		in Hg
SVE Influent Air Flow Rate (FIT-101)		cfm
SVE Effluent Air Temperature (TT-101)		°F
AS Discharge Pressure (PT-301)		psi

Hour Meter Logs		
B-101		hours
TP-101		hours
B-201		hours
TP-201		hours
ASC-301		hours
HE-301		hours

Total Gallons in Poly Storage Tank = ____________ gallons

Electricity Meter:	Startup	kwh

Notable Observations and Maintenance Activities:

System Maintenance
Equipment

Reason for Maintenance

Description of Maintenance Work

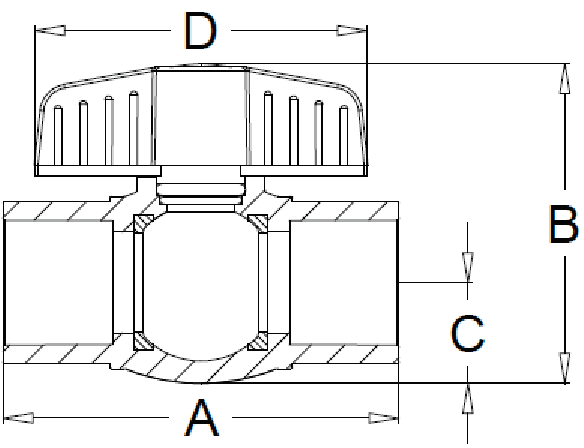
Appendix C – Manufacturer Specifications

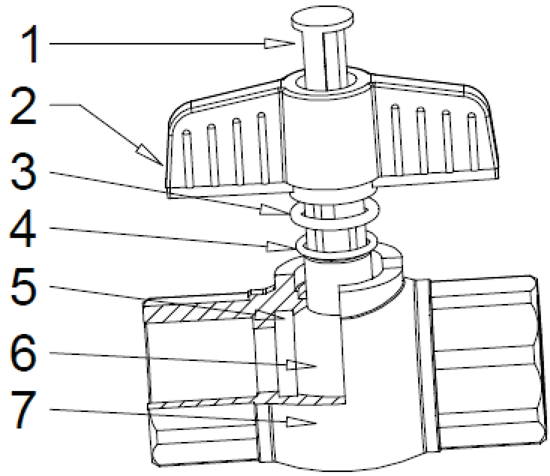
770 White PVC Ball Valve • Spec Sheet

Sizes 1/2” - 2”

FEATURES & BENEFITS

- ISO 9002
- 150 PSI @ 73 Deg. F.
- White Color
- NSF Approved
- Fits Sch. 40 & Sch. 80 Pipe
- Threaded or Solvent Ends
- Threaded Ends Comply With ANSI B1.20.1
- Solvent Ends Comply With ASTM D2466





DIMENSIONS

Part # Threaded	Part # Solvent	Size	A	B	C	D
770T03	770S03	1/2”	3.16	2.46	0.71	2.74
770T04	770S04	3/4”	3.61	2.98	0.87	3.01
770T05	770S05	1”	4.19	3.39	1.06	3.53
770T06	770S06	1-1/4”	4.76	3.80	1.21	3.54
770T07	770S07	1-1/2”	5.13	4.32	1.46	4.42
770T08	770S08	2”	5.93	5.36	1.83	5.53

MATERIAL SPECIFICATIONS

No.	Part	Material
1	Cap	ABS
2	Handle	ABS
3	O-Ring	EPDM
4	O-Ring	EPDM
5	Seat (2)	PTFE
6	Ball	PC + ABS
7	Body	PVC

MATCO-NORCA
Global sourcing. National compliance. Local service.

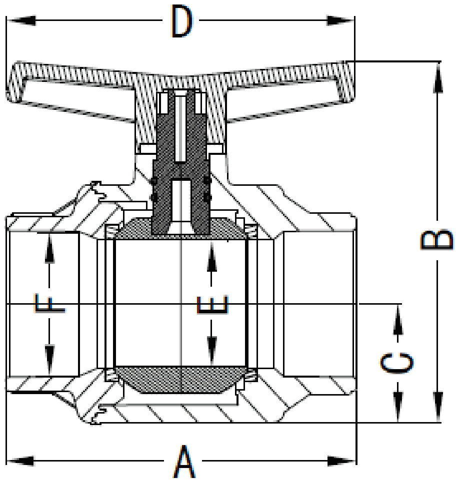
CALIFORNIA 5593 Fresca Dr., La Palma CA 90623 • Toll Free: 866-532-8306 • Fax: 866-532-8307
TEXAS 1150 Silber Rd., Houston TX 77055 • Toll Free: 800-935-5456 • Fax: 713-680-2999
NEW YORK PO Box 27, Rt. 22, Brewster NY 10509 • Toll Free: 800-431-2082 • Fax: 845-278-9056
WEB: www.matco-norca.com EMAIL: mail@matco-norca.com

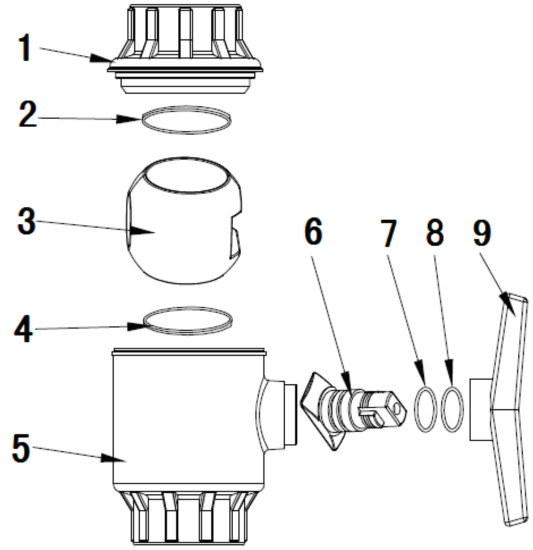
770 White PVC Ball Valve • Spec Sheet

Sizes 2-1/2" - 4"

FEATURES & BENEFITS

- ISO 9002
- 150 PSI @ 73 Deg. F.
- White Color
- NSF Approved
- Fits Sch. 40 & Sch. 80 Pipe
- Threaded or Solvent Ends
- Threaded Ends Comply With ANSI B1.20.1
- Solvent Ends Comply With ASTM D2466





DIMENSIONS

Part # Threaded	Part # Solvent	Size	A	B	C	D	E	F
770T09	770S09	2-1/2"	7.48	7.68	2.26	7.09	2.62	2.87
770T10	770S10	3"	8.66	8.86	2.66	9.05	3.06	3.49
770T11	770S11	4"	10.24	10.24	3.35	10.04	4.03	4.49

MATERIAL SPECIFICATIONS

No.	Part	Material
1	Nut	PVC
2, 4	Seat (2)	PTFE
3	Ball	PVC
5	Body	PVC
6	Stem	PVC
7, 8	O-Ring (2)	EPDM
9	Handle	ABS

MATCO-NORCA
Global sourcing. National compliance. Local service.

CALIFORNIA 5593 Fresca Dr., La Palma CA 90623 • Toll Free: 866-532-8306 • Fax: 866-532-8307
TEXAS 1150 Silber Rd., Houston TX 77055 • Toll Free: 800-935-5456 • Fax: 713-680-2999
NEW YORK PO Box 27, Rt. 22, Brewster NY 10509 • Toll Free: 800-431-2082 • Fax: 845-278-9056
WEB: **www.matco-norca.com** EMAIL: **mail@matco-norca.com**

Bimetal Thermometer
Model TI.30, Stainless Steel Case & Wetted Parts

Datasheet TI.30

Applications

- Suitable for fluid medium which does not corrode 304 stainless steel

Special features

- Industrial design
- Stainless steel case and wetted parts
- Back connection with external reset

Pressure Gauge TI.30

Standard version

Application
Industrial type design for fluid medium which does not corrode 304 stainless steel.

Sizes
3" (76.2 mm) Type TI.30

Accuracy
+ 1.0% full scale value (ASME B40.3)

Ranges
-100 °F to 1000 °F (and equivalent Celsius)

Working Range
Steady: full scale value
Short time: 110% of full scale value

Over Range
Temporary over or under range tolerance of 50% of scale up to 500 °F. (260°C). For ranges above 500°F, maximum over range is 800°F; continous. 1000°F intermittent.

Connection
Material: 304 stainless steel
Center back mount (CBM), 1/2" NPT

Measuring Element
Bi-metal helix

Pointer
Black aluminum

Stem
Material: 304 stainless steel
Diameter: ¼" (6.35 mm)
Length: 2 ½" to 72" (63.5 mm to 1,828.8 mm)

Case
Material: 304 stainless steel
Hermetically sealed per ASME B40.3 standard
Ingress protection IP 65
External reset slotted hex head on back of case

Dial
White aluminum, dished, with black markings

Dampening
Inert gel to minimize pointer oscillation

Standard Scales
Single: Fahrenheit or Celsius
Dual: Fahrenheit (outer) and Celsius (inner)

Window Gasket
Neoprene
Silicone (-100 °F and over 550 °F)

Window
Flat instrument glass

Weight
7 oz. (3" dial); Add 1 oz for every 2" of stem length

Movement
Viscous inert gel to enhance pointer operation

Optional Extras

- Thermowells
- Silicone fill
- Dampened Movement
- Special scales and dial markings
- Acrylic and safety glass windows
- Calibration certification traceable to NIST
- Min/max pointer
- DIN standards

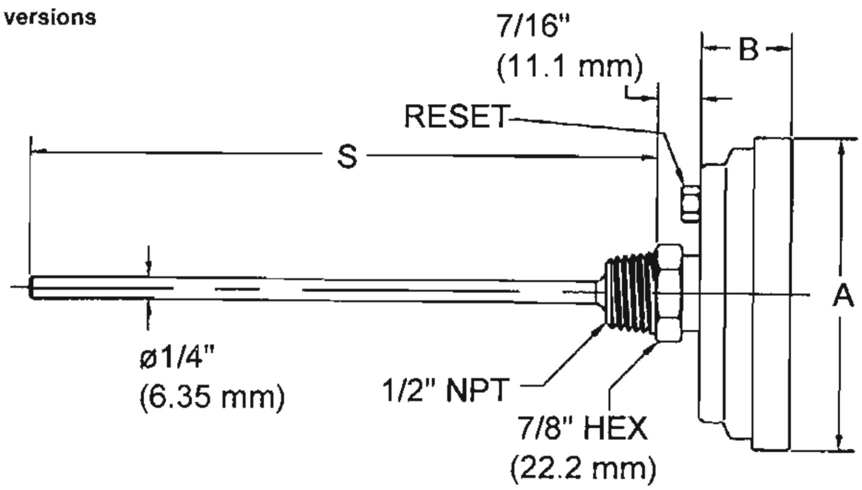
STANDARD RANGES

Fahrenheit Single Scale	Dual Scale F & C F Outer, C Inner	Celsius Single Scale
-100/150 F	-100/150 F & -70/70 C	-50/50 C
-40/120 F	-40/120 F & -40/50 C	-20/120 C
0/140 F	0/140 F & -20/60 C	0/50 C[1]
0/200 F	0/200 F & -15/90 C	0/100 C
0/250 F	0/250 F & -20/120 C	0/150 C
20/240 F	20/240 F & -5/115 C	0/200 C
25/125 F	25/125 F & -5/50 C[1]	0/250 C
50/300 F	50/300 F & 10/150 C	0/300 C
50/400 F	50/400 F & 10/200 C	0/450 C[1]
50/550 F	50/500 F & 10/260 C	100/550 C[1]
150/750 F	150/750 F & 65/400 C	
200/1000 F[1]	200/1000 F & 100/540 C[1]	

[1]Not recommended for continous service over 800°F (425°C)

Dimensions

Standard versions



Stem Length
2½" (63.5 mm)
4" (101.6 mm)
6" (152.4 mm)
9" (228.6 mm)
12" (304.8 mm)
15" (381.0 mm)
18" (457.2 mm)
24" (609.6 mm)

WIKA Type	DIAL SIZE	A	B	S (Stem Length)
30"	3" (76.2 mm)	3-1/4" (82.6 mm)	15/16" (23.8 mm)	As Specified

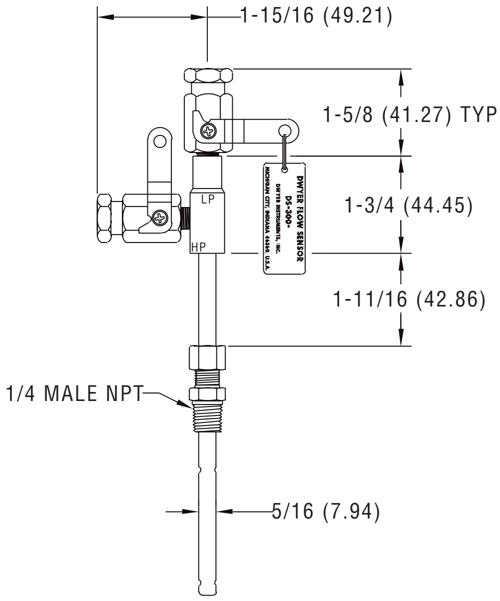
Note: Thermowells for temperature instruments are recommended for all process systems where pressure, velocity, or viscous, abrasive and corrosive meterials are present individually or in combination. A properly selected thermowell protects the temperature instrument from possible damage resulting from these process variables. Furthermore, a thermowell permits removal of the temperature instrument for replecement, repair or testing without effecting the process media or the system.

Ordering Information
State computer part number (if available) /type number/size/range/connection size and locations/options required. WIKA reserves the right to maka changes without prior notice.

WIKA Instrument Corporation
1000 Wiegand Boulevard
Lawrenceville, GA 30043
1-888-WIKA-USA /770-513-8200 (in GA)
Fax 770-338-5118
info@wika.com www.wika.com

Series DS-300 Flow Sensors

Installation and Operating Instructions Flow Calculations



Series DS-300 Flow Sensors are averaging pitot tubes that provide accurate, convenient flow rate sensing. When purchased with a Dwyer Capsuhelic® for liquid flow or Magnehelic® for air flow, differential pressure gage of appropriate range, the result is a flow-indicating system delivered off the shelf at an economical price. Series DS-300 Flow Sensors are designed to be inserted in the pipeline through a compression fitting and are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with 1/8˝ female NPT connections. Accessories include adapters with 1/4˝ SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® kit. Standard valves are rated at 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 Flow Sensors are available for pipe sizes from 1˝ to 10˝.

INSPECTION

Inspect 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. A rule of thumb is to allow 10 - 15 pipe diameters upstream and 5 downstream. The table below lists recommended up and down piping.

PRESSURE AND TEMPERATURE

Maximum: 200 psig (13.78 bar) at 200°F (93.3°C).

Upstream and Downstream Dimensions in Terms of Internal Diameter of Pipe*

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**	24	24	5

* 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.

** 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.**

DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46361, U.S.A.
Phone: 219/879-8000 www.dwyer-inst.com
Fax: 219/872-9057 e-mail: info@dwyer-inst.com

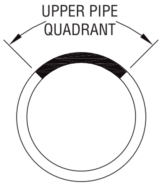
POSITION

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

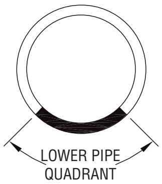
Install in upper quadrant of pipe



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˝ x 3/8˝) will be needed.

2. Drill through 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 sensor until it bottoms against opposite wall of the pipe, then withdraw 1/16˝ to allow for thermal expansion.

5. Tighten packing gland nut finger tight. Then tighten 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

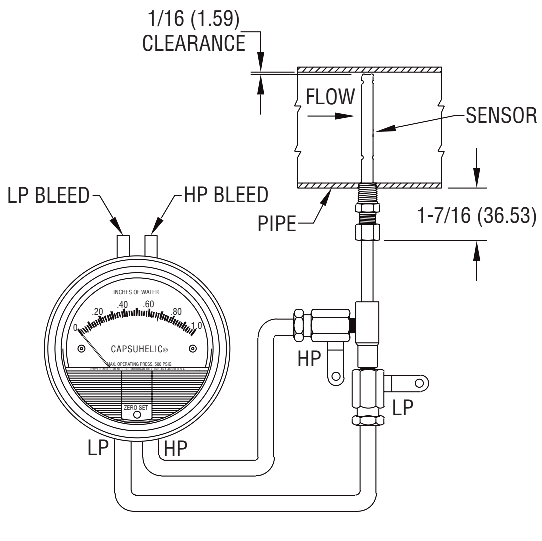
Connect the slide pressure tap to the high pressure port of the Magnehelic® (air only) or Capsuhelic® gage or transmitting instrument and the top connection to the low pressure port.

See the connection schematics below.

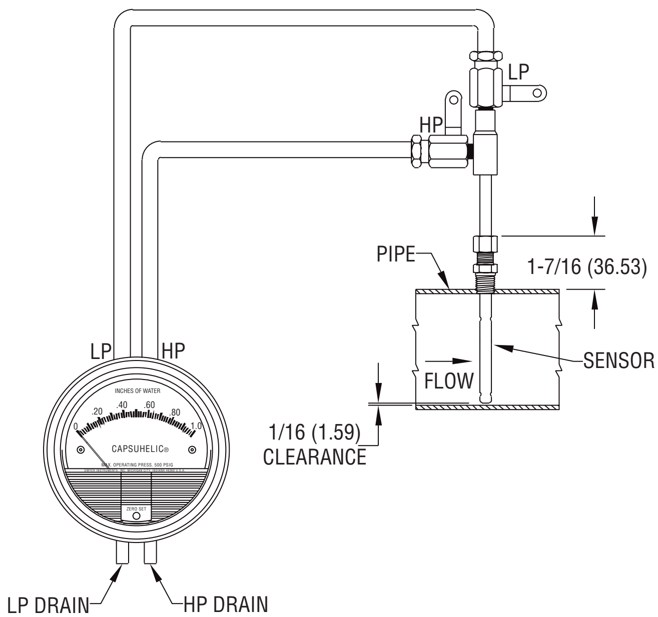
Bleed air from instrument piping on liquid flows. Drain any condensate from the instrument piping on air and gas flows.

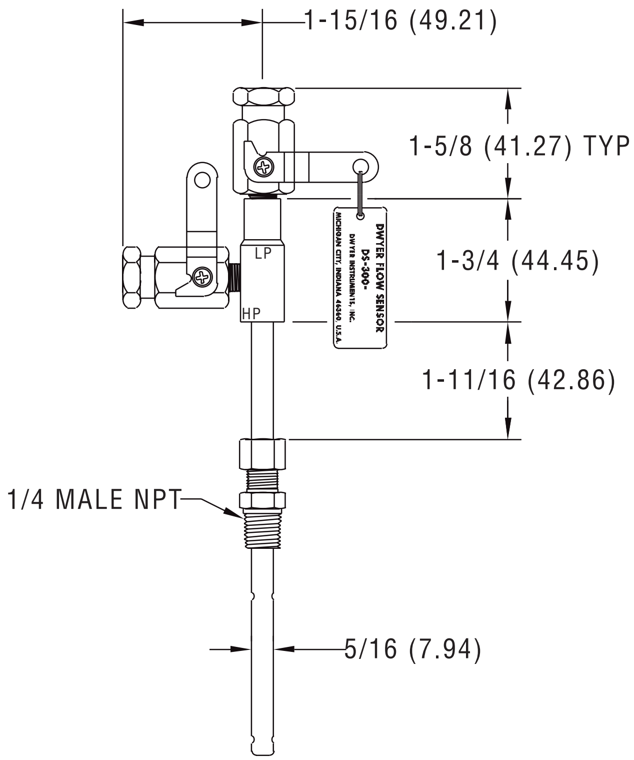
Open valves to instrument to place flow meter into service. For permanent installations, a 3-valve manifold is recommended to allow the gage to be zero checked without interrupting the flow. The Dwyer A-471 Portable Test Kit includes such a device.

Water Flow



Air or Gas Flow





Flow 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. When 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 service is recommended: Crane Valve Co. Technical Paper No. 410 "Flow of Fluids Through Valves, Fittings and Pipe." It is available from Crane Valve Company, www.cranevalve.com.

Using the appropriate differential pressure equation from Page 4 of this bulletin,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 of other gases, liquids an/or operating conditions, consult factory.

Note: the column on the right side of the chart which defines velocity ranges to avoid. Continuous operation within these ranges 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 in. W.C.)	Operating Ranges Water @ 70°F (D/P in. W.C.)	Velocity Ranges Not Recommended (Feet per Second)
1	0.52	1.10 to 186	4.00 to 675	146 to 220
1-1/4	0.58	1.15 to 157	4.18 to 568	113 to 170
1-1/2	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
2-1/2	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

FLOW EQUATIONS

1. Any Liquid

$$Q\ (GPM) = 5.668 \times K \times D^2 \times \sqrt{\Delta P / S_f}$$

2. Steam or Any Gas

$$Q\ (lb/Hr) = 359.1 \times K \times D^2 \times \sqrt{p \times \Delta P}$$

3. Any Gas

$$Q\ (SCFM) = 128.8 \times K \times D^2 \times \sqrt{\frac{P \times \Delta P}{(T + 460) \times S_s}}$$

DIFFERENTIAL PRESSURE EQUATIONS

1. Any Liquid

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

2. Steam or Any Gas

$$\Delta P\ (in.\ WC) = \frac{Q^2}{K^2 \times D^4 \times p \times 128{,}900}$$

3. Any Gas

$$\Delta P\ (in.\ WC) = \frac{Q^2 \times S_s \times (T + 460)}{K^2 \times D^4 \times P \times 16{,}590}$$

Technical Notations

The following notations apply:

ΔP = 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 Pg. 3.
D = Inside diameter of line size expressed in inches.

For square or rectangular ducts, use: $D = \sqrt{\dfrac{4 \times \text{Height} \times \text{Width}}{\pi}}$

P = Static Line pressure (psia)
T = Temperature in degrees Fahrenheit (plus 460 = °Rankine)
p = Density of medium in pounds per square foot
S_f = Sp Gr at flowing conditions
S_s = Sp Gr at 60°F (15.6°C)

SCFM TO ACFM EQUATION

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

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

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

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

1 Cubic foot of air = 0.076 pounds per cubic foot at 60° F (15.6°C) and 14.7 psia.
* (520°= 460 + 60°) Std. Temp. Rankine

Printed in U.S.A. 7/04 FR# 72-440451-01 Rev. 2

DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46361, U.S.A.
Phone: 219/879-8000 **www.dwyer-inst.com**
Fax: 219/872-9057 **e-mail: info@dwyer-inst.com**

Series RM Rate-Master® Flowmeters

Specifications - Installation and Operating Instructions

RMC RMB-SSV RMA-TMV

Fig. 1

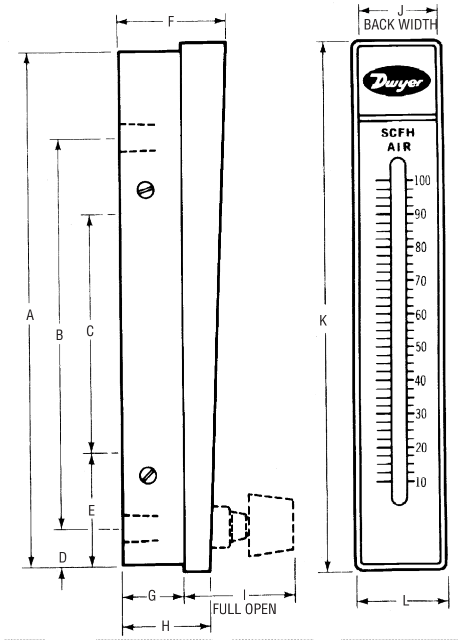


Fig. 2

Dimensions in Inches (Centimeters)			
	Model RMA	Model RMB	Model RMC
A	4 -9/16 (11.59)	8-1/2 (21.59)	15 -1/8 (38.42)
B	3 (7.62) 1/8 NPT CONN.	6-7/16 (16.35) 1/4 NPT CONN.	12 -1/4 (31.12) 1/2 NPT CONN.
C	1-5/8 (4.13) 10 - 32 Thds.	3-15/16 (10.00) 1/4 - 20 Thds.	8-3/4 (22.23) 10 - 32 Thds.
D	3/8 (.95)	5/8 (1.59)	1 (2.54)
E	1-1/16 (2.70)	1-7/8 (4.76)	2-3/4 (6.99)
F	1-3/16 (3.02)	1-3/4 (4.45)	2-1/2 (6.35)
G	11/16 (1.75)	1 (2.54)	1-7/16 (3.65)
H	61/64 (2.42)	1-7/16 (3.65)	1-31/32 (5.00)
I (OPEN)	1-3/8 (3.49)	1-13/16 (4.60)	2-1/2 (6.35)
J	3/4 (1.91)	1-1/4 (3.18)	2 (5.08)
K	4-13/16 (12.22)	8-3/4 (22.23)	15-3/8 (39.05)
L	1 (2.54)	1-1/2 (3.81)	2-1/4 (5.72)

Panel Cutout For Flush Mounting			
High	4-5/8 (11.75)	8-9/16 (21.75)	15 -3/16 (38.58)
Wide	7/8 (2.22)	1-5/16 (3.33)	2-1/16 (5.24)
Panel Hole Sizes for Surface Mounting			
Pipe	7/16 (1.11)	5/8 (1.59)	15/16 (2.38)
Bolt	1/4 (0.64)	9/32 (0.71)	13/32 (1.03)

The Series RM Rate-Master® Flowmeters are furnished in three models (see Fig. 2), each available in a broad array of flow ranges with direct reading scales for air, gas or water. Installation, operation and maintenance are very simple. Only a few common-sense precautions must be observed to assure long, trouble-free service.

CAUTION: Rate-Master® Flowmeters are designed to provide satisfactory long-term service when used with air, water or other compatible media. Refer to factory for information on questionable gases or liquids. Avoid solutions of acids, bases or salts having a pH below 5.0 or above 8.5. Caustic solutions, antifreeze (ethylene glycol) and aromatic solvents should definitely not be used.

Calibration

Each Rate-Master® Flowmeter is calibrated at the factory. If at any time during the meter's life, you wish to re-check its calibration, do so only with devices of certified accuracy. DO NOT attempt to check a Rate-Master® Flowmeter with a similar flowmeter, as seemingly unimportant variations in piping and back pressure may cause noticeable differences in the indicated reading. If in doubt, return your Rate-Master® Flowmeter to the factory. Before proceeding with installation, check to be sure you have the Rate-Master® flowmeter model and flow range you require.

LOCATION: Temperature, Pressure, Atmosphere and Vibration: Rate-Master® Flowmeters are exceptionally tough and strong. They are designed for use at pressures up to 100 psi (6.89 bar) and temperatures up to 130°F (54°C).

DO NOT EXCEED THESE LIMITS! The installation should not be exposed to strong chlorine atmospheres or solvents such as benzene, acetone, carbon tetrachloride, etc. The mounting panel should be free of excessive vibration, as it may prevent the unit from operating properly.

Inlet Piping Run: It is good practice to approach the flowmeter inlet with as few elbows and restrictions as possible. In every case, the inlet piping should be at least as large as the connection to the flowmeter; i.e.,1/8″ Iron Pipe Size for RMA models 1/4″ IPS for RMB models,1/2″ IPS for RMC models. Length of inlet piping makes little difference for normal pressure-fed flowmeters.

For flowmeters on vacuum air service, the inlet piping should be as short and open as possible. This will allow operation near atmospheric pressure and thereby insure the accuracy of the device. (**Note:** for vacuum air service, the flow control valve, if any, should be on the discharge side of the flowmeter. Either the TMV unit or a separate in-line valve may be applied.).

Discharge Piping: As on the inlet, discharge piping should be at least as large as the flowmeter connection. Also, for pressure-fed flowmeters on air or gas service, the discharge piping should be as short and open as possible. This will allow operation of the flow tube at near atmospheric pressure and insure the accuracy of the device. This is of less importance on water or liquid flowmeters, as the flowing medium is generally incompressible and moderate back pressure will not affect the accuracy of the instrument as calibrated.

POSITIONING AND MOUNTING

All Rate-Master® Flowmeters must be mounted in a vertical position with inlet connection at the bottom rear and outlet at the top rear.

Bezel or Through-Panel Mounting: Make panel cutout using appropriate dimensions from Fig. 2. Flowmeter must fit into panel freely without forcing or squeezing. Insert the flowmeter from the front of the panel and install the mounting clamps from the rear. Insert and tighten the clamp bolts in the locations shown in Fig. 3. Do not exceed 5 in./lbs. Make connections to inlet and outlet ports using pipe thread sealant tape to avoid leakage. Avoid excess torque, which may damage the flowmeter body.

DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, IN 46360, U.S.A.
Phone: 219/879-8000
Fax: 219/872-9057
www.dwyer-inst.com
e-mail: info@dwyermail.com

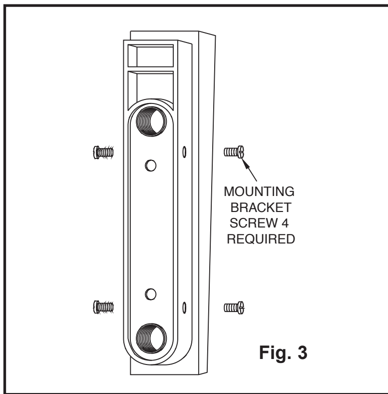


Fig. 3

Fig. 4

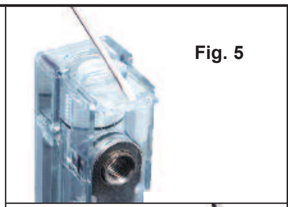


Fig. 5

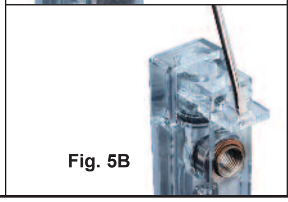


Fig. 5B

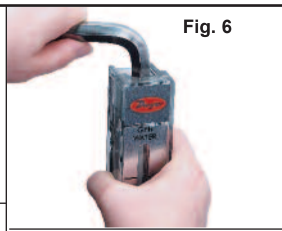


Fig. 6

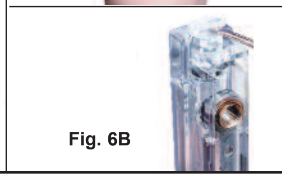


Fig. 6B

Fig. 7

Surface Mounting: Drill appropriate holes in panel, using the dimensions shown in Fig. 2. Hold the flowmeter in position in front of the panel and install the clamp bolts from the rear. (The mounting clamps may be used as washers, if desired, by installing them backwards or straightening them out.) Pipe up inlet and discharge following the directions in the previous sections.

Surface Mounting on Piping Only: An alternate method of surface mounting, omitting the clamp bolts and supporting the flowmeter solely on the connecting piping, is possible. For this method, extra-long or straight pipe threads should be used so that nuts may be run onto the pipe and later tightened against the back of the panel to retain the unit in proper position. Use appropriate hole layout in formation from Fig. 2, but omit the small holes.

Surface Mounting on Piping Only Without Panel: For a temporary or laboratory type installation, the panel may be omitted altogether and the flowmeter installed directly in rigid piping. Its light weight permits this without difficulty.

OPERATION

To start system, open valve slowly to avoid possible damage. Control valves on BV and SSV models are turned clockwise to reduce flow, counter-clockwise to increase flow (valve is designed for flow adjustment only, not intended to be used as an open/shut-off valve). A nylon insert is provided in the threaded section of the valve stem to give a firm touch to valve and to prevent change of setting due to vibration.

The performance of low range units used in air or gas applications may be affected by static electricity. Excessive static charge may cause the ball float to behave erratically or provide a false reading. To ensure the proper function of the unit, the application should be designed to minimize or dispel static electricity.

The standard technique for reading a Variable Area Flowmeter is to locate the highest point of greatest diameter on the float, and then align that with the theoretical center of the scale graduation. In the event that the float is not aligned with a grad, an extrapolation of the float location must be made by the operator as to its location between the two closest grads. The following are some sample floats shown with reference to the proper location to read the float.

Variable Area Flowmeters used for gases are typically labeled with the prefix "S" or "N", which represents "Standard" for English units or "Normal" for metric units. Use of this prefix designates that the flowmeter is calibrated to operate at a specific set of conditions, and deviation from those standard conditions will require correction for the calibration to be valid. In practice, the reading taken from the flowmeter scale must be corrected back to standard conditions to be used with the scale units. The correct location to measure the actual pressure and temperature is at the exit of the flowmeter, except when using the Top Mounted Valve under vacuum applications, where they should be measured at the flowmeter inlet. The equation to correct for nonstandard operating conditions is as follows:

$$Q_2 = Q_1 \times \sqrt{\frac{P_1 \times T_2}{P_2 \times T_1}}$$

Where: Q_1 = Actual or Observed Flowmeter Reading
Q_2 = Standard Flow Corrected for Pressure and Temperature
P_1 = Actual Pressure (14.7 psia + Gage Pressure)
P_2 = Standard Pressure (14.7 psia, which is 0 psig)
T_1 = Actual Temperature (460 R + Temp °F)
T_2 = Standard Temperature (530 R, which is 70°F)

Example: A flowmeter with a scale of 10-100 SCFH Air. The float is sitting at the 60 grad on the flowmeter scale. Actual Pressure is measured at the exit of the meter as 5 psig. Actual Temperature is measured at the exit of the meter as 85°F.

$$Q_2 = 60.0 \times \sqrt{\frac{(14.7 + 5) \times 530}{14.7 \times (460 + 85)}}$$

Q_2 = 68.5 SCFH Air

CAUTION: Do not completely unscrew valve stem unless the flowmeter is unpressurized and drained of any liquid. Removal while in service will allow gas or liquid to flow out the front of the valve body and could result in serious personal injury. For applications involving high pressure and/or toxic gases or fluids, please contact factory for details.

MAINTENANCE

The only maintenance normally required is occasional cleaning to assure reliable operation and good float visibility.

Disassembly: The flowmeter can be disassembled for cleaning simply as follows:

1. Remove valve knob from RMB or RMC -BV or -SSV units by pulling the knob forward. It is retained by spring pressure on the stem half-shaft so that a gentle pull will remove it. On RMA-BV or -SSV models, turn the valve knob counter-clockwise until the threads are disengaged. Then withdraw the stem from the valve by gently pulling on the knob.

2. Remove the four mounting bracket screws located in the sides of the flowmeter. See Fig. 3. Pull the flowmeter body gently forward away from the back plate to avoid undue strain on the body. Leave the piping connections intact. There is no need to disturb them. See Fig. 4.

3. Threaded body style flowmeters - Remove the slip cap with a push on a screwdriver as shown in Fig. 5. Remove the plug ball stop as shown in Fig. 6 using allen wrench sizes as follows: Model RMA - 1/4″, Model RMB - 1/2″ and Model RMC - 3/4″ Threadless body style flowmeters - Release the plastic retaining clip with a screw driver (Figure 5B), it will unclip from the valve body (TMV Option) or the plug ball stop, slide the clip back until the valve body or ball stop can be removed. The clip will remain in the body for convenience. Using a screwdriver gently lift up on the plug in the groove as shown in Figure 6B until the o-ring seal is released and remove the plug. For the TMV option gently pull up on the valve knob to release the valve body seals and remove the valve.

4. Take out the ball or float by inverting the body and allowing the float to fall into your hand, as shown in Fig. 7. (Note: It is best to cover the discharge port to avoid losing the float through that opening.)

Cleaning: The flow tube and flowmeter body can best be cleaned with a little pure soap and water. Use of a bottle brush or other soft brush will aid the cleaning. Avoid benzene, acetone, carbon tetrachloride, alkaline detergents, caustic soda, liquid soaps (which may contain chlorinated solvents), etc. Also, avoid prolonged immersion, which may harm or loosen the scale.

Reassembly: Simply reverse steps 1 through 4 and place the flowmeter back in service. A little stopcock grease or petroleum jelly on the "O" rings will help maintain a good seal as well as facilitate assembly. No other special care is required.

Printed in U.S.A. 10/14 FR# 440197-00 Rev. 22

DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, IN 46360, U.S.A.
Phone: 219/879-8000
Fax: 219/872-9057
www.dwyer-inst.com
e-mail: info@dwyermail.com

INSTALLATION OPERATION MAINTENANCE

ROOTS

Blowers Compressors Exhausters

US $3.00, Canada $4.50

Universal RAI®, URAI-DSL, URAI-G and Metric Series

Contents

Do These Things To Get The Most From Your ROOTS™ blower

- ❏ Check shipment for damage. If found, file claim with carrier and notify Roots.
- ❏ Unpack shipment carefully, and check contents against Packing List. Notify Roots if a shortage appears.
- ❏ Store in a clean, dry location until ready for installation. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather and corrosion if outdoor storage is necessary.
- ❏ Read OPERATING LIMITATIONS and INSTALLATION sections in this manual and plan the complete installation.
- ❏ Provide for adequate safeguards against accidents to persons working on or near the equipment during both installation and operation. See SAFETY PRECAUTIONS.
- ❏ Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.
- ❏ **Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.**
- ❏ Read starting check points under OPERATION. Run equipment briefly to check for installation errors and make corrections. Follow with a trial run under normal operating conditions.
- ❏ In event of trouble during installation or operation, do not attempt repairs of Roots furnished equipment. Notify Roots, giving all nameplate information plus an outline of operating conditions and a description of the trouble. Unauthorized attempts at equipment repair may void Roots warranty.
- ❏ Units out of warranty may be repaired or adjusted by the owner. Good inspection and maintenance practices should reduce the need for repairs.

NOTE: Information in this manual is correct as of the date of publication. Roots reserves the right to make design or material changes without notice, and without obligation to make similar changes on equipment of prior manufacture.

For your nearest Roots Office, dial our Customer Service Hot Line toll free; 1 877 363 ROOT(S) (7668) or direct 832-590-2600.

ISRB-2002 rev.0207

DRESSER®
Roots

ROOTS™ products are sold subject to the current General Terms of Sale, GTS-5001 and Warranty Policy WP-5020. Copies are available upon request.

Contact your local Roots Office or Roots Customer Service Hot Line 1-877-363-ROOT(S) (7668) or direct 832-590-2600.

Safety Precautions

It is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should be particularly noted:

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Protect external moving parts with adequate guards.
- Disconnect power before doing any work, and avoid bypassing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream. **CAUTION: Never cover the blower inlet with your hand or other part of body.**
- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Casing pressure must not exceed 25 PSI (1725 mbar) gauge. Do not pressurize vented cavities from an external source, nor restrict the vents without first consulting ROOTS.
- Do not use air blowers on explosive or hazardous gases.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be trained to exercise adequate general safety precautions.

Operating Limitations

A ROOTS blower or exhauster must be operated within certain approved limiting conditions to enable continued satisfactory performance. Warranty is contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in TABLE 1 for various models & sizes of blowers & exhausters. These limits apply to all units of normal construction, when operated under standard atmospheric conditions. Be sure to arrange connections or taps for instruments, thermometers and pressure or vacuum gauges at or near the inlet and discharge connections of the unit. These, along with a tachometer, will enable periodic checks of operating conditions.

PRESSURE – The pressure rise, between inlet and discharge, must not exceed the figure listed for the specific unit frame size concerned. Also, in any system where the unit inlet is at a positive pressure above atmosphere a maximum case rating of 25 PSI gauge (1725 mbar) should not be exceeded without first consulting Roots. Never should the maximum allowable differential pressure be exceeded.

On vacuum service, with the discharge to atmospheric pressure, the inlet suction or vacuum must not be greater than values listed for the specific frame size.

TEMPERATURE – Blower & exhauster frame sizes are approved only for installations where the following temperature limitations can be maintained in service:

- Measured temperature rise must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the unit. This is not outdoor temperature unless the unit is installed outdoors.
- If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by 2/3 of the difference between the actual measured inlet temperature and the ambient temperature.
- The average of the inlet and discharge temperature must not exceed 250°F. (121°C).
- The ambient temperature of the space the blower/motor is installed in should not be highter than 120°F (48.8°C).

SPEED – These blowers & exhausters may be operated at speeds up to the maximum listed for the various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be a limiting factor.

Special Note: The listed maximum allowable temperature rise for any particular blower & exhauster may occur well before its maximum pressure or vacuum rating is reached. This may occur at high altitude, low vacuum or at very low speed. The units' operating limit is always determined by the maximum rating reached first. It can be any one of the three: Pressure, Temperature or Speed.

ROOTS blowers & exhausters are treated after factory assembly to protect against normal atmospheric corrosion. The maximum period of internal protection is considered to be one year under average conditions, if shipping plugs & seals are not removed. Protection against chemical or salt water atmosphere is not provided. Avoid opening the unit until ready to start installation, as corrosion protection will be quickly lost due to evaporation.

If there is to be an extended period between installation and start up, the following steps should be taken to ensure corrosion protection.

- ❑ Coat internals of cylinder, gearbox and drive end bearing reservoir with Nox-Rust VCI-10 or equivalent. Repeat once a year or as conditions may require. Nox-Rust VCI-10 is petroleum soluble and does not have to be removed before lubricating. It may be obtained from Daubert Chemical Co., 2000 Spring Rd., Oak Brook, Ill. 60521.
- ❑ Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
- ❑ Seal inlet, discharge, and vent openings. It is not recommended that the unit be set in place, piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the Nox-Rust VCI-10 vapor will escape and lose its effectiveness.
- ❑ Protect units from excessive vibration during storage.
- ❑ Rotate shaft three or four revolutions every two weeks.
- ❑ Prior to start up, remove flange covers on both inlet and discharge and inspect internals to insure absence of rust. Check all internal clearances. Also, at this time, remove gearbox and drive end bearing cover and inspect gear teeth and bearings for rust.

Because of the completely enclosed unit design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is preferred. However, an outdoor location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected operating temperatures, and that the unit be located so that routine checking and servicing can be performed conveniently. Proper care in locating driver and accessory equipment must also be considered.

Supervision of the installation by a ROOTS Service Engineer is not usually required for these units. Workmen with experience in installing light to medium weight machinery should be able to produce satisfactory results. Handling of the equipment needs to be accomplished with care, and in compliance with safe practices. Unit mounting must be solid, without strain or twist, and air piping must be clean, accurately aligned and properly connected.

Bare-shaft Units: Two methods are used to handle a unit without base. One is to use lifting lugs bolted into the top of the unit headplates. Test them first for tightness and fractures by tapping with a hammer. In lifting, keep the direction of cable pull on these bolts as nearly vertical as possible. If lifting lugs are not available, lifting slings may be passed under the cylinder adjacent to the headplates. Either method prevents strain on the extended drive shaft.

Packaged Units: When the unit is furnished mounted on a baseplate, with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the unit casing or mounting feet, or on any mounted accessory equipment. **DO NOT** use the lifting lugs in the top of the unit headplates.

Before starting the installation, remove plugs, covers or seals from unit inlet and discharge connections and inspect the interior completely for foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with an appropriate solvent. Turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the connection flanges and drive shaft extension may also be removed at this time with the same solvent. Cover the flanges until ready to connect piping.

Mounting

Care will pay dividends when arranging the unit mounting. This is especially true when the unit is a "bare-shaft" unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad, but this generally produces the least satisfactory results. It definitely causes the most problems in leveling and alignment and may result in a "Soft Foot" condition. Correct soft foot before operation to avoid unnecessary loading on the casing and bearings. Direct use of building structural framing members is not recommended.

For blowers without a base, it is recommended that a well anchored and carefully leveled steel or cast iron mounting plate be provided. The plate should be at least 1 inch (25 mm) thick, with its top surface machined flat, and large enough to provide leveling areas at one side and one end after the unit is mounted. It should have properly sized studs or tapped holes located to match the unit foot drilling. Proper use of a high quality machinist's level is necessary for adequate installation.

With the mounting plate in place and leveled, set the unit on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop rocking. Place half of this under each of the diagonally-opposite short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers turn freely. If the unit is to be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the unit shaft. Best unit arrangement is directly bolted to the mounting plate while the driver is on shims of at least 1/8 inch (3mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

Aligning

When unit and driver are factory mounted on a common baseplate, the assembly will have been properly aligned and is to be treated as a unit for leveling purposes. Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration, and leveling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and partly inside the leveled and shimmed base is recommended.

It is possible for a base-mounted assembly to become twisted during shipment, thus disturbing the original alignment. For this reason, make the following checks after the base has been leveled and bolted down. Disconnect the drive and rotate the unit shaft by hand. It should turn freely at all points. Loosen the unit foot hold-down screws and determine whether all feet are evenly in contact with the base. If not, insert shims as required and again check for free impeller rotation. Finally, if unit is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections.

In planning the installation, and before setting the unit, consider how piping arrangements are dictated by the unit design and assembly. Drive shaft rotation must be established accordingly and is indicated by an arrow near the shaft.

Typical arrangement on vertical units has the drive shaft at the top with counterclockwise rotation and discharge to the left. Horizontal units are typically arranged with the drive shaft at the left with counterclockwise rotation and discharge down. See Figure 4 for other various unit arrangements and possible conversions.

When a unit is DIRECT COUPLED to its driver, the driver RPM must be selected or governed so as not to exceed the maximum speed rating of the unit. Refer to Table 1 for allowable speeds of various unit sizes.

A flexible type coupling should always be used to connect the driver and unit shafts.

When direct coupling a motor or engine to a blower you must insure there is sufficient gap between the coupling halves and the element to prevent thrust loading the blower bearings. When a motor, engine or blower is operated the shafts may expand axially. If the coupling is installed in such a manner that there is not enough room for expansion the blower shaft can be forced back into the blower and cause the impeller to contact the gear end headplate resulting in damage to the blower. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end-play exists. Coupling manufacturer's recommendations for maximum misalignment, although acceptable for the coupling, are normally too large to achieve smooth operation and maximum life of the blower.

The following requirements of a good installation are recommended. When selecting a coupling to be fitted to the blower shaft ROOTS recommends a taper lock style coupling to insure proper contact with the blower shaft. If the coupling must have a straight bore the coupling halves must be fitted to the two shafts with a line to line thru .001" interference fit. Coupling halves must be warmed up per coupling manufacturer's recommendations. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

When a unit is BELT DRIVEN, the proper selection of sheave diameters will result in the required unit speed. When selecting a sheave to be fitted to the blower shaft ROOTS recommends a taper lock style sheave to insure proper contact with the blower shaft. This flexibility can lead to operating temperature problems caused by unit speed being too low. Make sure the drive speed selected is within the allowable range for the specific unit size, as specified under Table 1.

Belt drive arrangements usually employ two or more V-belts running in grooved sheaves. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the unit shaft. **The driver should be mounted on the inlet side of a vertical unit (horizontal piping) and on the side nearest to the shaft on a horizontal unit. SEE PAGE 6 - Acceptable Blower Drive Arrangement Options.** The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

CAUTION: Drive couplings and sheaves (pulleys) should have an interference fit to the shaft of the blower (set screw types of attachment generally do not provide reliable service.) It is recommended that the drive coupling or sheave used have a taper lock style bushing which is properly sized to provide the correct interference fit required. Drive couplings, that require heating to fit on the blower shaft, should be installed per coupling manufacturer recommendations. A drive coupling or sheave should not be forced on to the shaft of the blower as this could affect internal clearances resulting in damage to the blower.

Engine drive applications often require special consideration to drive coupling selection to avoid harmful torsional vibrations. These vibrations may lead to blower damage if not dampened adequately. It is often necessary to install a flywheel and/or a torsionally soft elastic element coupling based on the engine manufacturer recommendations.

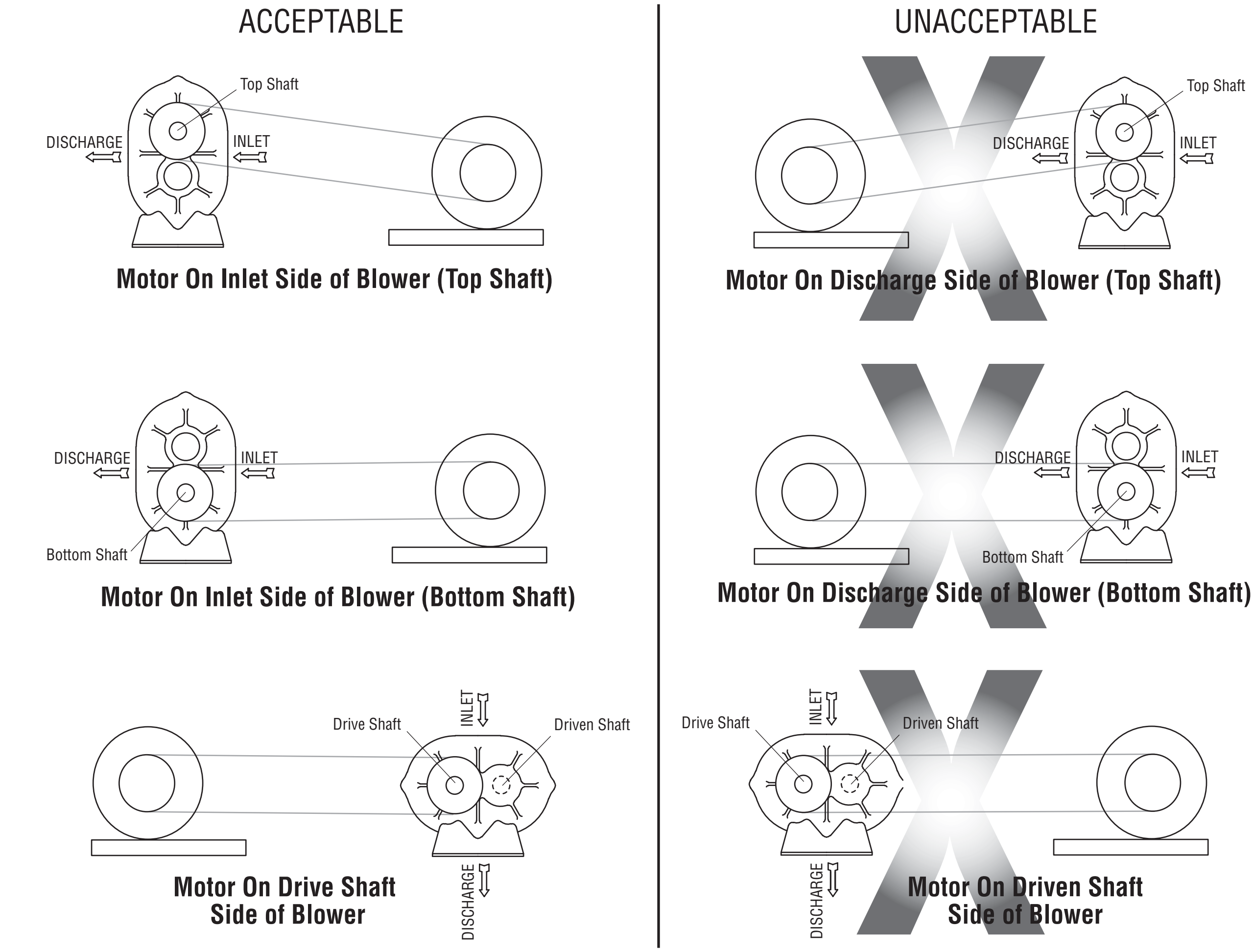
The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that 2/3 of the total movement is available in the direction away from the unit, and mount the assembly so that the face of the sheave is accurately in line with the unit sheave. This position minimizes belt wear, and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the unit is operating under load. Excessive tightening can lead to early bearing concerns or shaft breakage.

Before operating the drive under power to check initial belt tension, first remove covers from the unit connections. Make sure the interior is still clean, then rotate the shaft by hand. Place a coarse screen over the inlet connection to prevent anything being drawn into the unit while it is operating, and avoid standing in line with the discharge opening. Put oil in the sumps per instructions under **LUBRICATION.**

Piping

Before connecting piping, remove any remaining anti-rust compound from unit connections. Clean pipe should be no

Acceptable Blower Drive Arrangement Options



smaller than unit connections. In addition, make sure it is free of scale, cuttings, weld beads, or foreign material of any kind. To further guard against damage to the unit, especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours of operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the unit may cause serious damage.

Pipe flanges or male threads must meet the unit connections accurately and squarely. DO NOT attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the unit casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the unit to eliminate dead weight strains. Also, if pipe expansion is likely to occur from temperature change, installation of flexible connectors or expansion joints is advisable.

Figure 3 represents an installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or other restrictions. When a shut-off valve can not be avoided, make sure a full size vacuum relief is installed nearest the unit inlet. This will protect against unit overload caused by accidental closing of the shut-off valve.

Need for an inlet silencer will depend on unit speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is recommended, especially in dusty or sandy locations. A discharge silencer is also normally suggested, even though Whispair units operate at generally lower noise levels than conventional rotary blowers. Specific recommendations on silencing can be obtained from your local ROOTS distributor.

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the unit under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on unit operating conditions. The back-pressure regulator shown in Figure 3 is useful mainly when volume demands vary while the unit operates at constant output. If demand is constant, but somewhat lower than the unit output, excess may be blown off through the manual unloading valve.

In multiple unit installations where two or more units operate with a common header, use of check valves is mandatory. These should be of a direct acting or free swinging type, with one valve located in each line between the unit and header. Properly installed, they will protect against damage from reverse rotation caused by air and material back-flow through an idle unit.

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment.

DO NOT operate the unit at this time unless it has been lubricated per instructions.

Technical Supplement for 32, 33, 36, 42, 45, 47, 53, 56, 59, 65, 68, 615 Universal RAI-G blowers

ROOTS Universal RAI-G rotary positive gas blowers are a design extension of the basic Universal RAI blower model. URAI-G blower uses (4) mechanical seals in place of the standard inboard lip seals to minimize gas leakage into the atmosphere. The seal chambers are piped to plugged connections. These should be opened periodically to confirm that there is no build-up of oil due to leakage by the mechanical seal. Special traps may be required for vacuum operation. These units are intended for gases which are compatible with cast iron case material, steel shafts, 300/400 series stainless steel and carbon seal components, viton o-rings and the oil/grease lubricants. If there are any questions regarding application or operation of this gas blower, please contact factory.

Precaution: URAI-G blowers: Care must be used when opening the head plate seal vent chamber plugs (43) as some gas will escape–if it is a pressure system, or the atmospheric air will leak in-if the system is under vacuum. There is a possibility of some gas leakage through the mechanical seals. This leakage on the gear end will escape through the gear box vent, and on the drive end, through the grease release fittings. If the gas leakage is undesirable, each seal chamber must be purged with an inert gas through one purge gas hole (43) per seal . There are two plugged purge gas holes(1/8 NPT) provided per seal. The purge gas pressure must be maintained one psi above the discharge gas pressure. Also, there exists a possibility of gear end oil and drive end grease leakage into the gas stream.

The lubricants selected must be compatible with the gas.

URAI GAS Blower Oil and Grease Specifications

The specified oil should be ROOTS synthetic P/N 813-106- of the proper viscosity.

When servicing drive end bearings of a Gas blower, use the specified NLGI #2 premium grade aluminum complex* grease, ROOTS P/N T20019001, with 300°F (149°C) service temperature and moisture resistance and good mechanical stability.

*ROOTS Synthetic Oil & Grease is superior in performance to petroleum based products. It has high oxidation stability, excellent corrosion protection, extremely high film strength and low coefficient of friction. Typical oil change intervals are increased 2-3 times over petroleum based lubricants. Also, ROOTS Synthetic Oil is 100% compatible with petroleum based oils. Simply drain the oil in the blower and refill the reservoirs with ROOTS Synthetic Oil to maintain optimum performance of your ROOTS blower.

Due to sludge build-up and seal leakage problems, Roots recommendation is **DO NOT USE** Mobil SHC synthetic oils in Roots blowers.

For Units with a Grease Lubricated Drive End

A simple but very effective lubrication system is employed on the drive shaft end bearings. Hydraulic pressure relief fittings are provided to vent any excess grease, preventing pressure build-up on the seals. A restriction plug and metering orifice prevent loss of lubricant from initial surges in lubricant pressure but permit venting excess lubricant under steadily rising pressures.

For grease lubricated drive end blowers see page 16, table 4, regarding specified greasing intervals.

When servicing drive end bearings of Non Gas blower, use the specified NLGI #2 premium grade microgel grease with 250°F (121°C) service temperature and moisture resistance and good mechanical stability. ROOTS specifies Shell Darina EP NLGI Grade 2. Product Code 71522 or Shell Darina SD 2 product code 506762B.

URAI GAS Blower Oil and Grease Specifications

The specified oil should be ROOTS synthetic P/N 813-106- of the proper viscosity.

When servicing drive end bearings of a Gas blower, use the specified NLGI #2 premium grade aluminum complex* grease, ROOTS P/N T20019001, with 300°F (149°C) service temperature and moisture resistance and good mechanical stability.

NOTE: Lithium based greases are not compatible with the ROOTS Synthetic grease used when assembling a Gas blower or the non-soap base grease used when assembling a standard URAI blower. Lithium based grease is not approved for any ROOTS blowers.

Using a pressure gun, slowly force new lubricant into each drive end bearing housing until traces of clean grease comes out of the relief fitting. The use of an electric or pneumatic grease gun could force the grease in too rapidly and thus invert the seals and should not be used.

To fill the gearbox, remove the breather plug (25) and the oil overflow plug (21) - see page 14. Fill the reservoir up to the overflow hole. Place the breather and the overflow plug back into their respective holes.

After a long shutdown, it is recommended that the grease fittings be removed, the old grease flushed out with kerosene or #10 lubricating oil, drained thoroughly, and bearings refilled with new grease. Be sure grease relief fittings are reinstalled. Grease should be added using a hand operated grease gun to the drive end bearings at varying time intervals depending on duty cycle and RPM. Table 4 has been prepared as a general greasing schedule guide based on average operating conditions. More frequent intervals may be necessary depending on the grease operating temperature and unusual circumstances.

For Units with Splash Lubrication on Both Ends

Bearings and oil seals are lubricated by the action of the timing gears or oil slingers which dip into the main oil sumps causing oil to splash directly on gears and into bearings and seals. A drain port is provided below each bearing to prevent an excessive amount of oil in the bearings. Seals located inboard of the bearings in each headplate effectively retain oil within the sumps. Any small leakage that may occur should the seals wear passes into a cavity in each vented headplate and is drained downward.

Oil sumps on each end of the blower are filled by removing top vent plugs, Item (25), and filling until oil reaches the middle of the oil level sight gauge when the unit is not operating, Item (45 or 53), DO NOT FILL PAST THE MIDDLE OF THE SIGHT GLASS.

Initial filling of the sumps should be accomplished with the blower not operating, in order to obtain the correct oil level. Approximate oil quantities required for blowers of the various models and configurations are listed in Table 3. Use a good grade of industrial type non-detergent, rust inhibiting, anti-foaming oil and of correct viscosity per Table 2. ***ROOTS synthetic oil (ROOTS P/N 813-106-) is highly recommended and specified.** ROOTS does not recommend automotive type lubricants, as they are not formulated with the properties mentioned above.

The oil level may rise or fall on the gauge during operation, to an extent depending somewhat on oil temperature and blower speed.

Proper lubrication is usually the most important single consideration in obtaining maximum service life and satisfactory operation from the unit. Unless operating conditions are quite severe, a weekly check of oil level and necessary addition of lubricant should be sufficient. During the first week of operation, check the oil levels in the oil sumps about once a day, and watch for leaks. Replenish as necessary. Thereafter, an occasional check should be sufficient. It is recommended that the oil be changed after initial 100 hours of operation. Frequent oil changing is not necessary unless the blower is operated in a very dusty location.

Normal life expectancy of petroleum based oils is about 2000 hours with an oil temperature of about 180°F (82°C). As the oil temperature increases by increments of 15-18°F (8°C - 10°C), the life is reduced by half. Example: Oil temperatures of 210-216°F (99°C - 102°C) will produce life expectancy of 1/4 or 500 hours. Therefore, it is considered normal to have oil change periods of 500 hours with petroleum based oils.

Normal life expectancy of ROOTS™ Synthetic Oil is about 4000 to 8000 hours with an oil temperature of about 180°F (82°C). As the oil temperature increases by increments of 15-18°F (8°C - 10°C), the life is reduced by half. Example: Oil temperatures of 210-216°F (99°C - 102°C) will produce life expectancy of 1/4 or 1000 to 2000 hours.

NOTE: To estimate oil temperature, multiply the discharge temperature of the blower by 0.80. Example: if the discharge air temperature of the blower is 200° F, it is estimated that the oil temperature is 160° F.

*ROOTS™ Synthetic Oil & Grease is superior in performance to petroleum based products. It has high oxidation stability, excellent corrosion protection, extremely high film strength and low coefficient of friction. Typical oil change intervals are increased 2-3 times over petroleum based lubricants. Also, ROOTS™ Synthetic Oil is 100% compatible with petroleum based oils. Simply drain the oil in the blower and refill the reservoirs with ROOTS™ Synthetic Oil to maintain optimum performance of your ROOTS™ blower.

Before operating a blower under power for the first time, recheck the unit and the installation thoroughly to reduce the likelihood of avoidable troubles. Use the following procedure check list as a guide, but consider any other special conditions in the installation.

- ❑ Be certain that no bolts, tools, rags, or debris have been left in the blower air chamber or piping.
- ❑ If an outdoor intake without filter is used, be sure the opening is located so it cannot pick up dirt and is protected by a strong screen or grille. Use of the temporary protective screen as described under INSTALLATION is strongly recommended.
- ❑ Recheck blower leveling, drive alignment and tightness of all mounting bolts if installation is not recent. If belt drive is used, adjust belt tension correctly.
- ❑ Turn drive shaft by hand to make sure impellers still rotate without bumping or rubbing at any point.
- ❑ Ensure oil levels in the main oil sumps are correct.
- ❑ Check lubrication of driver. If it is an electric motor, be sure that power is available and that electrical overload devices are installed and workable.
- ❑ Open the manual unloading valve in the discharge air line. If a valve is in the inlet piping, be sure it is open.
- ❑ Bump blower a few revolutions with driver to check that direction of rotation agrees with arrow near blower shaft, and that both coast freely to a stop.

After the preceding points are cleared, blower is ready for trial operation under “no-load” conditions. The following procedure is suggested to cover this initial operation test period.

a. Start blower, let it accelerate to full speed, then shut off. Listen for knocking sounds, both with power on and as speed slows down.

b. After blower comes to a complete stop, repeat above, but let blower run 2 or 3 minutes. Check for noises, such as knocking sounds.

c. After blower comes to a complete stop, operate blower for about 10 minutes unloaded. Check oil levels. Observe cylinder and headplate surfaces for development of hot spots such as burned paint, indicating impeller rubs. Be aware of any noticeable increase in vibration.

Assuming that all trials have been satisfactory, or that necessary corrections have been made, the blower should now have a final check run of at least one hour under normal operating conditions. After blower is restarted, gradually close the discharge unloading valve to apply working pressure. At this point it is recommended that a pressure gauge or manometer be connected into the discharge line if not already provided, and that thermometers be in both inlet and discharge lines. Readings from these instruments will show whether pressure or temperature ratings of the blower are being exceeded.

During the final run, check operating conditions frequently and observe the oil levels at reasonable intervals. If excessive noise or local heating develops, shut down immediately and determine the cause. If either pressure rise or temperature rise across the blower exceeds the limit specified in this manual, shut down and investigate conditions in the piping system. Refer to the TROUBLESHOOTING CHECKLIST for suggestions on various problems that may appear.

The blower should now be ready for continuous duty operation at full load. During the first few days make periodic checks to determine whether all conditions remain steady, or at least acceptable. This may be particularly important if the blower is supplying air to a process system where conditions can vary. At the first opportunity, stop the blower and clean the temporary inlet protective screen. If no appreciable amount of debris has collected, the screen may be removed. See comments under INSTALLATION. At this same time, verify leveling, coupling alignment or belt tension, and mounting bolt tightness.

Should operating experience prove that blower capacity is a little too high for the actual air requirements, a small excess may be blown off continuously through the manual unloading or vent valve. Never rely on the pressure relief valve as an automatic vent. Such use may cause the discharge pressure to become excessive, and can also result in failure of the valve itself. If blower capacity appears to be too low, refer to the TROUBLESHOOTING CHECKLIST.

Vibration Assessment Criteria

With measurements taken at the bearing locations on the housings, see chart below for an appropriate assessment guide for rotary lobe blowers rigidly mounted on stiff foundations.

In general, blower vibration levels should be monitored on a regular basis and the vibration trend observed for progressive or sudden change in level. If such a change occurs, the cause should be determined through spectral analysis.

As shown on the chart below, the level of all pass vibration will determine the need to measure discrete frequency vibration levels and the action required.

All Pass Vibration (in/sec)	Discrete Frequency Vibration (in/sec)	Action
0.45 or less	N/R	Acceptable
Greater than 0.45 but 1.0 or less	0.45 or less @ any frequency	Acceptable
	Greater than 0.45 @ any frequency	Investigate
Greater than 1.0	Less than 1.0	Investigate
	Greater than 1.0	Investigate

Troubleshooting Checklist

Trouble	Item	Possible Cause	Remedy
No flow	1	Speed too low	Check by tachometer and compare with published performance
	2	Wrong rotation	Compare actual rotation with Figure 1 Change driver if wrong
	3	Obstruction in piping	Check piping, valves, silencer to assure open flow path
Low capacity	4	Speed too low	See item 1, If belt drive, check for slippage and readjust tension
	5	Excessive pressure rise	Check inlet vacuum and discharge pressure and compare with Published performance
	6	Obstruction in piping	See item 3
	7	Excessive slip	Check inside of casing for worn or eroded surfaces causing excessive clearances
Excessive power	8	Speed too high	Check speed and compare with published performance
	9	Excessive pressure rise	See Item 5
	10	Impeller rubbing	Inspect outside of cylinder for high temperature areas, then check for impeller contact at these points. Correct blower mounting, drive alignment
	11	Scale, sludge, rust or product build up	Clean blower appropriately
Damage to bearings or gears	12	Inadequate lubrication	Check oil sump levels in gear and drive end headplates
	13	Excessive lubrication	Check oil levels. If correct, drain and refill with clean oil of recommended grade
	14	Excessive pressure rise	See Item 5
	15	Coupling misalignment	Check carefully. Realign if questionable
	16	Excessive belt tension	Readjust for correct tension
Vibration	17	Misalignment	See Item 15
	18	Impellers rubbing	See Item 10
	19	Worn bearings/gears	Check gear backlash and condition of bearings, and replace as indicated
	20	Unbalanced or rubbing impeller	Scale or process material may build up on casing and impellers, or inside impellers. Remove build-up to restore original clearances and impeller balance
	21	Driver or blower loose	Tighten mounting bolts securely
	22	Piping resonances	Determine whether standing wave pressure pulsations are present in the piping
	23	Scale/sludge build-ups	Clean out interior of impeller lobes to restore dynamic balance
	24	Casing strain	Re-work piping alignment to remove excess strain
Driver stops, or will not start	25	Impeller stuck	Check for excessive hot spot on headplate or cylinder. See item 10. Look for defective shaft bearing and/or gear teeth
	26	Scale, sludge, rust or product build-up	Clean blower appropriately
Excessive breather	27	Broken seal	Replace seals
Blow-by or excessive oil leakage to vent area	28	Defective O-ring	Replace seals and O-ring
Excessive oil leakage in vent area	29	Defective/plugged breather	Replace breather and monitor oil leakage
	30	Oil level too high	Check sump levels in gear and drive headplates.
	31	Oil type or viscosity incorrect	Check oil to insure it meets recommendations. Drain then fill with clean oil of recommended grade.
	32	Blower running hot	Check blower operating conditions to ensure they are within the operating limitations defined in this manual.

A good program of consistent inspection and maintenance is the most reliable method of minimizing repairs to a blower. A simple record of services and dates will help keep this work on a regular schedule. Basic service needs are:

- Lubrication
- Checking for hot spots
- Checking for increases or changes in vibration and noise
- Recording of operating pressures and temperatures

Above all, a blower must be operated within its specified rating limits, to obtain satisfactory service life.

A newly installed blower should be checked often during the first month of full-time operation. Attention there after may be less frequent assuming satisfactory performance. Lubrication is normally the most important consideration and weekly checks of lubricant levels in the gearbox and bearing reservoirs should be customary. Complete oil change schedules are discussed under **LUBRICATION.**

Driver lubrication practices should be in accordance with the manufacturer's instructions. If direct connected to the blower through a lubricated type coupling, the coupling should be checked and greased each time blower oil is changed. This will help reduce wear and prevent unnecessary vibration. In a belted drive system, check belt tension periodically and inspect for frayed or cracked belts.

In a new, and properly installed, unit there is no contact between the two impellers, or between the impellers and cylinder or headplates. Wear is confined to the bearings (which support and locate the shafts) the oil seals, and the timing gears. All are lubricated and wear should be minimal if clean oil of the correct grade is always used. Seals are subject to deterioration as well as wear, and may require replacement at varying periods.

Shaft bearings are designed for optimum life under average conditions with proper lubrication and are critical to the service life of the blower. Gradual bearing wear may allow a shaft position to change slightly, until rubbing develops between impeller and casing. This will cause spot heating, which can be detected by observing these surfaces. Sudden bearing failure is usually more serious. Since the shaft and impeller are no longer supported and properly located, extensive general damage to the blower casing and gears is likely to occur.

Oil seals should be considered expendable items, to be replaced whenever drainage from the headplate vent cavity becomes excessive or when the blower is disassembled for any reason. Some oil seal leakage may occur since an oil film under the lip is required for proper operation. Periodically leaked oil should be wiped off from surfaces. Minor seal leakage should not be considered as indicating seal replacement.

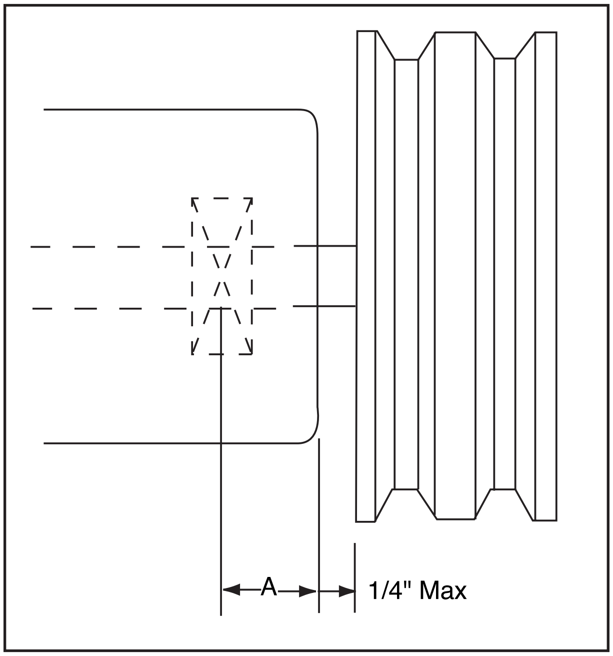
Timing gear wear, when correct lubrication is maintained, should be negligible. Gear teeth are cut to provide the correct amount of backlash, and gears correctly mounted on the shafts will accommodate a normal amount of tooth wear without permitting contact between lobes of the two impellers. However, too high an oil level will cause churning and excessive heating. This is indicated by unusually high temperature at the bottom of the gear housing. Consequent heating of the gears will result in loss of tooth-clearance , backlash and rapid wear of the gear teeth usually will develop. Continuation of this tooth wear will eventually produce impeller contacts (knocking), and from this point serious damage will be unavoidable if blower operation is continued. A similar situation can be produced suddenly by gear tooth fracture, which is usually brought on by sustained overloading or momentary shock loads.

Problems may also develop from causes other than internal parts failure. Operating clearances within a blower are only a few thousandths of an inch. This makes it possible for impeller interference or casing rubs to result from shifts in the blower mounting, or from changes in piping support. If this type of trouble is experienced, and the blower is found to be clean, try removing mounting strains. Loosen blower mounting bolts and reset the leveling and drive alignment. Then tighten mounting again, and make sure that all piping meets blower connections accurately and squarely Foreign materials in the blower will also cause trouble, which can only be cured by disconnecting the piping and thoroughly cleaning the blower interior.

A wide range of causes & solutions for operating troubles are covered in the **TROUBLE SHOOTING CHECKLIST.** The remedies suggested should be performed by qualified mechanics with a good background. Major repairs generally are to be considered beyond the scope of maintenance, and should be referred to an authorized ROOTS distributor.

Warranty failures should not be repaired at all, unless specific approval has been obtained through ROOTS before starting work. Unauthorized disassembly within the warranty period may void the warranty.

Figure 2 - Allowable Overhung Loads for V-Belt Drives Universal RAI®/URAI®-J Units



$$\text{Belt Pull lbs} = \frac{252100 \bullet \text{Motor HP}}{\text{Blower RPM} \bullet \text{Sheave Diameter}}$$

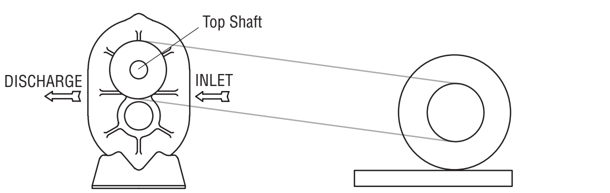
$$\text{Shaft Load (lb.in)} = \text{Belt Pull} \bullet \left(A + 1/4" + \frac{\text{Sheave Width}}{2}\right)$$

Frame Size	Dimension "A"	Max Allowable Shaft Load (lb-in.)	Min Sheave Diameter
22, 24	0.61	150	4.00
32, 33, 36	0.80	400	5.00
42, 45, 47	1.02	650	5.00
53, 56, 59	1.13	1,325	6.00
65, 68, 615	1.36	2,250	8.00
76, 711, 718	1.16	2,300	9.50

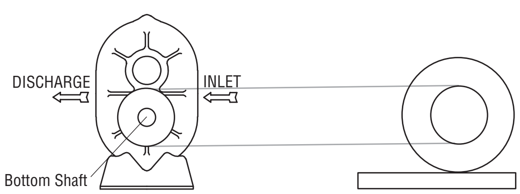
NOTE:
Arc of sheave belt contact on the smaller sheave not to be less than 170°
Driver to be installed on the inlet side for vertical units, and on the drive shaft side for horizontal units.
ROOTS recommends the use of two or more 3V, 5V or 8V belts and sheaves.

Acceptable Blower Drive Arrangement Options

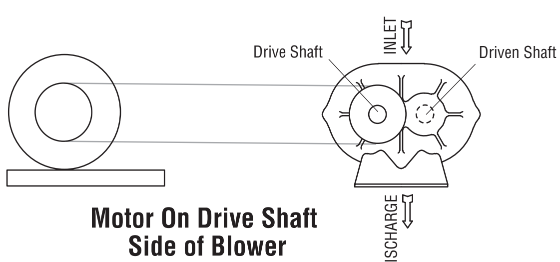
ACCEPTABLE



Motor On Inlet Side of Blower (Top Shaft)

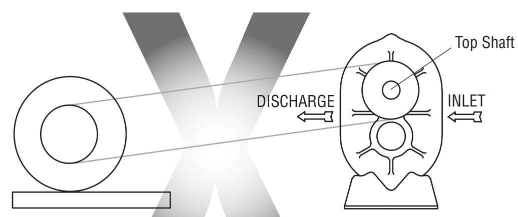


Motor On Inlet Side of Blower (Bottom Shaft)

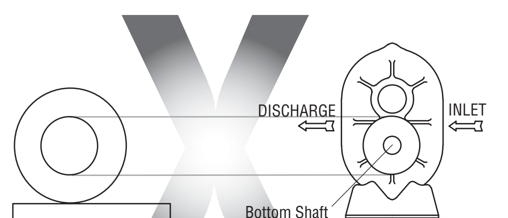


Motor On Drive Shaft Side of Blower

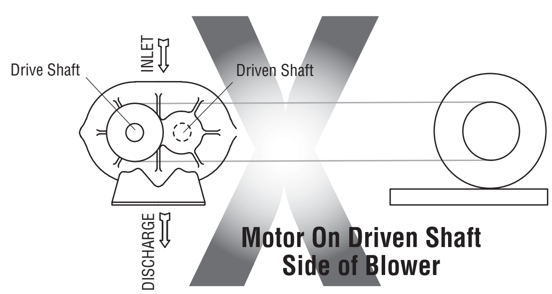
UNACCEPTABLE



Motor On Discharge Side of Blower (Top Shaft)

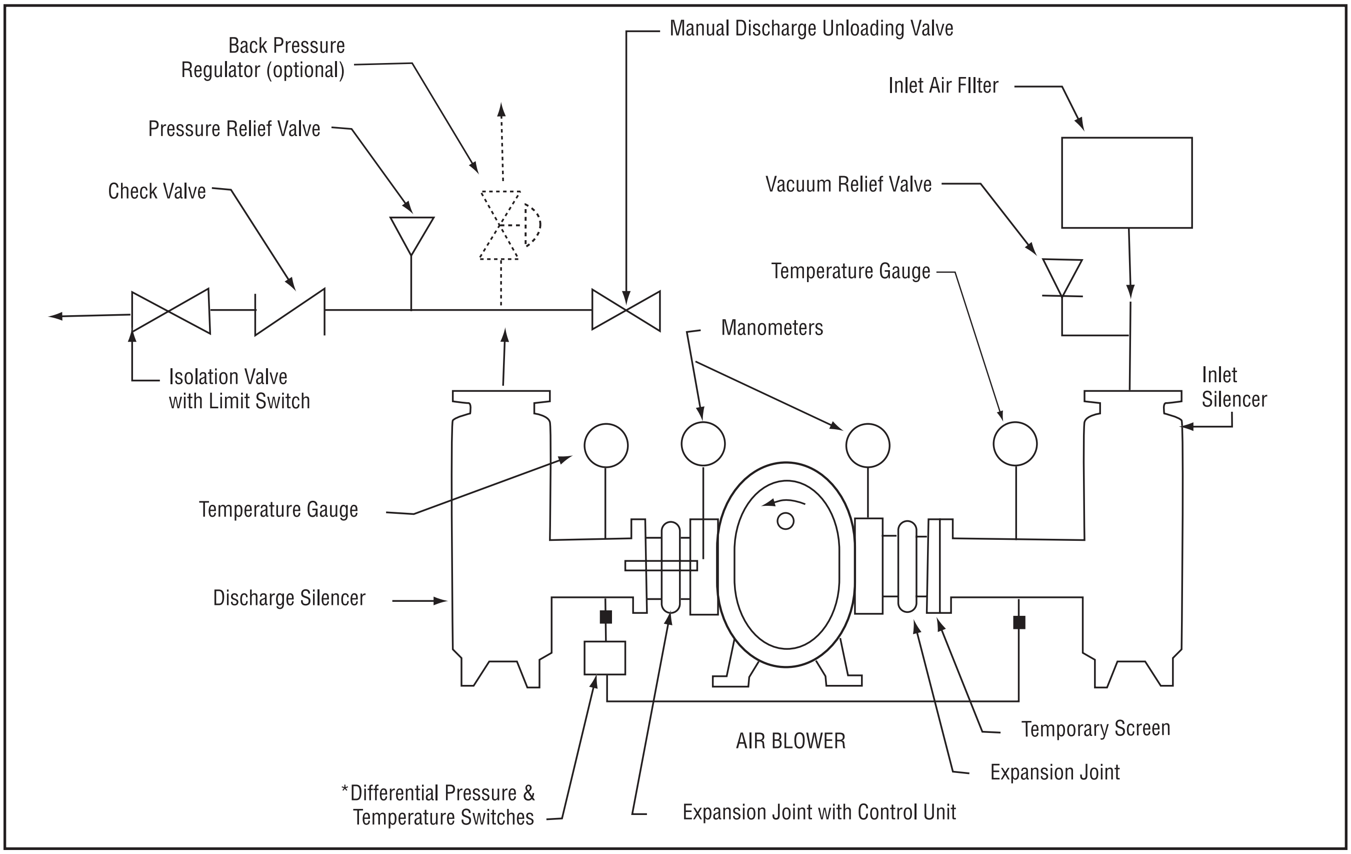


Motor On Discharge Side of Blower (Bottom Shaft)



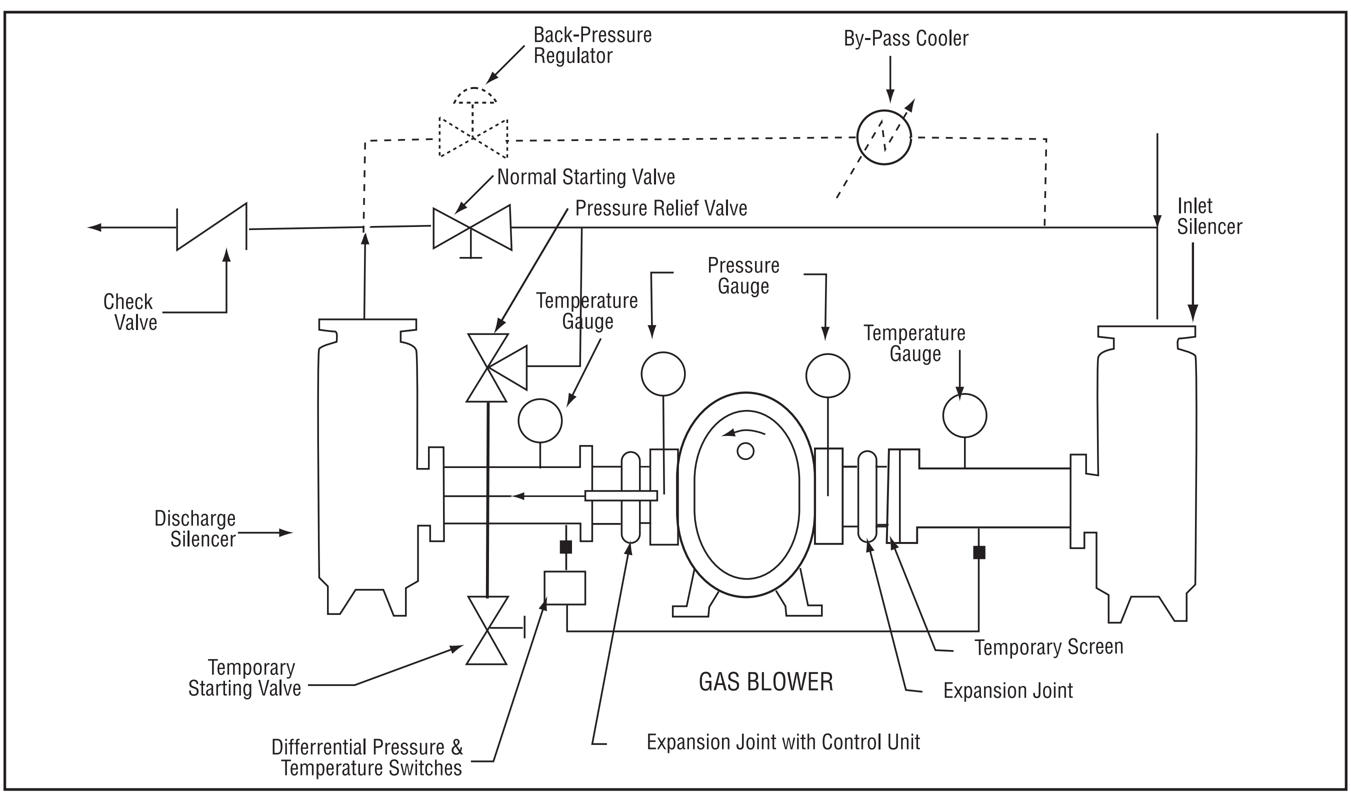
Motor On Driven Shaft Side of Blower

Figure 3a - Air Blower Installation with Accessories



Above are suggested locations for available accessories.

Figure 3b -Gas Blower Installation with Accessories



Above are suggested locations for available accessories.

Figure 4

Blower Orientation Conversion

Model	Reversible Rotation	Whispair™ Design
Universal RAI	yes	no
URAI-J Whispair™	no	yes
URAI-G	yes	no

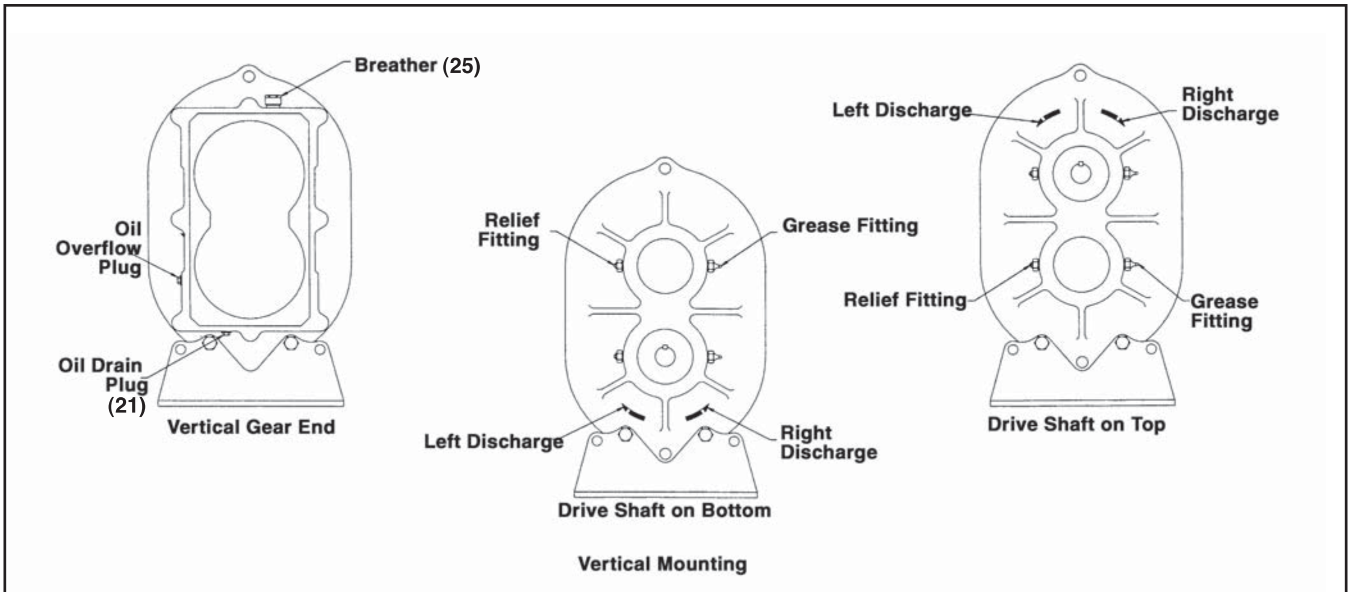
Special Note: WHISPAIR™ models are designed to operate with only one shaft rotation direction to take full advantage of the Whispair feature. Therefore, a WHISPAIR™ blower may be operated in the following combinations.

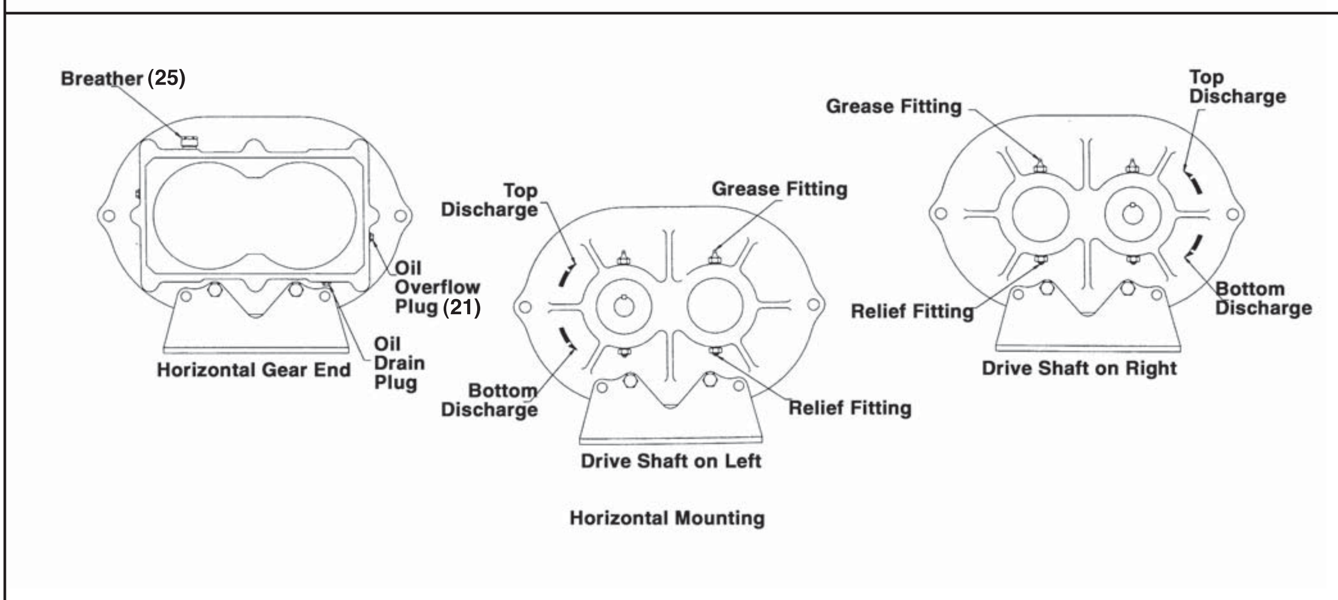
- CCW Rotation: Bottom Shaft; Right side discharge or a Left Shaft; Bottom discharge
- CCW Rotation: Top Shaft; Left side discharge or a Right Shaft; Top discharge

or

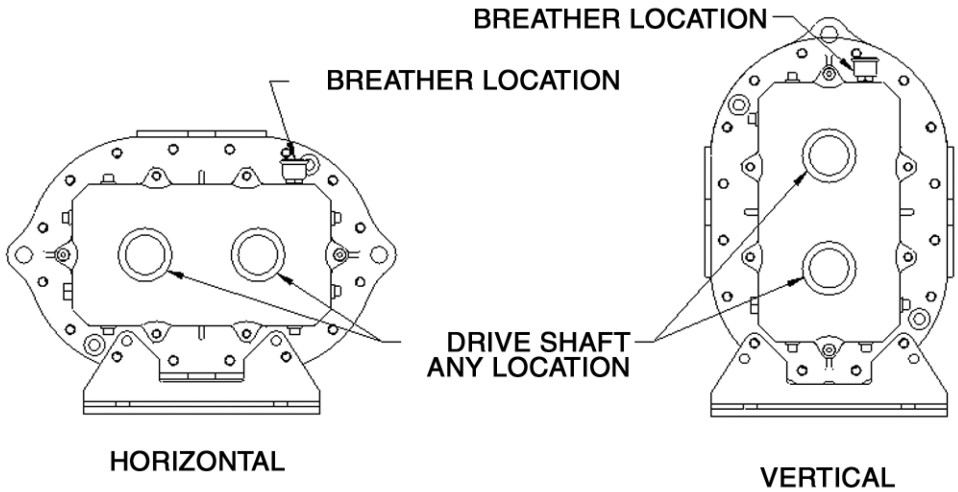
- CW Rotation: Bottom Shaft; Left side discharge or a Right Shaft Bottom discharge
- CW Rotation: Top Shaft; Right side discharge or a Left Shaft Top discharge

Blower Orientation and Lubrication Points: Grease Lubricated Drive End
Universal RAI series & URAI-G gas blowers





Drive End Breather Orientation for U-RAI series - DSL with Oil Lube



U-RAI DLS BREATHER ORIENTATION

REVISED DATE: 1/11/05

Table 1 - Universal RAI series, Universal URAI-DSI & URAI-G gas blower, Maximum Allowable Operating Conditions

Frame Size	Gear Diameter (Inch)	Speed RPM	Temp. Rise F°	(C°)	Delta Pressure PSI	(mbar)	Inlet Vacuum INHG	(mbar)
22	2.5	5275	225	(125)	12	(827)	15	(500)
24	2.5	5275	210	(117)	7	(483)	15	(500)
32	3.5	3600	240	(133)	15	1034	16	(539)
33	3.5	3600	225	(125)	12	(827)	15	(500)
36	3.5	3600	225	(125)	7	(483)	15	(500)
42	4.0	3600	240	(133)	15	(1034)	16	(539)
45	4.0	3600	225	(125)	10	(690)	16	(539)
47	4.0	3600	225	(125)	7	(483)	15	(500)
53	5.0	2850	225	(125)	15	(1034)	16	(539)
56	5.0	2850	225	(125)	13	(896)	16	(539)
59	5.0	2850	225	(125)	7	(483)	15	(500)
65	6.0	2350	250	(130)	15	(1034)	16	(539)
68	6.0	2350	240	(133)	14	(965)	16	(539)
615	6.0	2350	130	(72)	7	(483)	14	(472)
76	7.0	2050	250	(139)	15	(1034)	16	(539)
711	7.0	2050	225	(125)	10	(690)	16	(539)
718	7.0	2050	130	(72)	6	(414)	12	(405)

Table 2 - Recommended Oil Grades

Ambient Temperature °F (°C)	ISO Viscosity No.
Above 90° (32°)	320
32° to 90° (0° to 32°)	220
0° to 32° (-18° to 0°)	150
Below 0° (-18°)	100

URAI GAS Blower Oil and Grease Specifications

The specified oil should be ROOTS synthetic P/N 813-106- of the proper viscosity.

Table 3 - Approximate Oil Sump Capacities

These capacities are provided to assist in stocking the correct amount of oil. Exact sump capacities may differ slightly. See "Lubrication" section for proper filling instructions.

UNIVERSAL RAI, URAI-J, URAI-G

Frame Size	Gear End Capacity Fl. Oz. (Liters)	
	Vertical	Horizontal
22	3.4 (.1)	6.1 (.18)
24	3.4 (.1)	6.1 (.18)
32	8.5 (.25)	16.0 (.47)
33	8.5 (.25)	16.0 (.47)
36	8.5 (.25)	16.0 (.47)
42	12.7 (.37)	14.5 (.43)
45	12.7 (.37)	14.5 (.43)
47	12.7 (.37)	14.5 (.43)
53	16.0 (.47)	27.6 (.82)
56	16.0 (.47)	27.6 (.82)
59	16.0 (.47)	27.6 (.82)
65	28.3 (.84)	52.1 (1.54)
68	28.3 (.84)	52.1 (1.54)
615	28.3 (.84)	52.1 (1.54)
76	32.3 (.96)	59.5 (1.76)
711	32.3 (.96)	59.5 (1.76)
718	32.3 (.96)	59.5 (1.76)

See page 14 and 15 for illustration of vertical and horizontal configurations.

UNIVERSAL URAI series-DSL Splash Lubricated Drive End

Note that the gear end sump capacity is provided on the adjacent table.

Frame Size	Drive End Capacity Fl. Oz. (Liters)	
	Vertical	Horizontal
32	4.0 (.12)	6.5 (.19)
33	4.0 (.12)	6.5 (.19)
36	4.0 (.12)	6.5 (.19)
42	5.5 (.16)	10.8 (.32)
45	5.5 (.16)	10.8 (.32)
47	5.5 (.16)	10.8 (.32)
53	7.5 (.22)	14.8 (.44)
56	7.5 (.22)	14.8 (.44))
59	7.5 (.22)	14.8 (.44)
65	16 (0.47)	31 (0.91)
68	16 (0.47)	31 (0.91)
615	16 (0.47)	31 (0.91)

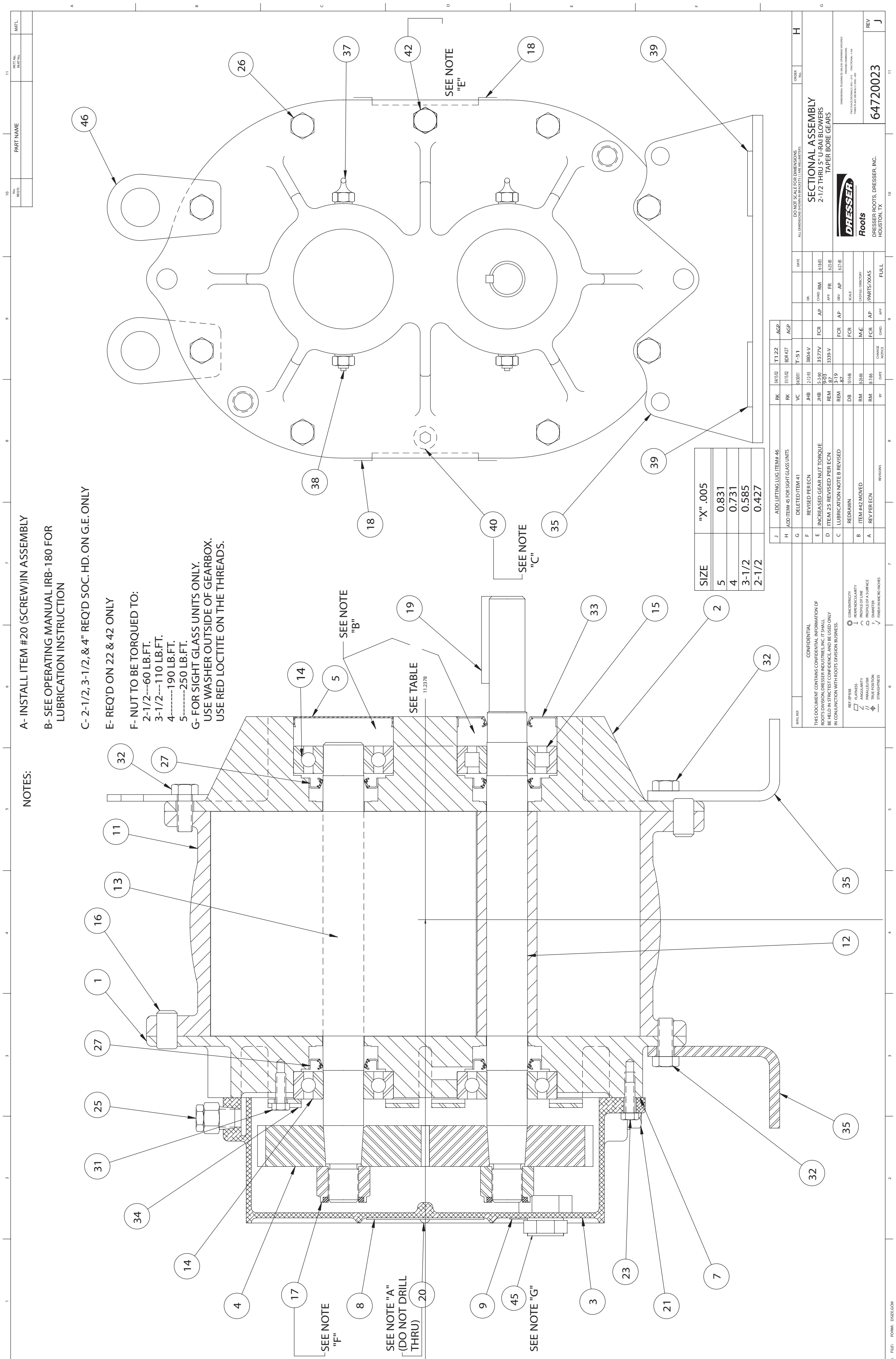
Table 4 - Universal URAI series with Grease Lubricated Drive End: Specified Bearing Greasing Intervals

Speed In RPM	Operating Hours Per Day		
	8	16	24
	Greasing Intervals in Weeks		
750-1000	7	4	2
1000-1500	5	2	1
1500-2000	4	2	1
2000-2500	3	1	1
2500-3000	2	1	1
3000 and up	1	1	1

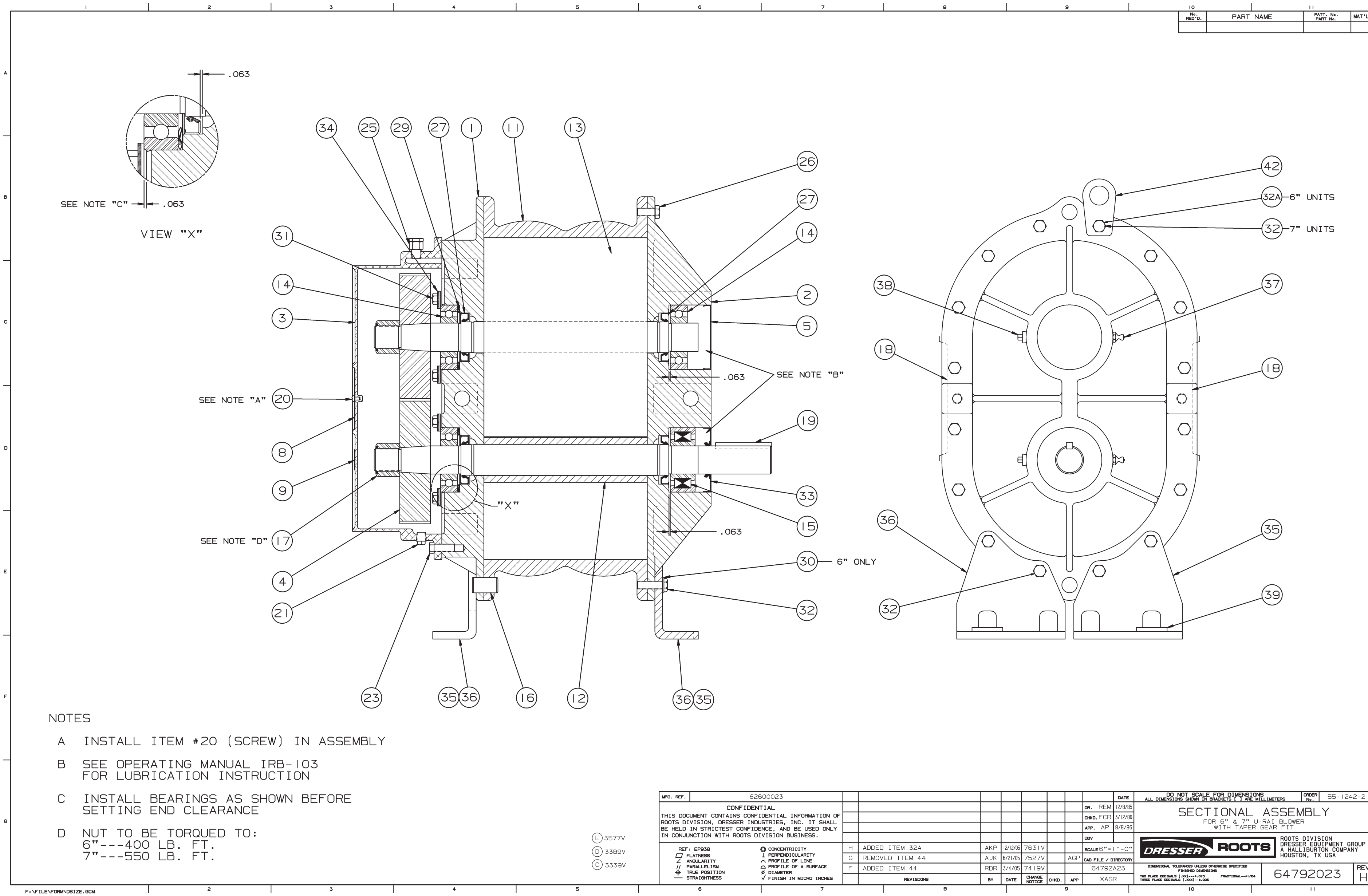
The specified grease for servicing drive end bearings of a Gas blower, use a NLGI #2 premium grade aluminum complex* grease, ROOTS P/N T20019001 with 300°F (149°C) service temperature and moisture resistance and good mechanical stability.

When servicing drive end bearings of Non Gas blower, use a NLGI #2 premium grade microgel grease with 250°F (121°C) service temperature and moisture resistance and good mechanical stability. ROOTS specifies Shell Darina EP NLGI Grade 2. Product Code 71522.

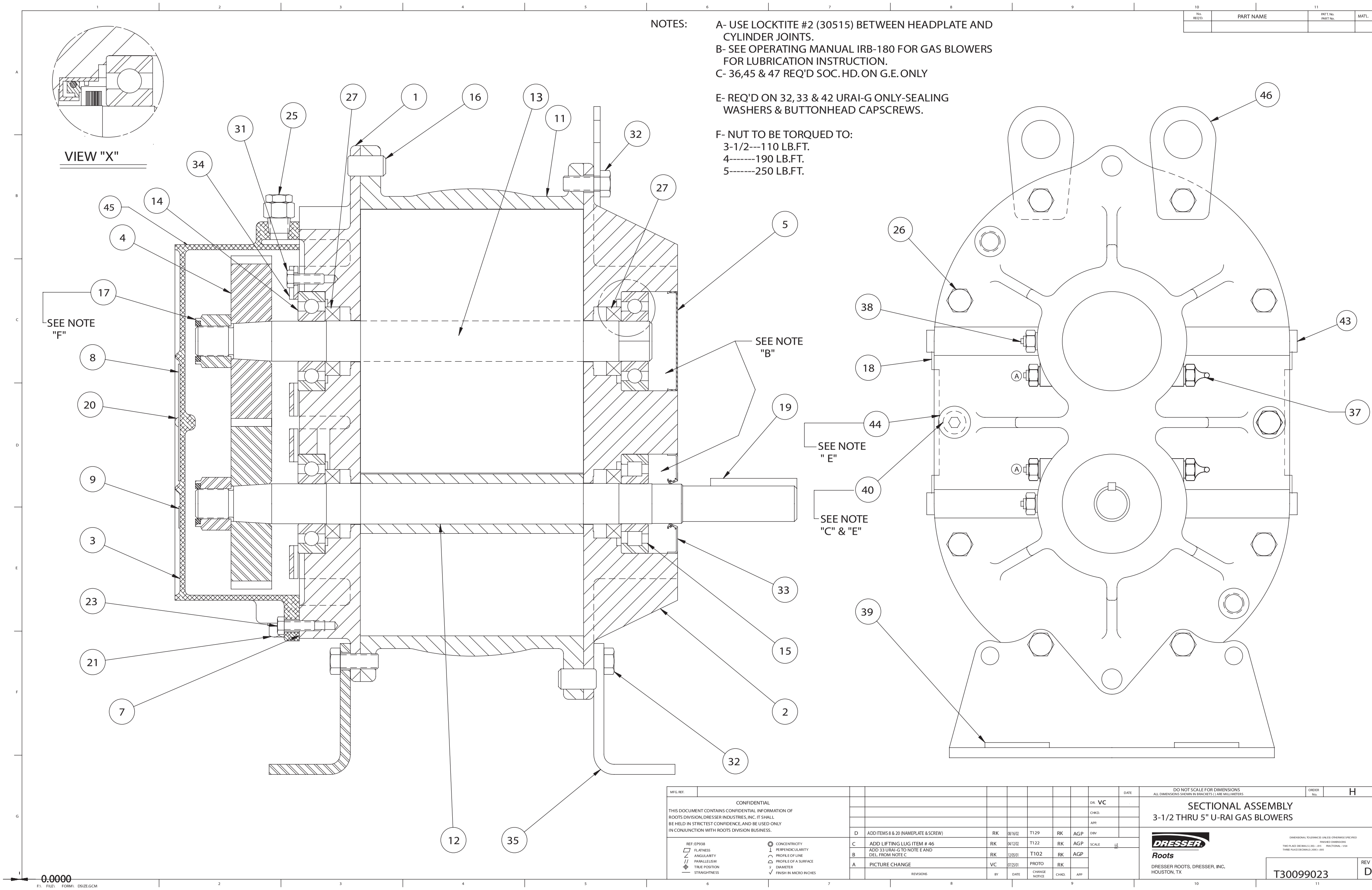
NOTE: Lithium based greases are not compatible with the ROOTS Synthetic grease used when assembling a Gas blower or the non-soap base grease used when assembling a standard URAI blower. Lithium based grease is not approved for any ROOTS blowers.



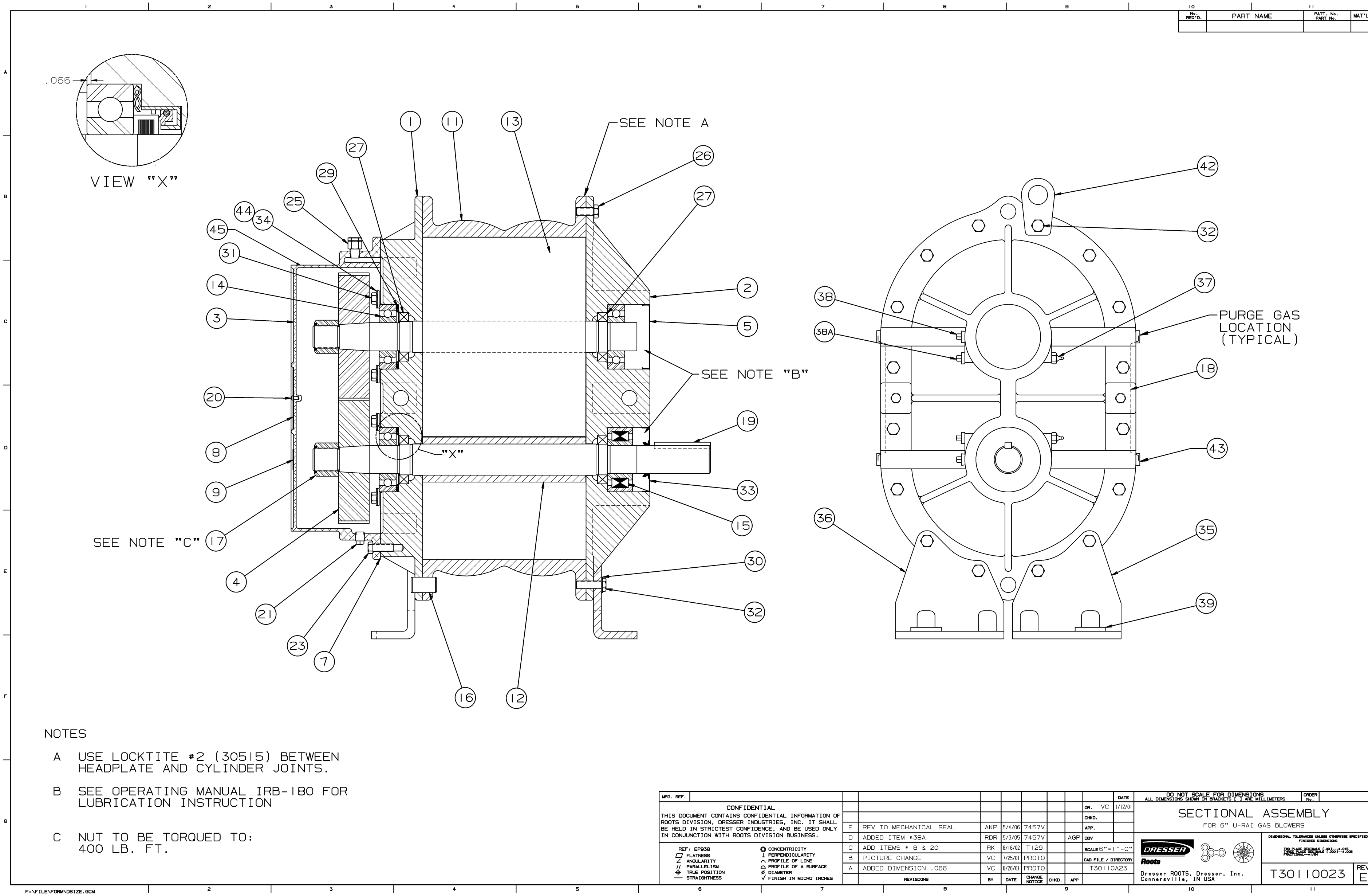
Assembly of UNIVERSAL RAI Series, Air Blowers, 2-1/2" Through 5" Gear Diameter



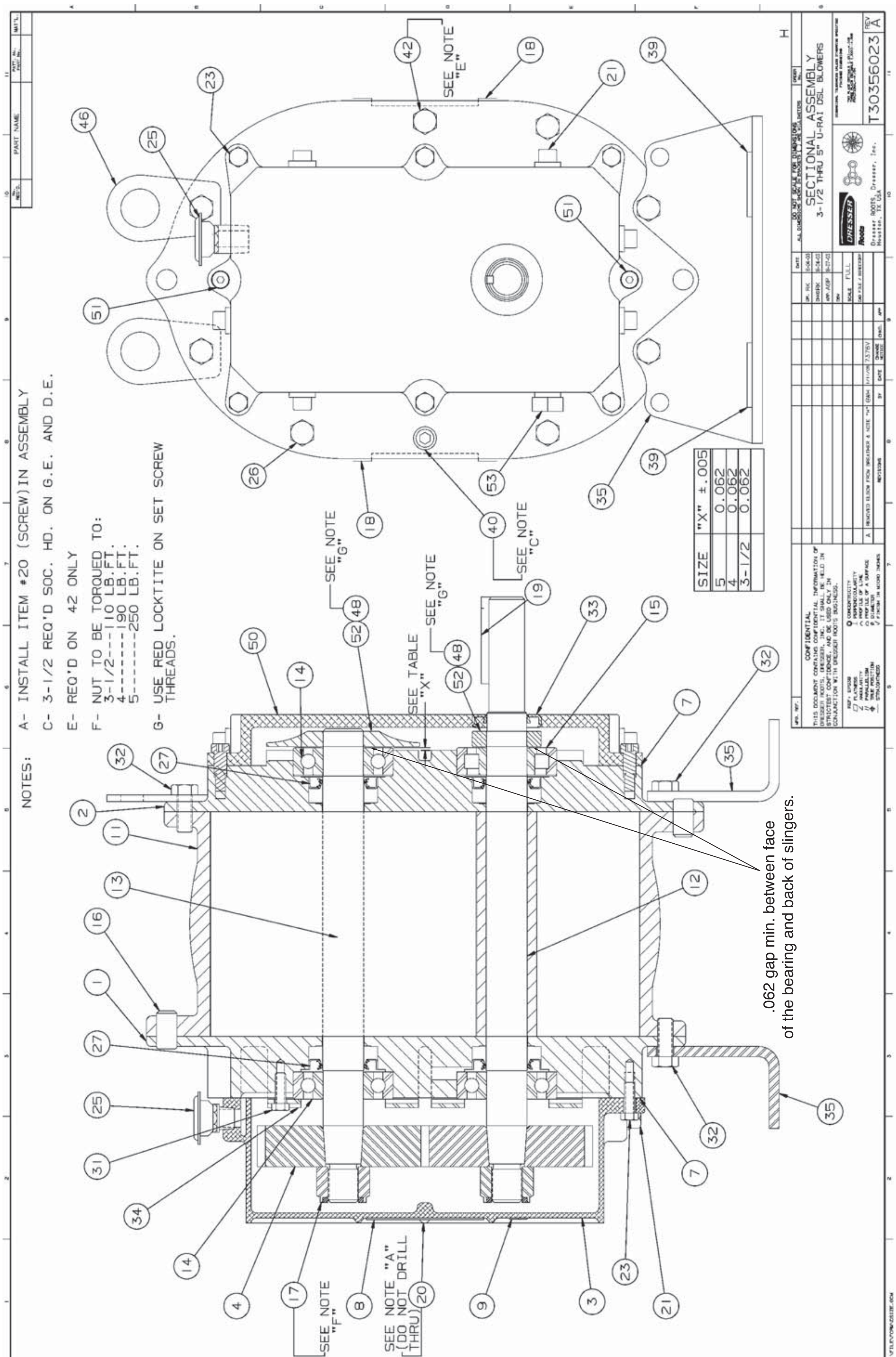
Assembly of UNIVERSAL RAI Blowers, 6" and 7" Diameter



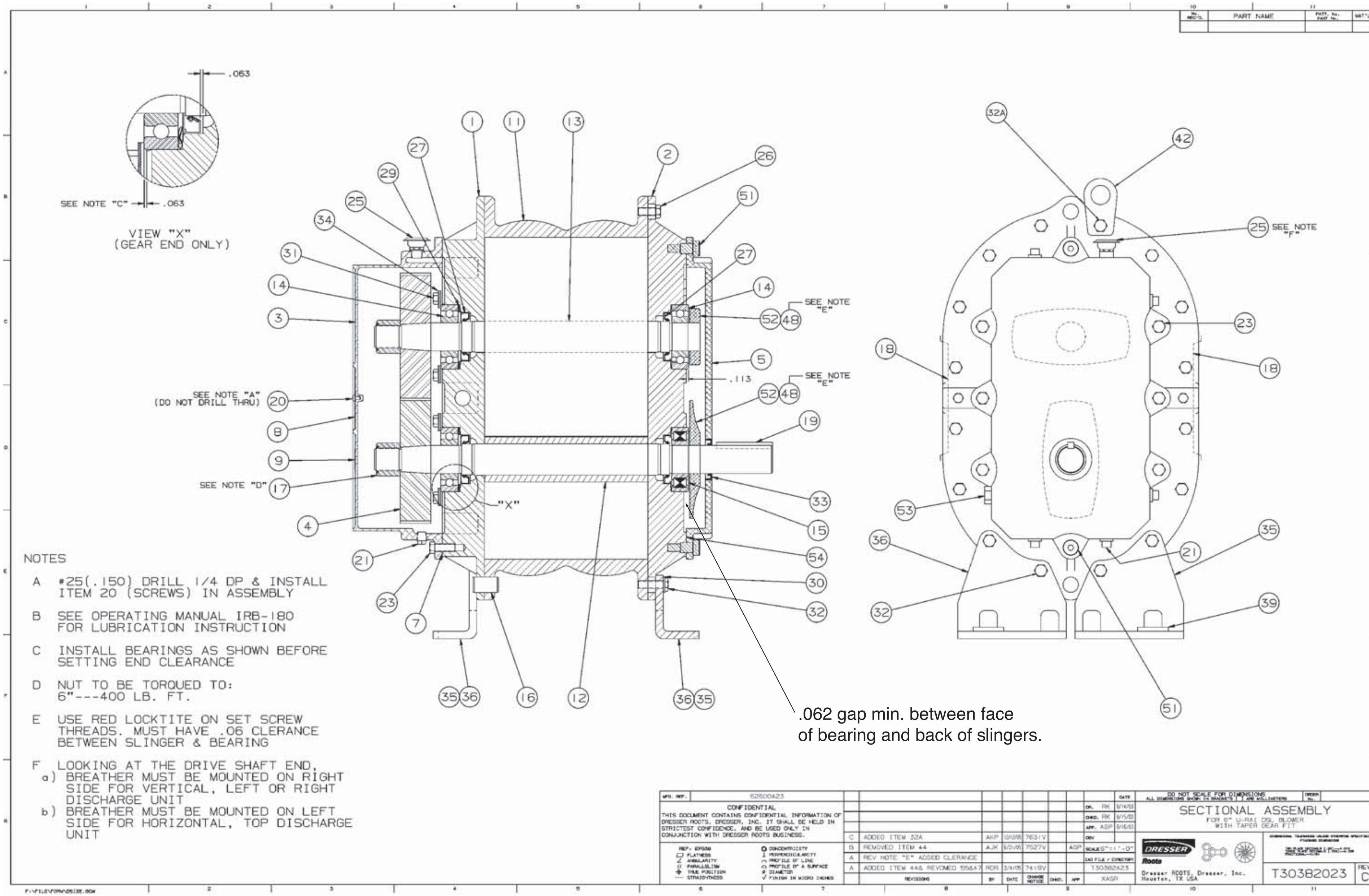
Assembly of UNIVERSAL RAI-G Series Gas Blowers, 3-1/2”Through 5” Gear Diameter



Assembly of UNIVERSAL RAI Series Gas Blowers, 6" Gear Diameter



Assembly of UNIVERSAL RAI Series - DSL with Splash Lubricated Drive End 3-5" Gear Diameter



Assembly of UNIVERSAL RAI Series - DSL with Splash Lubricated Drive End 6” Gear Diameter

Universal RAI Series Blowers Parts List 2-1/2" – 5" Gear Diameter

(Refer to drawing #64720023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
5	Cover-Blind (Plug Opening)	1
7	Gasket, Gear Box	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex	6
25	Breather (Plug Vent)	1
26	Screw, Hex	*
27	Seal, Lip Bearing	4
31	Screw, Hex, Nylock	4
32	Screw, Hex	6
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
37	Fitting, Grease	2
38	Fitting, Relief	2
39	Washer Mounting	4
40	Screw Socket	2
42	Screw Hex	2

*Quantities vary by blower.

Universal RAI Series Blowers Parts List 6" & 7" Gear Diameter

(Refer to drawing #64792023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
5	Cover-Blind (Plug Opening)	1
7	Gasket, Gear Box	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex Nylock	8
25	Breather (Plug Vent)	1
26	Screw, Hex	*
27	Seal, Lip Bearing	4
29	Washer, Spring Wavy	2
31	Screw, Hex, Nylock	4
32	Screw, Hex	10
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
37	Fitting, Grease	2
38	Fitting, Relief	2
39	Washer Mounting	4

*Quantities vary by blower.

Universal RAI-DSL Series Blowers Parts List 3-1/2" – 5" Gear Diameter

(Refer to drawing #T30356023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
7	Gasket, Gear Box, DE Cover	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex	6
25	Breather (Plug Vent)	1
26	Screw, Hex	*
27	Seal, Lip Bearing	4
31	Screw, Hex, Nylock	4
32	Screw, Hex	6
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
39	Washer Mounting	4
40	Screw Socket	2
42	Screw Hex	2
48	DE Oil Slinger Set Screw	4
50	Drive End Cover	1
52	Drive End Oil Slinger	2
53	Oil Sight Glass	2

*Quantities vary by blower.

Universal RAI®-DSL Series Blowers Parts List 6" Gear Diameter

(Refer to drawing #T30382023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
7	Gasket, Gear Box	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex Nylock	8
25	Breather (Plug Vent)	1
26	Screw, Hex	*
27	Seal, Lip Bearing	4
31	Screw, Hex, Nylock	4
32	Screw, Hex	10
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
39	Washer Mounting	4
48	DE Oil Slinger Set Screw	4
50	Drive End Cover	1
52	Drive End Oil Slinger	2
53	Oil Sight Glass	2

*Quantities vary by blower.

Universal RAI Series Gas Blowers Parts List
3-1/2" & 5" Gear Diameter
(Refer to drawing #T30099023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
5	Cover-Blind (Plug Opening)	1
7	Gasket, Gear Box	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex	8
25	Breather (Plug Vent)	1
26	Screw, Hex	14*
27	Seal, Bearing	4
31	Screw, Hex	4
32	Screw, Hex	4
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
37	Fitting, Grease	2
38	Fitting, Relief	2
39	Washer Mounting	4
40	Screw Socket	2
42	Screw Hex	2

*Quantities vary by blower.

Specified Lubricants
ROOTS Synthetic Oil: ISO-VG-220 Grade

	Part Number
Quart	813-106-001
Gallon	813-106-002
Case (12 qts)	813-106-008

ROOTS Synthetic Oil: ISO-VG-320 Grade

	Part Number
Quart	813-106-004
Gallon	813-106-005
Case (12 qts)	813-106-007

ROOTS Synthetic Grease: NLGI #2

	Part Number
14.5 oz. Tube	T200019-001
5 Gallon Pail	T200019-003
Case (30 tubes)	T200019-002

Universal RAI Series Gas Blowers Parts List
6" Gear Diameter
(Refer to drawing #T3011023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
5	Cover-Blind (Plug Opening)	1
7	Gasket, Gear Box	1
7*	Gasket DE Cover	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex Nylock	8
25	Breather (Plug Vent)	1
26	Screw, Hex	14**
27	Seal, Bearing	4
31	Screw, Hex	4
32	Screw, Hex	10
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
37	Fitting, Grease	2
38	Fitting, Relief	2
39	Washer Mounting	4
40	Screw Socket	2
42	Screw Hex	2
43	Plug	8
51	Shoulder Bolt	2
53	Oil Sight Glass	2

*DE cover gasket is not the same as the gasket used on the GE. You must specify the gasket required when ordering.
**Quantities vary by blower.

UNIVERSAL RAI (URAI) AIR BLOWERS

URAI AIR BLOWERS (with Grease Lubricated Drive End)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
65102020	22	1" NPT	0.625"	32
65103020	24	2" NPT	0.625"	43
71048020	32	1.25" NPT	0.750"	69
65105020	33	2" NPT	0.750"	74
65106020	36	2.5" NPT	0.750"	102
65108020	42	1.5" NPT	0.875"	88
65109020	45	2.5" NPT	0.875"	109
65110020	47	3" NPT	0.875"	128
65112020	53	2.5" NPT	1.125"	143
65113020	56	4" NPT	1.125"	170
65114020	59	4" NPT	1.125"	204
65116020	65	3" NPT	1.375"	245
65117020	68	5" NPT	1.375"	285
65118020	615	6" Flange	1.375"	425
65120020	76	4" NPT	1.562"	400
65121020	711	6" Flange	1.562"	530
65122020	718	8" Flange	1.562"	650

Refer to Specification Sheet S-12K84

URAI-DSL AIR BLOWERS (with Dual Splash Lubrication *DSL*)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
T30378020	32	1.25" NPT	0.750"	72
T30379020	33	2" NPT	0.750"	77
T30380020	36	2.5" NPT	0.750"	105
T30352020	42	1.5" NPT	0.875"	92
T30353020	45	2.5" NPT	0.875"	113
T30354020	47	3" NPT	0.875"	132
T30359020	53	2.5" NPT	1.125"	148
T30360020	56	4" NPT	1.125"	175
T30361020	59	4" NPT	1.125"	209
T30384020	65	3" NPT	1.375"	250
T30385020	68	5" NPT	1.375"	290
T30386020	615	6" Flange	1.375"	430

Refer to Specification Sheet S-27S03

Universal RAI air blowers include detachable mounting feet which permit vertical or horizontal installation. The units are center timed for rotation in either direction. The bearings on the URAI are grease lubricated on the drive end and splash lubricated on the gear end. The URAI-DSL is splash lubricated on BOTH ends.

UNIVERSAL RAI (URAI) GAS BLOWERS

URAI-G™ GAS BLOWERS (with Grease Lubricated Drive End)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
710480G0	32	1.25" NPT	0.750"	69
651050G0	33	2" NPT	0.750	74
651060G0	36	2.5" NPT	0.750	102
651080G0	42	1.5" NPT	0.875"	88
651090G0	45	2.5" NPT	0.875	109
651100G0	47	3" NPT	0.875	128
651120G0	53	2.5" NPT	1.125"	143
651130G0	56	4" NPT	1.125	170
651140G0	59	4" NPT	1.125	204
651160G0	65	3" NPT	1.375"	245
651170G0	68	5" NPT	1.375	285
651180G0	615	6" NPT	1.375	425

Refer to Specification Sheet S-60A01

Universal RAI-G™ gas blowers include detachable mounting feet which permit vertical or horizontal installation. **Feet are different for vertical and horizontal mounting**.

The units are center timed for rotation in either direction. The bearings on the Universal RAI-GTM are grease lubricated on the drive end and splash lubricated on the gear end. ROOTS Synthetic lubricant is recommended.

UNIVERSAL RAI (URAI-J) WHISPAIR AIR BLOWERS

URAI-J WHISPAIR AIR BLOWERS (with Grease Lubed Drive End)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
74065020	33J	2" NPT	0.750"	84
74086020	36J	2.5" NPT	0.750	112
74066020	45J	2.5" NPT	0.875"	119
74087020	47J	3" NPT	0.875	138
74067020	56J	4" NPT	1.125"	180

Refer to Specification Sheet S-33A93

URAI-J-DSL WHISPAIR AIR BLOWERS (with Dual Splash Lubrication *DSL*)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
T30417020	33J	2" NPT	0.750"	87
T30418020	36J	2.5" NPT	0.750	115
T30410020	45J	2.5" NPT	0.875"	122
T30412020	47J	3" NPT	0.875	141
T30415020	56J	4" NPT	1.125"	185

Refer to Specification Sheet S-30S03

URAI-J METRIC WHISPAIR AIR BLOWERS (with Grease Lubed Drive End)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
TBD	33J	2" BSP	19 mm	84
740860M0	36J	2.5" BSP	19 mm	112
TBD	45J	2.5" BSP	24 mm	119
TBD	47J	3" BSP	24 mm	138
TBD	56J	4" BSP	28 mm	180

URAI-J-DSL METRIC WHISPAIR AIR BLOWERS (with Dual Splash Lubrication *DSL*)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
TBD	33J	2" BSP	19 mm	87
T304660M0	36J	2.5" BSP	19 mm	115
TBD	45J	2.5" BSP	24 mm	122
T304550M0	47J	3" BSP	24 mm	141
TBD	56J	4" BSP	28 mm	185

Universal RAI-J air blowers incorporate the patented WhispairTM design in addition to the same features as the original URAI blowers. The URAI-J's are center timed, however the WhispairTM benefits can only be realized when the jet is located in the discharge position.

UNIVERSAL RAI METRIC (URAI-M) AIR BLOWERS

NOTE: METRIC URAI product has metric shaft diameter and connection sizes

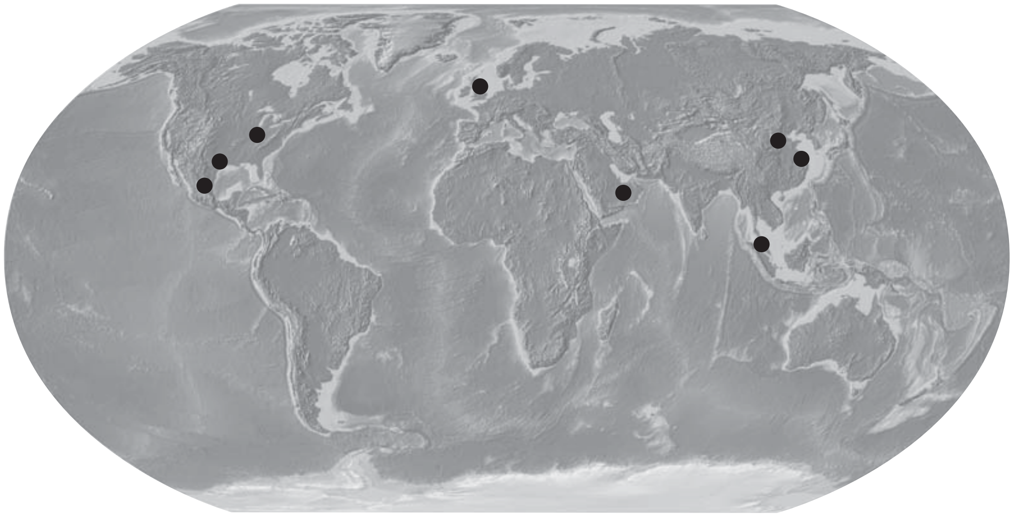
URAI-METRIC AIR BLOWERS (with Grease Lubricated Drive End)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
651020M0	22	1" BSP	16 mm	32
651030M0	24	2" BSP	16 mm	43
710480M0	32	1 1/4" BSP	19 mm	69
651050M0	33	2" BSP	19 mm	74
651060M0	36	2 1/2" BSP	19 mm	102
651080M0	42	1 1/2" BSP	24 mm	88
651090M0	45	2 1/2" BSP	24 mm	109
651100M0	47	3" BSP	24 mm	128
651120M0	53	2 1/2" BSP	28 mm	143
651130M0	56	4" BSP	28 mm	170
651140M0	59	4" BSP	28 mm	204
T30392060	65	3" BSP	32 mm	245
T30394060	68	5" BSP	32 mm	285
T30390060	615	150 NP10	32 mm	425
T30396060	76	4" BSP	38 mm	400
T30398060	711	150 NP10	38 mm	530
T30400060	718	200 NP10	38 mm	650

URAI-DSL-METRIC AIR BLOWERS (with Dual Splash Lubrication *DSL*)

BOM # *	FRAME SIZE	INLET/DISCH CONN.	SHAFT DIAMETER	BARE WEIGHT
T30463060	32	1 1/4" BSP	19 mm	72
T30464060	33	2" BSP	19 mm	77
T30465060	36	2 1/2" BSP	19 mm	105
T30451060	42	1 1/2" BSP	24 mm	92
T30452060	45	2 1/2" BSP	24 mm	113
T30453060	47	3" BSP	24 mm	132
T30459060	53	2 1/2" BSP	28 mm	148
T30460060	56	4" BSP	28 mm	175
T30461060	59	4" BSP	28 mm	209
T30472060	65	3" BSP	32 mm	250
T30473060	68	5" BSP	32 mm	290
T30474060	615	150 NP 10	32 mm	430

Universal RAI air blowers include detachable mounting feet which permit vertical or horizontal installation. The units are center timed for rotation in either direction. The bearings on the URAI are grease lubricated on the drive end and splash lubricated on the gear end. The URAI-DSL is splash lubricated on BOTH ends.



Dresser Roots Sales

Houston, TX • Toll Free: 1-877-363-ROOT(S) (7668) • Direct: 832-590-2600

Connersville, IN • Toll Free: 1-877-442-7910 • Direct: 765-827-9305

Huddersfield, UK • Ph: +44 (0) 1484 422 222

Mexico City, Mexico • Ph: +52 55 5889 5811

Dubai, UAE • Ph: +971 4-8830831

Kuala Lumpur, Malaysia • Ph: +60 3 2163 0480

Beijing, China • Ph: +86 10 8486 2440

Dresser Roots Factory Service & Repair

Houston, TX • Ph: 713-896-4810

Connersville, IN • Ph: 765-827-9200

Huddersfield, UK • Ph: +44 (0) 1484 487 669

Mexico City, Mexico • Ph: +52 55 5889 5811

Dubai, UAE • Ph: +971 4-8830831

Shanghai, China • Ph: +86 21 5858 7638

DRESSER Roots

Headquarters
16240 Port Northwest Drive
Houston, TX 77041
Toll Free (US): 1-877-363-7668
Ph: 832-590-2305
Toll Free Fax: 1-877-357-7238
Fx: 832-590-2326

Connersville Operations
900 West Mount Street
Connersville, IN 47331
Ph: 765-827-9200
Fx: 765-827-9266

Huddersfield Operations
PO Box B7
Off St. Andrews Rd
Turnbridge, Huddersfield
England HD1 6RB
Ph: +44 (0) 1484 422 222
Fx: +44 (0) 1484 423 429

ISRB-2002 rev.0207

website: www.rootsblower.com • US email: roots@dresser.com • UK email: dmd_roots@dresser.co.uk

BECKER

Betriebsanleitung
Operating Instructions
Instructions de service
Istruzioni d'uso
Handleiding
Instrucciones para el manejo
Manual de instruções
Naudojimosi instrukcija
Kasutusjuhend
Lietošanas instrukcija
Driftsinstruks
Driftsinstruktioner
Käyttöohje
Driftsvejledning
Instrukcja obsługi
Kezelési útmutató
Návod k obsluze
Navodilo za uporabo
Návod na obsluhu
Upute za rad
Manual de operatii
Treoracha Oibriúcháin
Οδηγίες χρήσης
El Kitabi
Инструкции за експлоатация
Инструкция по эксплуатации
取扱説明書
사용설명서
使用说明书

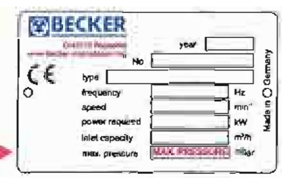
DTLF 2.200
DTLF 2.250
DTLF 2.360

2006/42/EG

DIN EN ISO 14001:2005

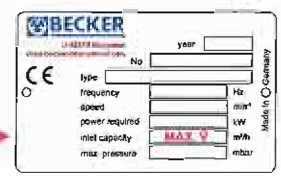
DIN EN ISO 9001 001922 QM

MAX.
PRESSURE



mbar

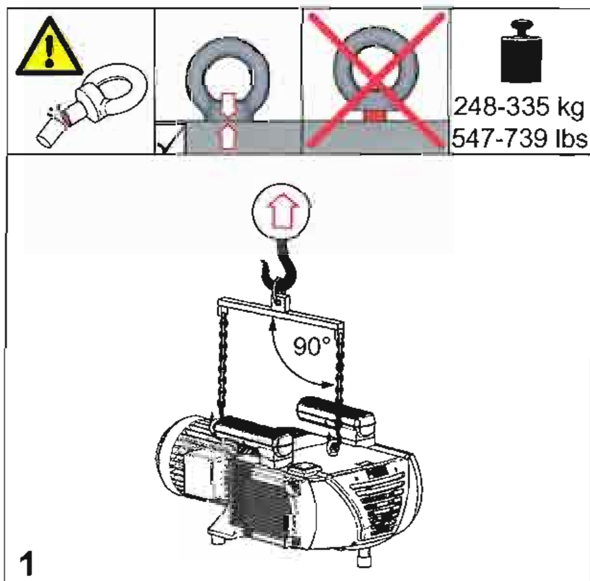
MAX.

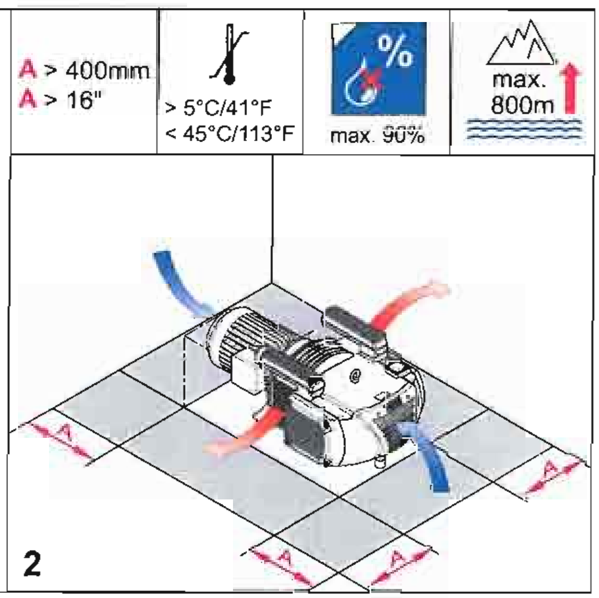


m³/h

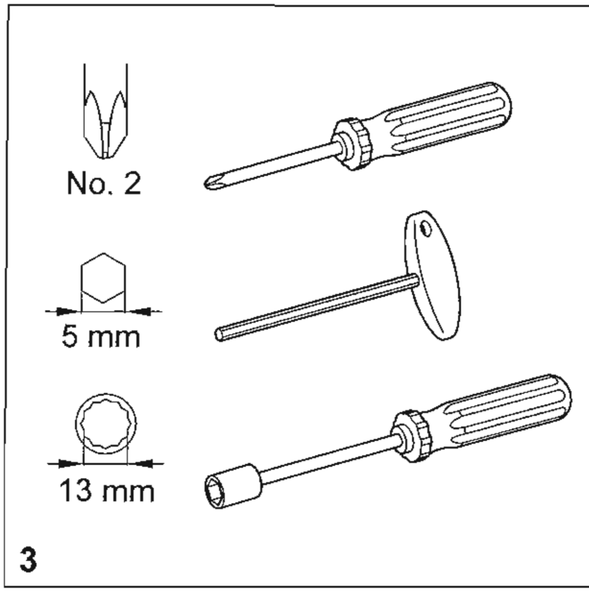
DIN EN ISO 3744

L_{pA} = **79-84** dB(A) - 50Hz
L_{pA} = **80-85** dB(A) - 60Hz
K_{pA} = 3 dB(A)

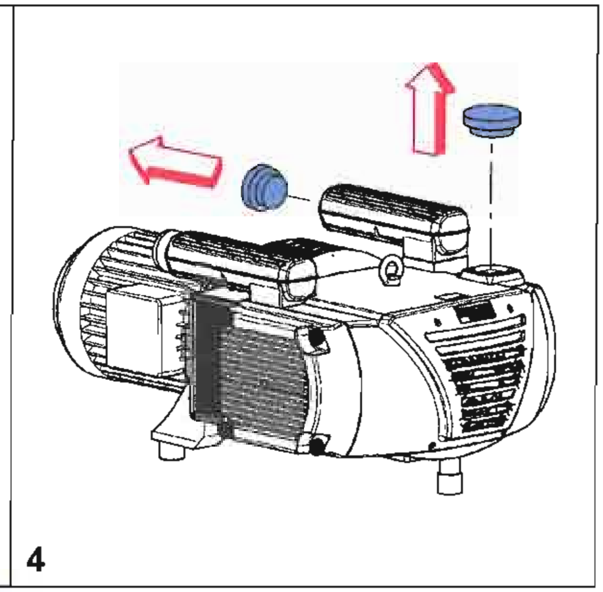




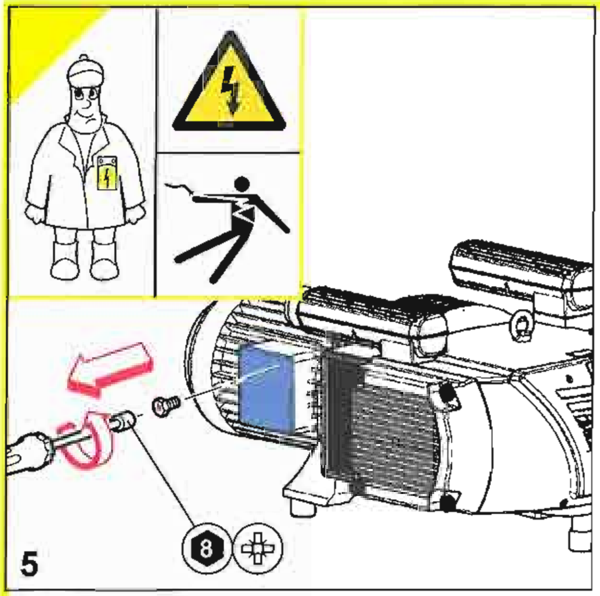
28100052201 01/15


No. 2
5 mm
13 mm

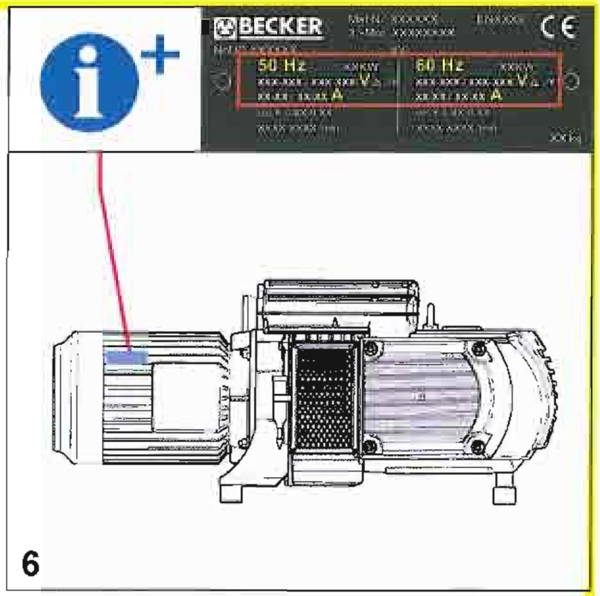
3



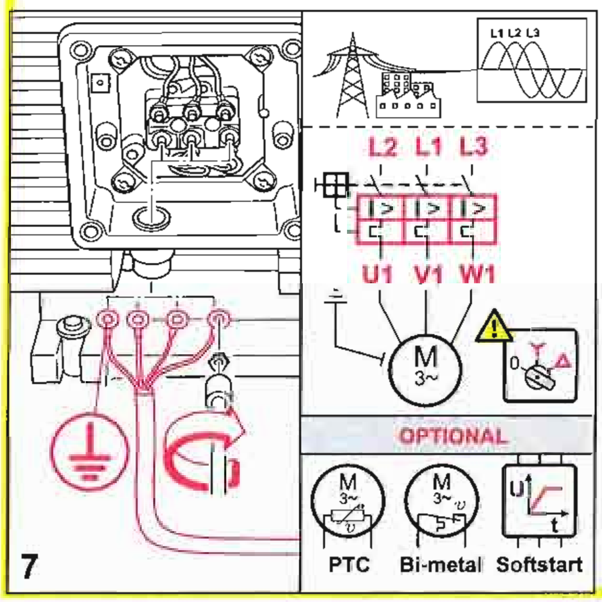
4


8

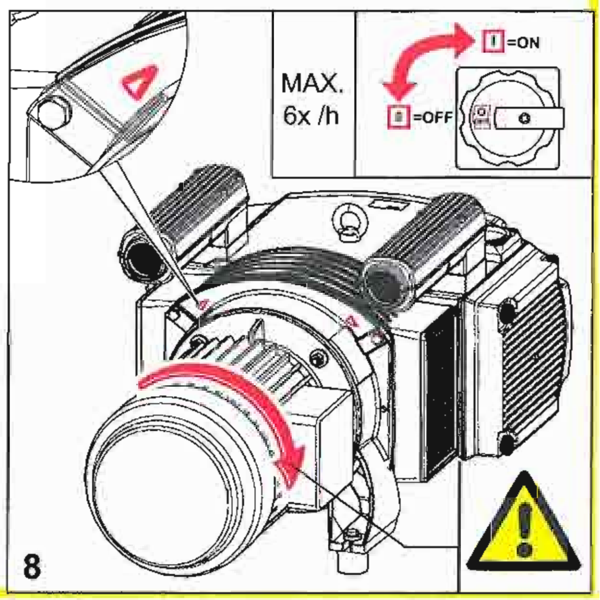
5


BECKER
CE
50 Hz
60 Hz

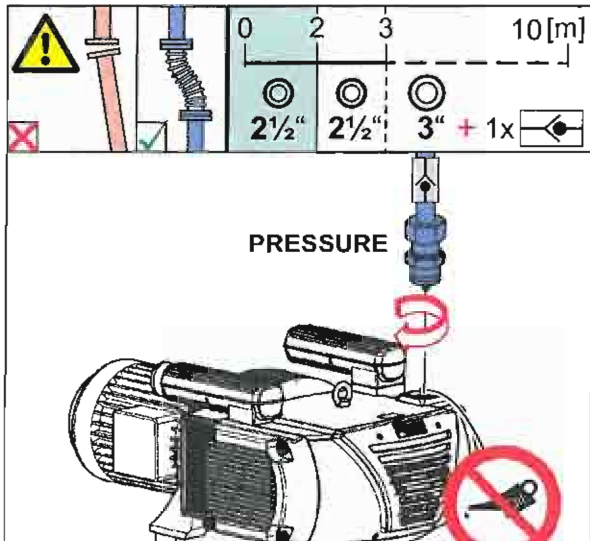
6


L1 L2 L3
L2 L1 L3
I> I> I>
U1 V1 W1
M
3~
0
OPTIONAL
PTC
Bi-metal
Softstart

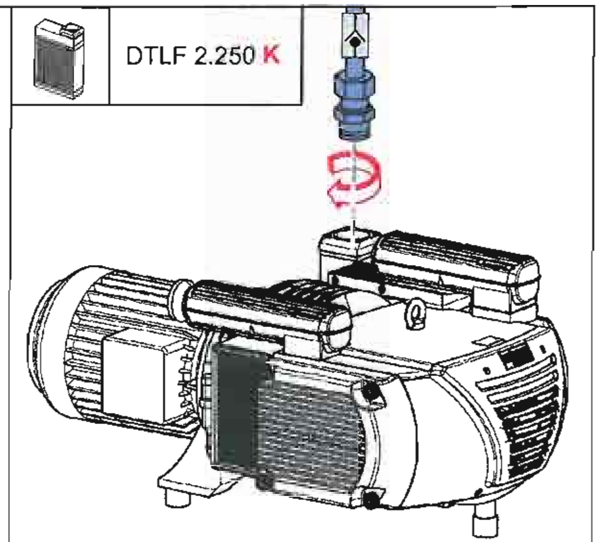
7


MAX.
6x /h
I =ON
0 =OFF

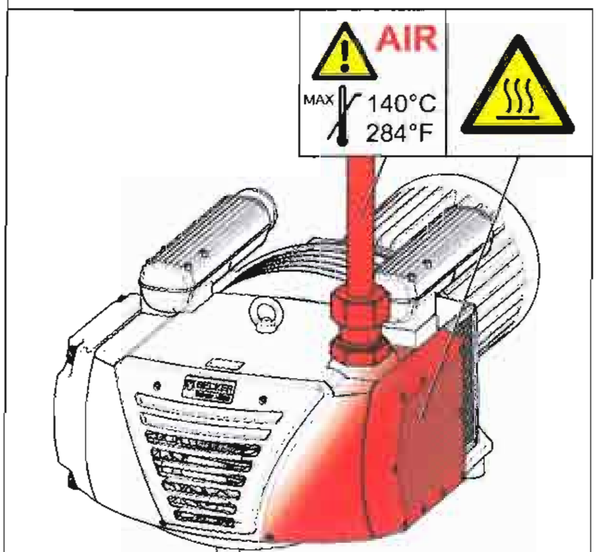
8



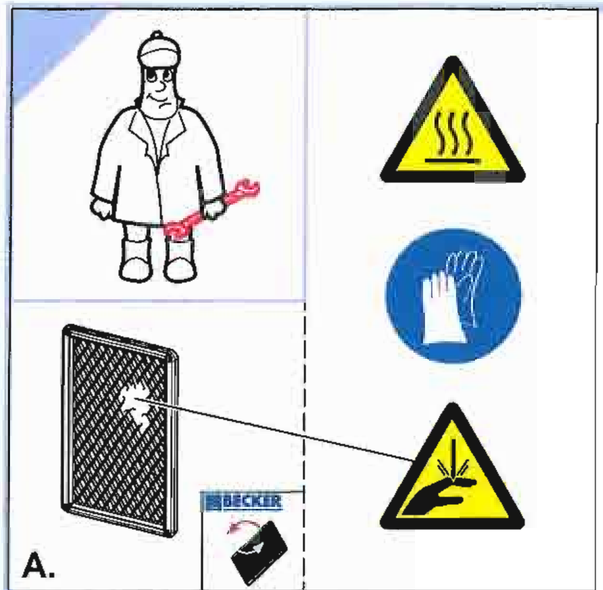
9

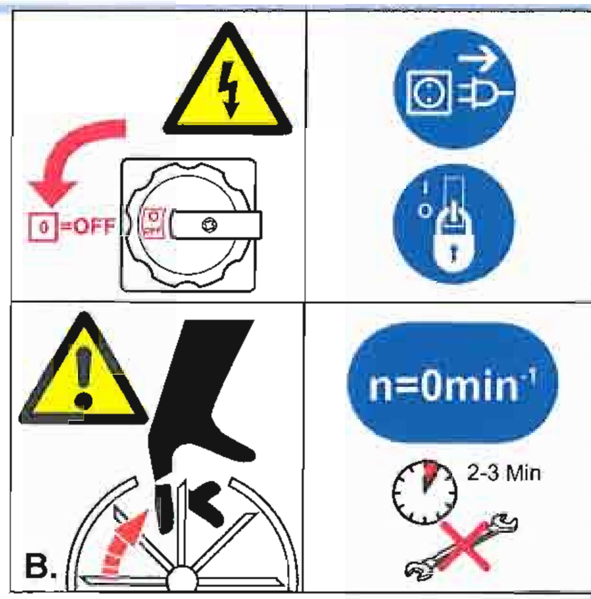


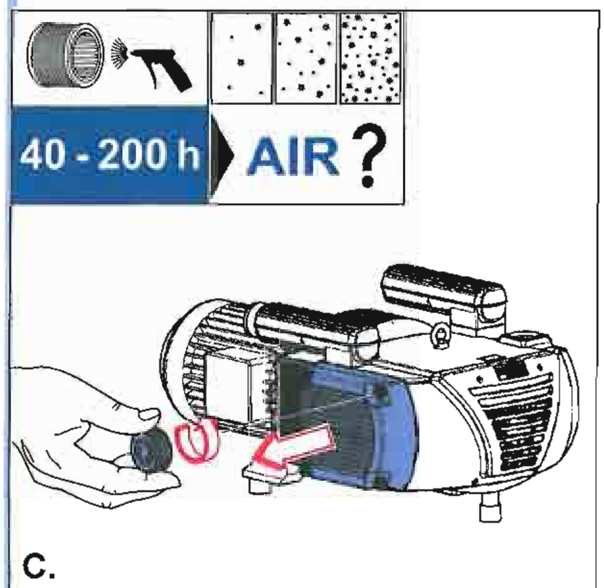
10

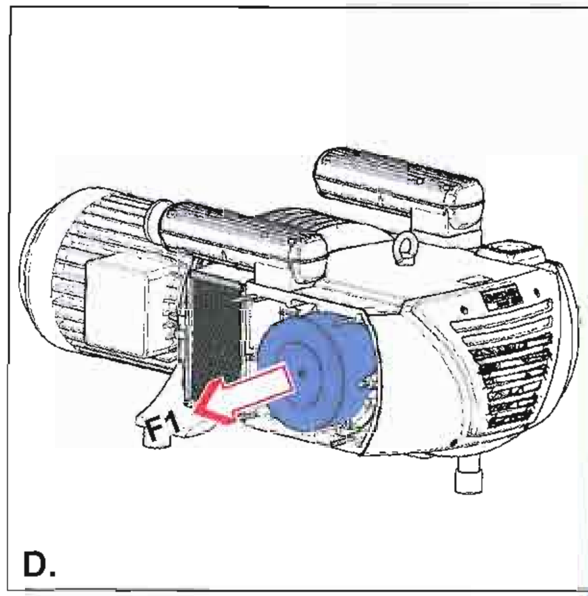


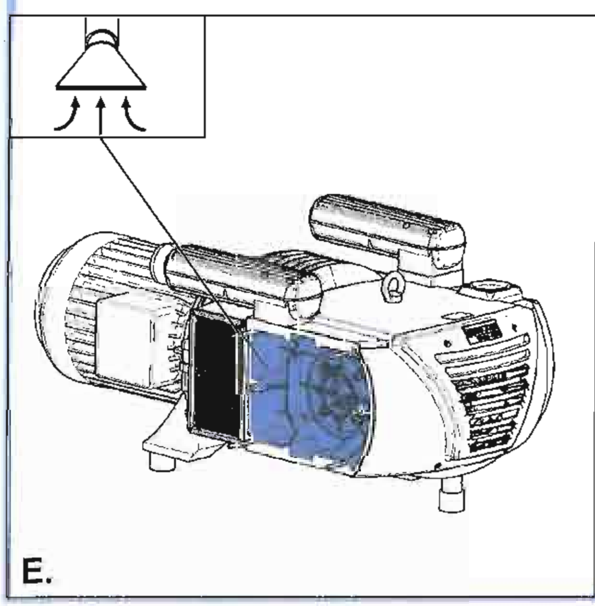
11

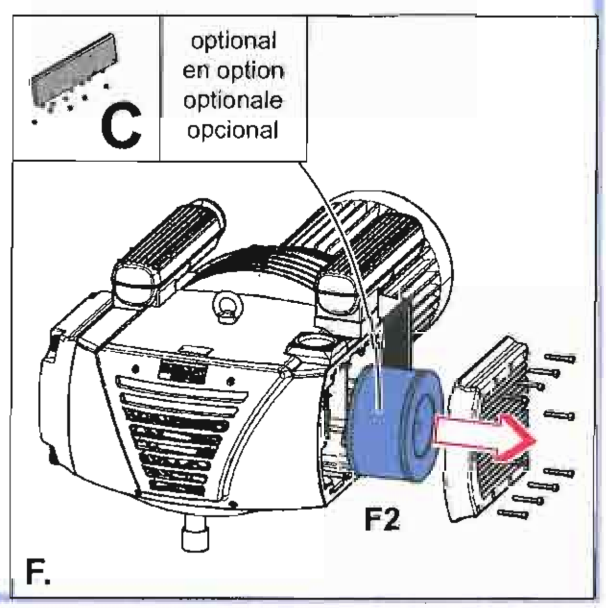

BECKER
A.

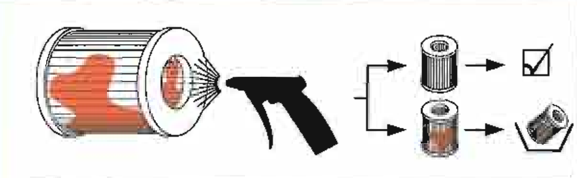

0 =OFF
n=0min-1
2-3 Min
B.

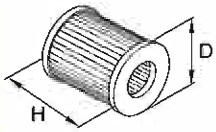

40 - 200 h
AIR ?
C.


F1
D.


E.


C
optional
en option
optionale
opcional
F2
F.

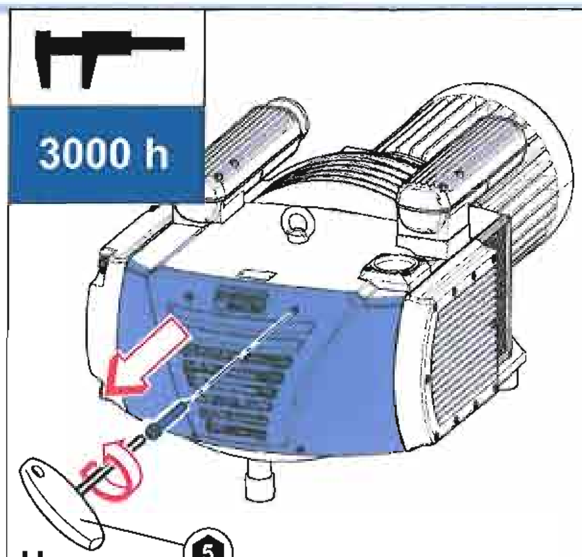




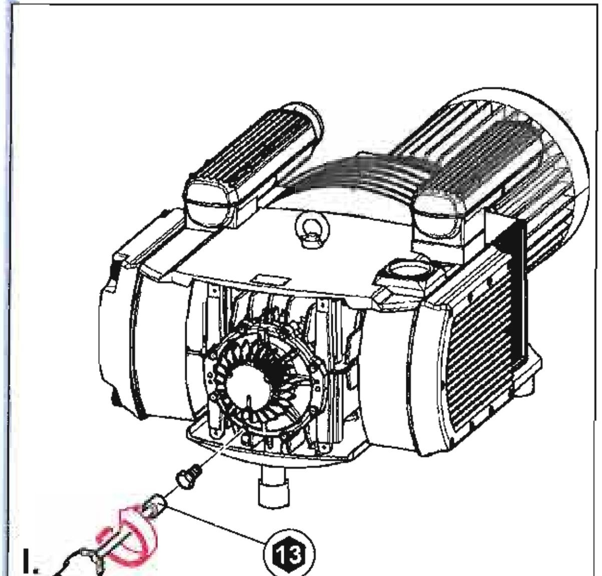
F1: D: 218 mm
H: 122 mm
No.: **90951200000**

F2: D: 211 mm
H: 87 mm
No.: **90954100000**

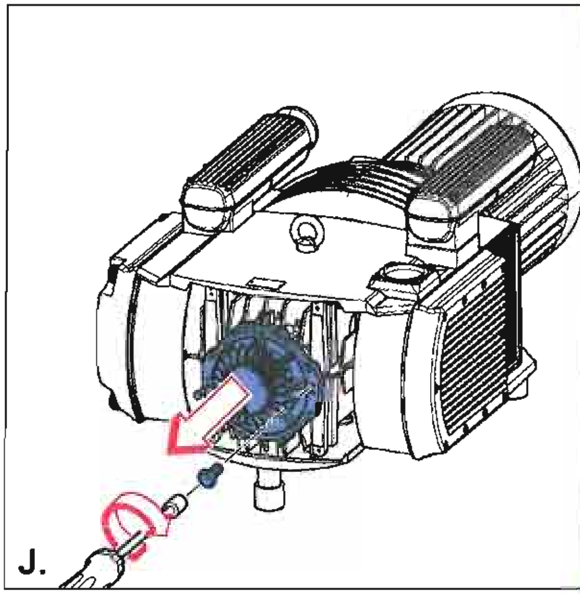
EN149 - **FFP3**
42 CFR 84 - **N100**



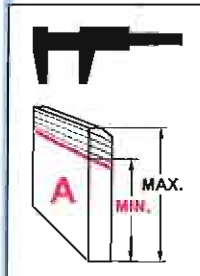
H.

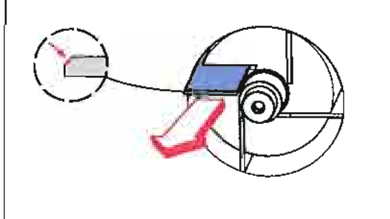


I.



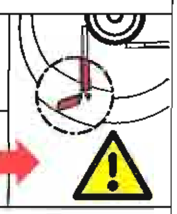
J.



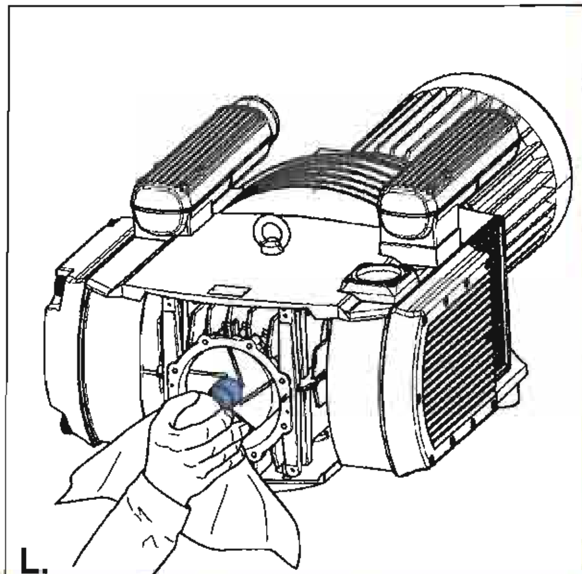


A_{MAX} = 65mm
A_{MIN} = 41mm

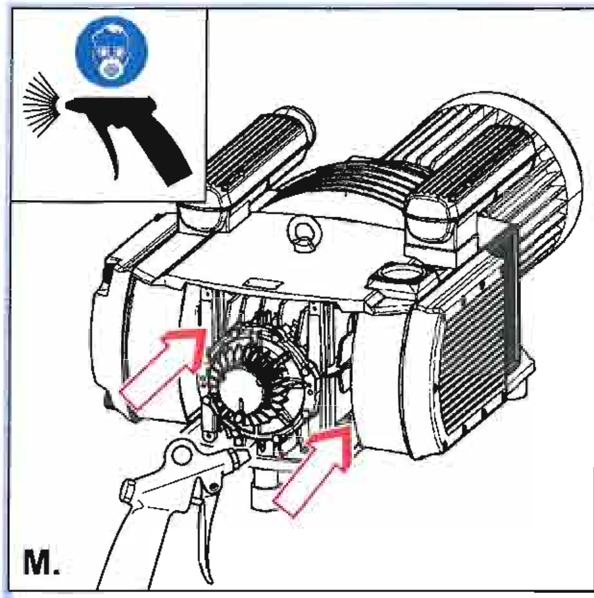
A < 41mm

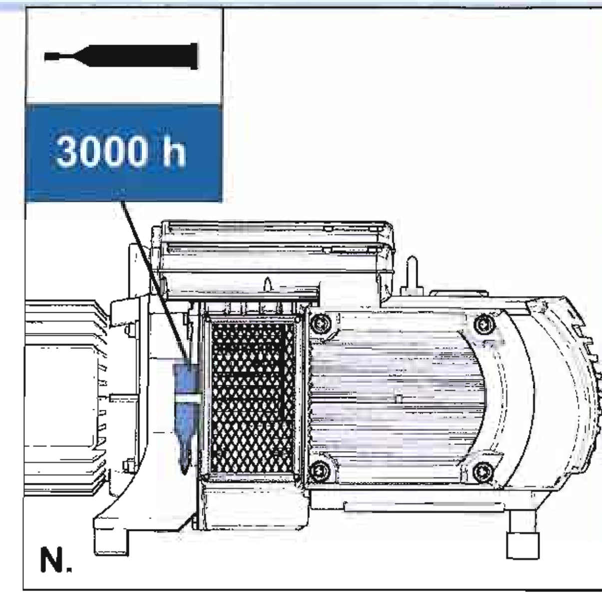


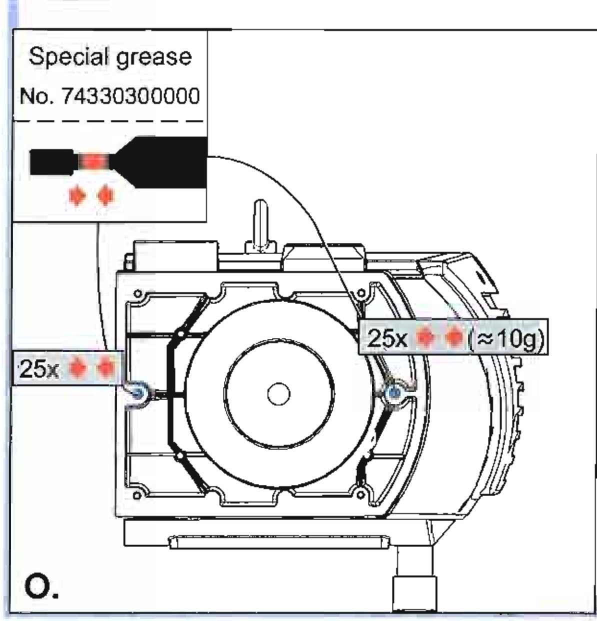
DTLF 2.200/2.250 → No. 90136701005 **(SET)**
K. DTLF 2.360 → No. 90132500005 **(SET)**

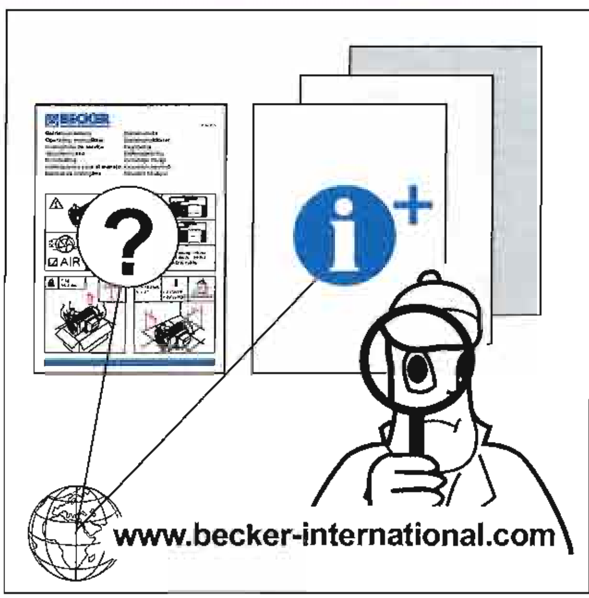


L.









BECKER

Gebr. Becker GmbH
Hölker Feld 29-31
D-42279 Wuppertal
info@becker-international.com

WSP
5 Sullivan Street
Cazenovia, NY 13035
Tel: +1 315 655 3900
Fax: +1 315 655 3907
www.wspgroup.com/usa

WSP
5 Sullivan Street
Cazenovia, New York 13035

Tel: 315.655.3900
Fax: 315.655.3907
www.wspgroup.com/usa