100% Design
Sub-Slab Depressurization System
Second-Phase Expansion – Building A
Lockheed Martin Middle River Complex
2323 Eastern Boulevard
Middle River, Maryland

Prepared for:

Lockheed Martin Corporation

Prepared bu p.8 TD [(P)5.9(r)1 n41RBao24(t)7.6 10(h)14(e),u p.8 (L)30 -(k)10(h).rkocT526gD

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APPENDICES

ACRONYMS

µg/m^3	micrograms per cubic meter
%	percent
cis-1,2-DCE	*cis*-1,2-dichloroethene
CQCP	construction quality control plan
COMAR	Code of Maryland Regulations
ºF	degrees Fahrenheit
FMEA	failure mode and effects analysis
GAC	granular-activated carbon
HASP	health and safety plan
HVAC	heating, ventilation, and air conditioning
lbs/day	pounds per day
Lockheed Martin	Lockheed Martin Corporation
MDE	Maryland Department of the Environment
p/n	part number
OM&M	operation, maintenance, and monitoring
PVC	polyvinyl chloride
RTO	remedial technical operations
SCFM	standard cubic feet per minute
SSD	sub-slab depressurization
TCE	trichloroethene
Tetra Tech	Tetra Tech, Inc.
TO-15	Toxic Organic Method-15
USEPA	United States Environmental Protection Agency
VMP	vapor monitoring point
VOC	volatile organic compound
WC	water column
WMP	waste management plan

Section 2
Basis of Design

Each new vertical extraction point was constructed using two-inch-diameter 0.020-inch slot Schedule 40 PVC pipe (screen), and two-inch diameter solid Schedule 40 PVC pipe (riser) in a six-inch diameter borehole. The screen extended from the bottom of the slab to a depth of 12 to 18 inches. The annular space was filled with clean pea gravel and a two-inch thick bentonite grout seal was placed above the screen and gravel to prevent short-circuiting (extracting indoor air).

The vapor extraction points were located as close to a wall or column as possible, so that cutting the concrete slab (other than for coring at the vapor extraction point) was avoided, and the extraction point and piping were placed outside normal traffic flow in the facility. The riser pipes from the new extraction points were brought above ground at the columns/walls shown on Drawing G2 in Appendix A, and were covered with a PVC cap until piping to the blower skid is installed. SSD-37--A and SSD-38-A, located in a driving aisle, were installed using a horizontal extension pipe connected at a 90-degree angle within the floor slab to keep the piping away from the driving aisle. The extension pipe, a solid, 1.5-inch diameter steel pipe, was installed approximately 3.5 inches below grade. A three-foot high, four-inch diameter steel pipe sleeve was placed on the riser pipe for SSD-35-A, and one two-inch diameter steel bollard was installed at SSD-34-A and SSD-36-A to prevent ground-level damage.

The concrete around each point was finished in a manner equal to or better than surrounding areas, as required by Lockheed Martin. The new extraction points and VMPs are in areas with no floor coverings. Extraction point and bollard details are on Drawing G2 in Appendix A.

3.2 PIPING

The riser pipes from the extraction points will be supported on the columns/walls shown on Drawing G2 (Appendix A) with pipe supports placed near valves, elbows, fittings, and joints. Each riser pipe will have a measuring point for sampling, flow, and vacuum monitoring, and a lockable diaphragm valve for throttling or shutting off flow. The pipe will be connected to an elevated, six-inch-diameter Schedule 40 PVC pipe installed overhead. Sub-slab soil vapor from the five new extraction points will be routed into the common header to the blower skid, where it will be joined with vapor from the four existing extraction trenches before heading to the moisture separator.

The six-inch-diameter header pipe will be run along wall and ceiling sections in the eastern area of Building A (see Drawing G2 in Appendix A), and will be tied-in to the existing SSD system before

3.3 MODIFICATIONS TO EXISTING SSD SYSTEM

Required modifications to the main system are:

- ¶ replacing the current blower and moisture separator and installing a new blower skid with larger units and add a heat exchanger (mounted on the new skid) to reduce the temperature of the vapor stream from the blower prior to the vapor treatment units
- ¶ hard-wiring three indoor-air filters in the Building A basement directly into the facility's emergency power system

The current blower skid will be replaced with a skid that includes one AMETEK® Rotron® regenerative blower model DR909BB72W rated for 300 SCFM at 75 inches of water column (WC) suction. A new moisture separator (Gasho Model GX-100DL) will be provided with the new skid. The replaced blower skid will be returned to the supplier (Gasho, Inc.) for recycling. A heat exchanger (Xchanger, Inc. model AA-400) will be installed before the granular-activated-carbon (GAC) units to protect the GAC units and PVC pipe from potential temperatures higher than

The three IQAir® GC™

required for the emission rates associated with the SSD system. An e-mail communication on September 22, 2015 from Mr. Nolan Penney of the MDE Air Quality Permits Section (Appendix E) reconfirmed that no permit would be needed, and that extraction rates less than one pound per day qualify for the *de minimus* exemption under COMAR 26.11.02.10X. Therefore, no air permit is required for the second-phase expansion of the SSD system (MDE, 2015). We will provide the Middle River facility with total annual emission volumes for their reporting requirements. Based on discussions with the facility during previous SSD system installations, no building or other permits are required for the proposed second-phase system expansion.

3.6 FAILURE-MODE AND EFFECTS ANALYSIS

Tetra Tech, Lockheed Martin, and its remedial technical operations (RTO) contractor conducted a failure mode and effects analysis (FMEA) on December 8, 2015 via a virtual (online) meeting. The purpose of the FMEA is to examine work for single or multiple point failures that could cause a release of untreated soil vapors to the environment or cause damage to the SSD system. The results

emergency procedures. The system's OM&M manual has been updated to include the new extraction points, VMPs, and new equipment skid. The work plans and updated OM&M manual are available under separate cover.

The preliminary construction schedule for construction of the system expansion is in Appendix G, and is based on approval of the 100% design documents on or before February 2016.

Table 3-1

New Vapor Extraction Points and Associated Monitoring Points
Building A SSD System Second-Phase Expansion

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Section 4
Performance Monitoring

4.1 SYSTEM STARTUP AND OPERATION

After the second-phase system expansion is installed, the system will be rebalanced by taking vacuum and flow rate measurements from each extraction point and induced vacuum monitoring point, and adjusting the diaphragm throttling valves, to pull about 35 standard cubic feet per minute (SCFM) from each of the current vapor extraction trenches, and 25 SCFM from each of the new points. To rebalance the system, each individual extraction point will initially be run alone to establish its vacuum-flow relationship. The vacuum applied at each extraction point will vary considerably to achieve the target flow rates. A wellhead vacuum may be as high as 40 inches of water column (WC) for some extraction points, while others may be less than 20 inches water column. Multiple iterations are needed before the entire well set is balanced and the system is functional.

Once the extraction points are set to pull the target flows (or as close as possible), the system vacuum and flows will be adjusted to achieve the design criterion of a vacuum of 0.01 inches water column or greater at each vapor monitoring point within the radius of influence, when possible. A photoionization detector will be used to check for volatile organic compounds (VOC) at each extraction point during startup, and one sample from each point (collected 24 hours after startup) will be submitted for laboratory analysis. Moisture accumulation will also be monitored during startup.

System checks will occur weekly during the first month of operation, and every two weeks thereafter. System checks will include applied vacuum and flow rate at each extraction point, and induced vacuum at vapor monitoring points (VMPs). Maintenance will be conducted per manufacturer recommendations. System vapor samples (influent, midpoint, and effluent) will be collected and analyzed every two weeks for volatile organic compounds during the first month of operation; thereafter, these samples will be collected monthly. All sub–slab vapor samples will be

submitted to TestAmerica in Knoxville, Tennessee for analysis of currently agreed list of target compounds by United States Environmental Protection Agency (USEPA) Toxic Organic Method 15 (TO-15). The resulting data will be used to determine mass removal trends, and to verify that breakthrough of the granular activated-carbon units has not occurred. Typically, a sub-slab depressurization (SSD) system removes relatively high levels of VOC mass in the initial few days of operation, followed by a substantial drop in mass removal rates thereafter.

4.2 SYSTEM MONITORING

System checks after the first month of operation will be completed by following these steps:

- Measure and record the vacuum and air velocity from each extraction point using a manometer and velocity meter, respectively, and adjust as needed.
- Replace the lead granular activated-carbon unit when 50% or higher breakthrough is observed in the midpoint air sample, or at Tetra Tech's discretion (with concurrence from

Table 4-1

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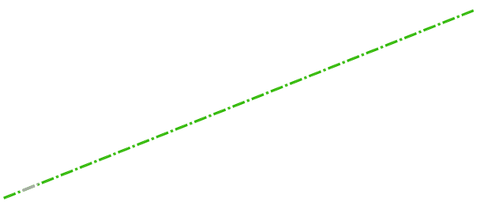
APPENDIX A—DESIGN DRAWINGS



APPENDIX B— GEOPHYSICAL UTILITY-INVESTIGATION REPORT

Abon
air vent

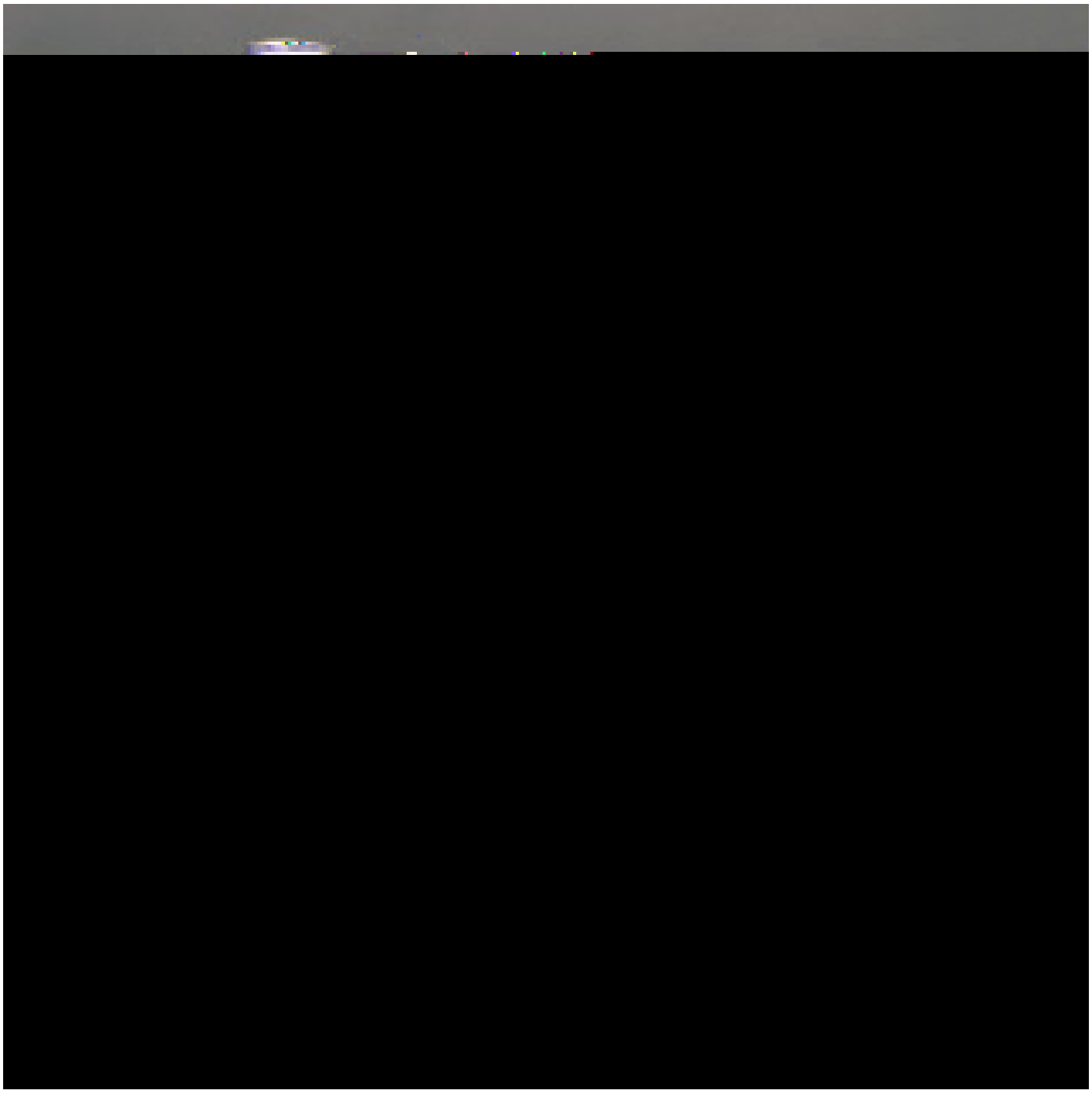
APPENDIX C— EQUIPMENT LIST, CUT SHEETS, AND TECHNICAL SPECIFICATIONS

EQUIPMENT LIST

1. Cox-Colvin and Associates, Inc.'s stainless steel VaObsso Pn,

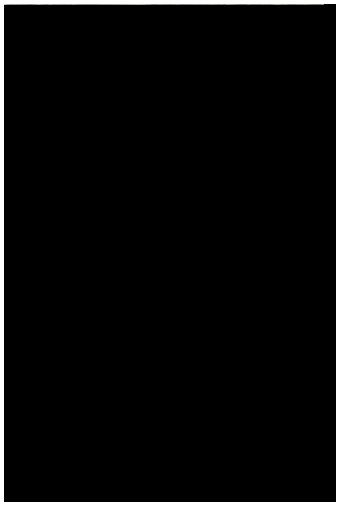
.ele anduaim.e(t)-828.0(S)-3.0k(i)2.0(d)-7-4.0wT1it tellinassoeanat

Vapor Pin® Extension 1.5″



Stainless Steel Secured Cover

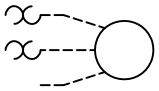
Cox-Colvin & Associates, Inc. has developed the Vapor Pin®, a unique, patented, re-usable sub-slab soil-gas sampling device. Traditional sub-slab soil-gas sampling methods are time consuming, expensive, and prone to leaks. Cox-Colvin designed the Vapor Pin® specifically to eliminate many of the problems associated with traditional sub-slab soil gas sampling methods. Advantages of the Vapor Pin®over traditional methods include:



- unique patented design reduces the potential for leaks during sample collection, improving sample quality;
- built-in disposable seal eliminates the need for grout, increasing productivity;
- connects easily to sampling equipment;
- easily installed, sampled, and retrieved for reuse;
- reduces damage to the slab;
- improves diagnostic testing;
- improves spatial resolution;
- reduces sampling time allowing collection of more samples for less cost, and thus provides a better understanding of site conditions.

The patented design of the Vapor Pin®provides environmental professionals a means of collecting high-quality, low-cost soil gas samples within minutes. Plus, the Vapor Pin® is made in the USA. Protected under US Patent # 8,220,347 B2

Products



R

– HIGH LIQUID LEVEL

PL–1
PL–2
PL–3 – PRESSURE

7. LS – INDICATT

SS–1 – SVE HAND–OFF–AUTO

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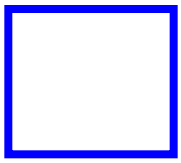
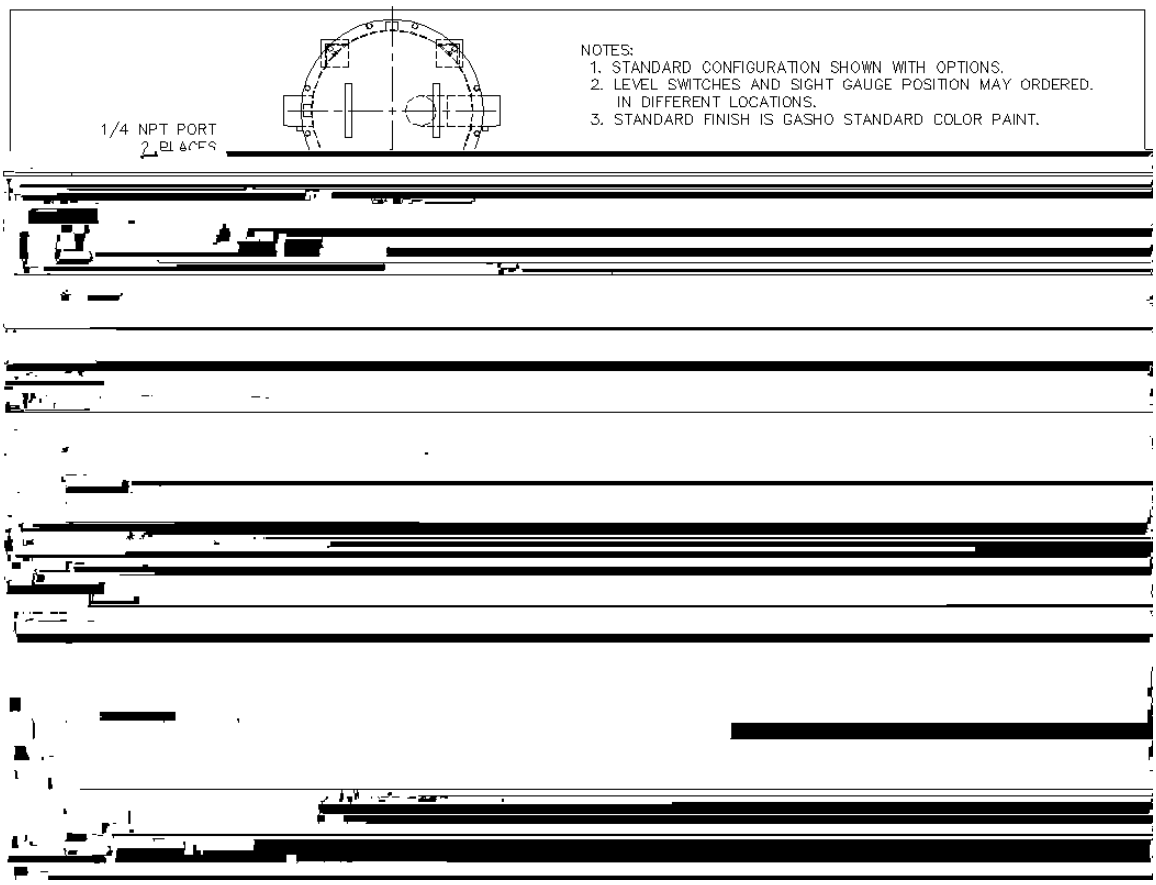


x²¼«-¬®·¿´ ñ Ý ¸» ³ ·

460 West Gay Street
West Chester, PA 19380

GX100-DL Moisture Separator, 400 CFM Specification

100 gallon vessel with approx. 40 gallons of storage
Flow Rate- 400 ICFM, Vacuum rating 28” Hg
Integral SS demister / filter media, 99.5% entrained water removal
Pressure drop through clean media = .25 IWC
Welded steel construction, reinforced for high vacuum
External Site Gauge
Level Switch Ports- (3) 1” NPT ports, 6” 150 Lb. Flange Cleanout port with clear cover



1	Xchanger, Inc.	Rating for Model AA-400 ref #125244	Page 1 of 1
2			
3	Prepared for:		
4	J.E. Gasho & Associates, Inc.		
5	Jim Gasho Jr.		
6			
7			
8	PERFORMANCE	HOT SIDE	COLD SIDE
9	Fluid Circulated	Air	Air
10	Volumetric Flow Rate	400 ft^3 Std. ft^3/min	400 ft^3 Std. ft^3/min
11	Total Mass Entering	1,800.1 lb/hr	1,800.1 lb/hr
12	Vapors		
13	Non-Condensable Mass Entering	1,800.1 lb/hr	1,800.1 lb/hr
14	Vaporized or (Cond.)		
15	Temperature In	180.0 °F	90.0 °F
16			
17		10,770.11 / .00	11,770.11 / .00
18		1,016.51 /	1,106.51 /
19			
20		0.0001 ft^2 °F hr / BTU	0.0001 ft^2 °F hr / BTU
21			
22	Total Heat Exchanged: 30,374 BTU/hr		
23			
24	AVERAGE MEDIA PROPERTIES		
25			
26		60.0 %	60.0 %
27	Latent Heat of Vapor		
28			
29			
30			
31	CONSTRUCTION		
32	Design Temperature	200 °F	Not Applicable
33	Design Pressure (Gauge)	15 lb/in^2	Not Applicable
34	Test Pressure (Gauge)	15 lb/in^2	Not Applicable
35	Gasket Material	None	Not Applicable
36	Primary Surface	Plain Fins, Horizontal	Internally Finned Tubes
37	Coating	None	None
38			
39	Plate, Fin, Sep.	Aluminum	Fan Hood	Galvanized Steel
40			
41			
42			
43	CONNECTIONS		
44			
45			
46	Instrument		
47			
48			
49			
50	Fan Qty/Speed	1 / 3450 RPM	Motor Qty/Speed	1 / 3450 RPM
51	Fan Type	4 Blade Mill Galv. St	Motor Electrical	208-230/460/3/60
52			
53	NOTES		
54			
55			
56			
57			
58			
59	A motor access panel is included in the fan hood.		
60			

D
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PV

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Nor
Size

Sche
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Size

[redacted]

and Seamless Steel Pipe.

Reference ANSI/ASME B36.10M-1996 "Welded and Seamless Wrought

Main Categories

... Engineering Drawing

Diameter (Inches), ... Wall ... Properties of Sect...

6	6.065	0.625	280	18.97	28.14	2.245	8.496

Pipe attached to 1/4-inch steel diamond plate - anchor type.

Pipe Marker, Vacuum, Grn, 2-1/2 to 7-7/8 In

Pipe Marker, Legend Vacuum, Legend Color White, Background Color Green, Fits Pipe O.D. 2-1/2 to 7-7/8 In., Height 2-1/4 In., Width 14 In., 1 Markers per Card, Material Pressure Sensitive Vinyl, Marker Attachment Style Self-Adhesive, Standards ASME (ANSI) A13.1

Grainger Item #	6M602
Price (ea.)	**$2.78**
Brand	BRADY
Mfr. Model #	7292-1
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	0.01
Availability	Typically in Stock
Catalog Page No.	2930

Price shown may not reflect your price. Pipe Marker

Legend: Vacuum

Legend Color: itLeMarker ckwb(grou)7(ndd)-.7Color:nMarker 5(i

Vent-Scrub® Vapor Phase Adsorbers

Applications

The Vent-Scrub® adsorbers have been roven to be the s est and ost cost e ect ve a to treat a odorous and V e ss on rob e s Sturd stee construct on and s ec a or u ated corros on res stant nterna coat n ensures on serv ce e and o a ntenance cat ons or Vent-Scrub adsorbers nc ude

- se arator vents

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t T tnuT t-uT T T T T t uT

NOTES:

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TO USF AND ARE SUBMITTED IN CONFIDENCE. THEY

		DESCRIPTION
2	1	DRUM, 110 GAL, COATED
6		
7	1	ADAPTER 4" PVC MALE

SECTION 01010 – SUMMARY OF THE WORK

PART 1 - GENERAL

1.1 PROJECT/WORK IDENTIFICATION

A. General: Project name is Sub-Slab Depressurization (SSD) System Second-Phase Expansion, Building A, Lockheed Martin Middle River Complex, Middle River, Maryland.

B. Summary of Work by Reference: The work of the Contract includes, but is not necessarily limited to, the following Contract Documents:

1. Contractual Legal Requirements

2. Drawings as listed in the Schedule of Drawings

3. Technical Specification – Section 01010 – Summary of the Work

C. Addenda and Modifications: The work of the Contract also includes addenda and modifications to the Contract Documents issued subsequent to the initial printing of the Contract Documents and include, but are not necessarily limited to, printed matter referenced by any of these.

D. Abbreviated Written Summary: Briefly, and without force and effect upon Contract Documents, and including, but not necessarily limited to, printed matter referenced by any of the following.

1. The project is generally described as construction of a second-phase expansion to an existing SSD System. The work includes:

i. Installing five sub-slab soil vapor extraction points (completed by others)

ii. Installing eight vapor monitoring points (completed by others)

iii. Installing header piping from the loading dock to the extraction points

iv. Installing piping to connect the extraction points to the header piping

v. Installing the new blower skid at the current blower skid location and removing the old skid

vi. Hard-wiring the existing indoor air filters in the Building A

basement to the facility's emergency power system

vii. Pilot-testing and startup testing of the expanded system

Second-Phase Expansion – Building A

PART 2 - PRODUCTS

Refer to Section 13825 – Special Equipment for vapor monitoring point and blower-skid component specifications.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01620 – STORAGE AND PROTECTION OF MATERIALS

PART 1 - GENERAL

1.1 GENERAL

A. Store and protect materials in accordance with manufacturer's recommendations and requirements of Specifications.

B. The CONTRACTOR will make all arrangements and provisions necessary for material and equipment storage. All excavated materials, construction equipment, and materials and equipment to be incorporated into the work will be placed so as not to injure any part of the work or existing facilities, and to provide free access to all parts of the work at all times, and to all utility installations in near the work. Materials and equipment will be stored neatly and compactly in locations that will cause the least inconvenience to the OWNER, tenants, and occupants. Storage will be arranged in a manner to provide easy access for inspection.

C. Areas available on the construction site for material and equipment storage will be approved by the ENGINEER and OWNER. Storage areas will be located within the property at locations designated by the OWNER during the pre-construction meeting.

D. Materials and equipment that will become the property of the OWNER will be stored to facilitate their inspection and ensure preservation for work quality and fitness, including proper prevention against damage by freezing and moisture. They will be placed inside storage areas unless otherwise acceptable to the OWNER.

E. Lawns, grass plots, or other private property will not be used for storage purposes without written permission of the OWNER.

F. The CONTRACTOR will be fully responsible for loss or damage to stored materials and equipments withoutan1.1aG2030.0(Ma)3.0(tD10.0(r)2)4.0(a)0(be)-246.rtofaget

A. State of storage facilities is adequate to provide required conditions.

B. Required environmental conditions are maintained on continuing basis.

C. Products exposed to elements are not adversely affected.

1.6 PROTECTION AFTER INSTALLATION

A. Provide protection of installed products to prevent damage from subsequent operations. Remove when no longer needed, before work is complete.

B. Communicate with ENGINEER to coordinate with OWNER traffic control to prevent damage to equipment, materials, and surfaces.

1.7 SECURITY

The OWNER assumes no responsibility for security of the CONTRACTOR's materials or equipment on the property at any time.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01650 – FIELD TESTING AND STARTUP

PART 1 - GENERAL

1.1 GENERAL

Summary: This section specifies the requirements for field-testing and startup activities to verify operation of the expanded sub-slab depressurization (SSD) system.

1.2 REQUIREMENTS

A. Provide the services of qualified technicians who will provide the following services:

1. Assist in the installation of the equipment.

2. Check the installation of the equipment and make all necessary adjustments before testing begins.

3. Perform equipment and system tests and startup procedures as described herein and in accordance with the project's Construction Quality Control Plan (CQCP).

B. The CONTRACTOR will include sufficient time in the construction schedule to complete all equipment and system testing, troubleshooting, corrections, and startup activities as specified. The ENGINEER will witness and document all field-testing and startup activities.

1.2 CHECKS AND FIELD TESTS

A. The following operations will be conducted as a prerequisite for the field tests:

1. Set, align, and assemble all equipment and systems in conformance with the manufacturer's drawings and instructions.

2. Check equipment for proper rotation.

3. Check motors for no-load current draw.

4. Run the equipment and check equipment for excessive vibration and noise.

5. Complete the equipment checklists in the CQCP.

6. Check all equipment, interconnections, and accessories to verify condition and specified performance capability. Instrumentation and

controls will be tested with the equipment to which they are connected.

B. Field tests of equipment will prove that equipment and appurtenances are free from defects such as overheating, overloading, and undue vibration.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION AND VERIFICATION OF CONDITION

A. The CONTRACTOR will inspect system equipment for readiness before testing and startup. Hazardous conditions will be corrected by the CONTRACTOR before proceeding.

1. Testing and startup will not proceed using temporary power or temporary instrumentation and control wiring.

2. All electrical and control connections will be permanent and complete, and all such electrical components and equipment fully functional.

3. Clearly identify all energized electrical equipment during testing.

B. The CONTRACTOR will notify the ENGINEER of any startup activities at least 72 hours before the scheduled startup. Notification will be made during normal working hours.

C. All tests and startup will be performed in the presence of the ENGINEER, who will be present for the entire duration of the test. Checklists in the CQCP will be used.

D. The CONTRACTOR is responsible for the performance and operation of the equipment and systems during testing and startup.

E. Any failures of equipment or systems operated under the direction of the CONTRACTOR will be considered deficiencies and will be corrected.

F. The CONTRACTOR will make all adjustments and corrections necessary to achieve normal, stable operation of the system.

3.2 FINAL TESTING AND SYSTEM STARTUP

A. The CONTRACTOR will test the expanded SSD system by operating all system equipment as a unit, including all related piping, valves, electrical controls, instrumentation, and mechanical parts.

B. For a successful test, the system must run trouble free for four (4) continuous hours. The test will prove the system equipment and appurtenances are properly installed, free from defects, and that they meet their operating parameters as specified in the CQCP.

END OF SECTION

SECTION 05503 – ANCHOR BOLTS, EXPANSION ANCHORS AND CONCRETE INSERTS

PART 1 - GENERAL

1.1 DESCRIPTION

2.2 MATERIALS

C. Expansion anchors may be used for hanging or supporting pipe two inches diameter and smaller, except for use in new concrete construction (see F below). Expansion anchors will not be used for larger pipe unless so shown or approved by the ENGINEER.

TABLE 05503-2: EPOXY RESIN ANCHORS

Bolt Dia. (in.)	Allowable Work Load (lb)	Embedment (in.)	Min. Spacing (in.)	Min. Edge Distance (in.)

6. Vacuum gauges with isolation valves
7. Pressure gauges with isolation valves
8. Temperature gauges

C. The blower will be provided with the following 460v, 3-phase control panel mounted and wired:

1. 30-inch×24-inch×8-inch National Electrical Manufacturers Association (NEMA)-4 enclosure with control panel
2. Main non-fused disconnect with thru-door operator
3. 10 horsepower 460v blower starter with fusing
4. One (1) horsepower 460v heat exchanger (HEX) starter with fusing
5. HEX to run when blower runs
6. Hand-Off-Auto (H-O-A) selector switch for blower and HEX
7. One (1) green run light for blower and heat exchanger
8. Six (6) red fault indicating lights for:
    a. high level (normally closed)
    b. high temperature (normally closed) (2)
    c. high pressure (normally closed)
    d. low vacuum(normally closed)
    e. spare
9. Alarm condition reset button
10. 250va control transformer with fused primary and secondary
11. Eight-channel auto-dialer: Sensaphone® 800 Monitoring System, part number FGD-0800
12. Terminal blocks for remote connections

2.3 HEAT EXCHANGER

The heat exchanger will be model AA-400 by Xchanger Industrial Heat Exchangers rated for 400 SCFM:

A. Design temperature: 200ºF

B. Temperature in: 180ºF

C. Temperature out: 110ºF

D. Connections (inlet and outlet): 4-inch diameter

2.4 MOISTURE SEPARATOR

A. The moisture separator will be model GX-100DL by Gasho, Inc.:

1. Diameter: 27 inches
2. Height: 75 inches
3. Integral demister/inline filter rated for 99.5% entrained water removal
4. Connections (inlet and discharge): 4-inch diameter
5. Liquid capacity: 40 gallons
6. Nominal flow rate: 400 SCFM
7. Level switch
8. Heat traced and insulated

2.5 SWITCHES

A. Two NEMA 4 temperature switches, Ashcroft part number T424-T050303 or approved equal.

B. One NEMA 4 pressure switch, Dwyer part number 1950-P or approved equal.

C. One NEMA 4 low vacuum switch, Dwyer part number 1950P-5-2F or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

The CONTRACTOR will install all equipment specified in accordance with each manufacturer's recommendations. The blower, heat exchanger and associated control panel, piping, valves, and switches will be provided on a prefabricated skid by Gasho, Inc.

SECTION 15050 – PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

around the joints. Where stud bolts are used, the bolts will be uniformly centered in the connections and equal pressure applied to each nut on the studs.

G. Installation of Threaded Piping: All threaded joints will have long taper thread that will be made tight with oil and graphite paste applied to external threads only. All pipe 1-1/2 inches and smaller will be reamed to remove scale and dirt. Wrenches on valves and fittings will be applied directly over the joint tightened.

3.2 TESTING OF PIPING SYSTEMS

A. All piping systems installed under this section will be tested in the manner specified herein and in the presence of the ENGINEER. No piping will be concealed until it has been tested to the satisfaction of the ENGINEER. Testing media will be furnished and disposed of by the CONTRACTOR, and all materials, labor and equipment required for the testing procedures will be at his expense. Any leaks or defective piping disclosed by the test will be replaced or repaired, and the test repeated until all piping proves tight. No caulking of defective piping or joints will be permitted.

B. The CONTRACTOR will furnish, install, and remove temporary flanges, plugs, or bulkheads whenever necessary to complete the required pressure tests.

C. Pipe system tightness will be tested at approximately sixty (60) inches of water vacuum. The vacuum will be held for one hour with a maximum 0.5-inch drop. Any leaks will be located and repaired.

END OF SECTION

A5.1. In addition, welding rods 1/8-inch diameter and over will be marked or stamped with positive identification marks at intervals of not more than 18 inches. Such marks will be clearly distinguishable and will include the classification number of the welding rod and the trade designation of the manufacturer. Filler metal requirements will conform to AWS A5.1.

PART 3 - EXECUTION

3.1 PRODUCTS/EQUIPMENT

Product Shipping Requirement: The CONTRACTOR will be responsible for the delivery of all job-related materials and/or equipment to the job site. All furnished materials and equipment will be delivered clean, undamaged, and in good condition.

3.2 PREPARATION

A. Protection: All welding/fabricating activities will be protected from inclement weather at all times.

B. Primer and Finish Application: All structural steel pipe-support material systems will be prime-coated after fabrication. The items that are painted as standard by the manufacturer do not require prime coating.

3.3 INSTALLATION

Hangers and support components will be installed in accordance with the manufacturer’s recommended installation procedures.

END OF SECTION

other trades.

B. Replacements: If damage occurs, immediately make all repairs and replacements necessary to the approval of the ENGINEER and at no additional cost to the OWNER.

C. Valve Identification:

Cast marking will appear on each valve, identifying the following:

1. Manufacturer's name or mark
2. Size of valve (pie size)
3. Working pressure
4. Year of valve manufacture
5. Flow direction arrow (required for swing check valves, rate of flow valves, plug valves, pressure-reducing valves and pressure relief valves only)

PART 2 - PRODUCTS

2.1 GENERAL

A. Design:

1. Where used, the names of manufacturers and specific catalog numbers are given only as an indication of the quality of the materials and workmanship to be used. Equal products by other manufacturers approved by the ENGINEER will be acceptable.
2. For uniformity, all valves of a particular type will be furnished by one manufacturer.

B. End Connections: All valve end connections will match the piping to which they will be installed, as described in Section 15050, Piping.

2.2 THROTTLING DIAPHRAGM VALVES

A. Diaphragm valves will be PVC body, manual operation, 2-inch diameter; PTFE diaphragm; by IPEX or approved equal.

PART 3 - EXECUTION

3.1 INSPECTION

Examine the areas and conditions under which work of this section will be installed. Correct conditions detrimental to proper and timely completion of the work. Do not proceed until all unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Interior Installations: Valves installed in interior piping will be supported on both the suction and discharge sides.

B. Cleaning Valves: The inside of all valves will be cleaned by brushing and by thoroughly blowing out with air to remove slag, dirt and other sediment, as

APPENDIX D—PRESSURE-LOSS CALCULATIONS

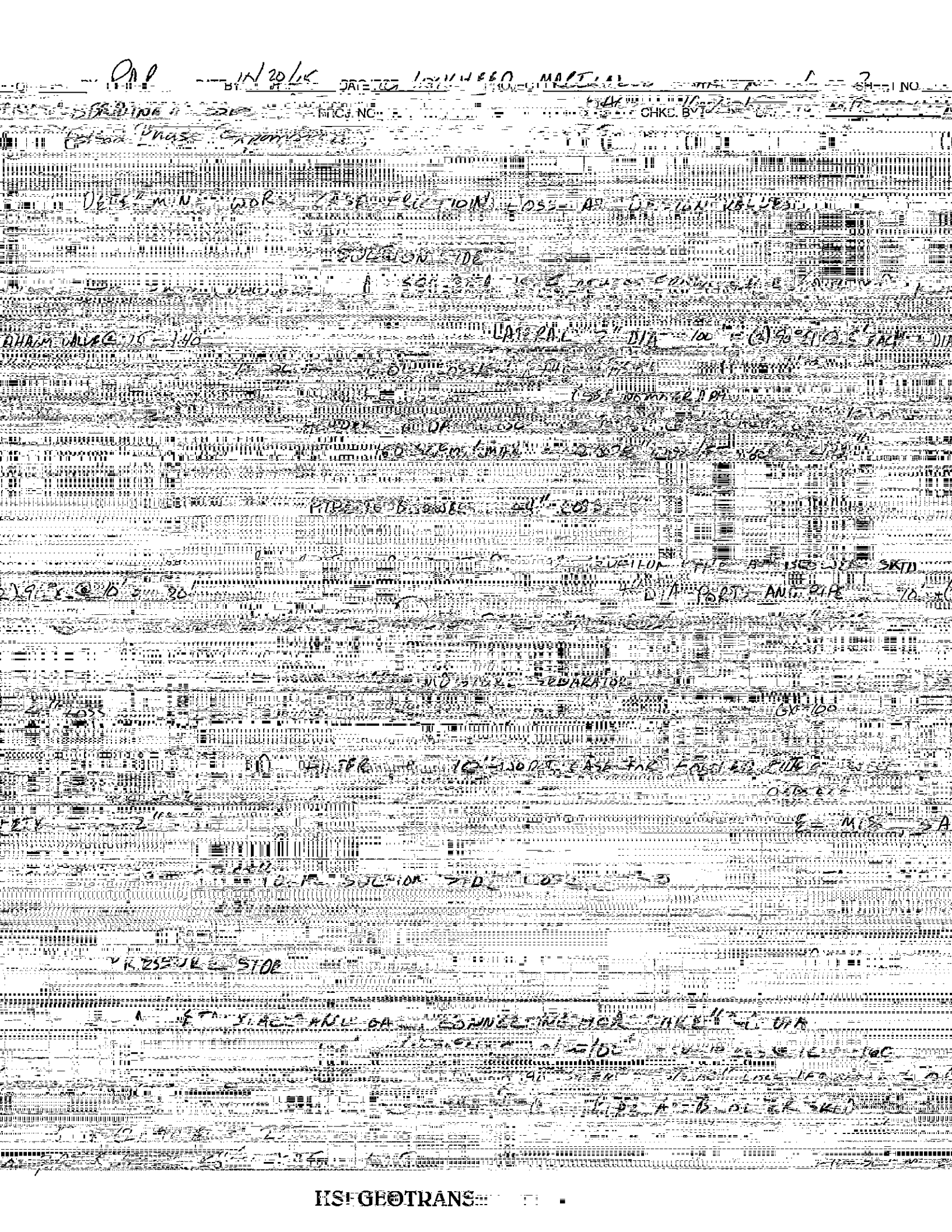
SYSTEM-COMPONENT HEAD LOSS

Building A Sub-Slab Depressurization System Second-Phase Expansion
Lockheed Martin Corporation, Middle River Complex

System flow: 265 standard cubic feet per minute (SCFM)

Vacuum-side loss for system components

Cominute



BY DAL DATE 10/20/15 PROJECT LOCKHEED MARTIN SHEET NO. 7 OF 7

CHKD. BY [illegible] DATE 10/21/15 SUBJECT MRL BLOWER PRESSURE PROJ. NO.

(SEE CUT SHEET) (1) FLOW METER

(SEE SHEET) 6 GATE 3.5" LOSS EACH (SEE

MTS SAFETY 3"

TOTAL PRESSURE SYSTEM 23"

CHECK

BLOWER SUCTION 29 SCFM @ 80" H2O

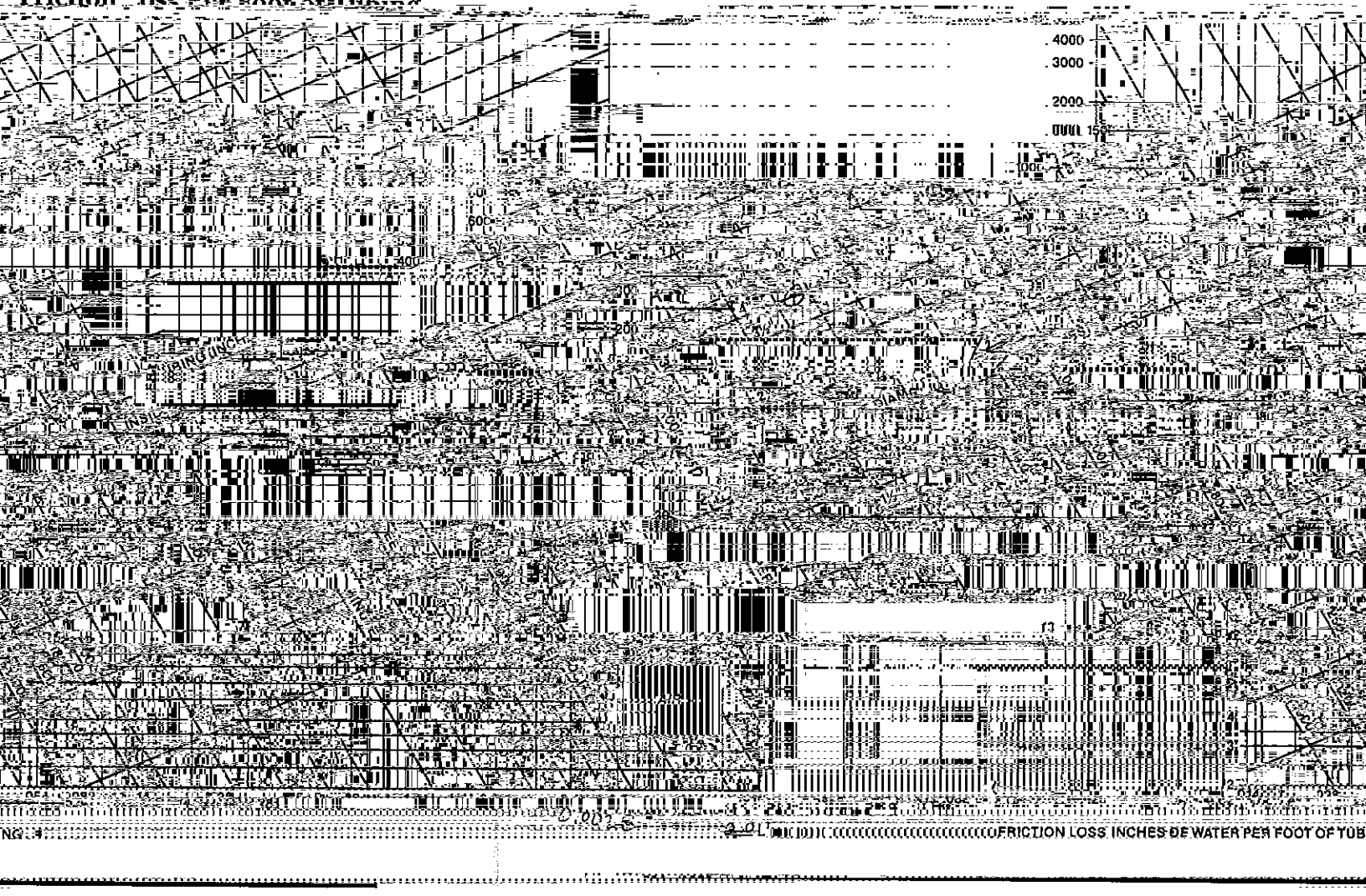
28" LOSS

PRESSURE 290 SCFM @ 115" H2O

37" LOSS

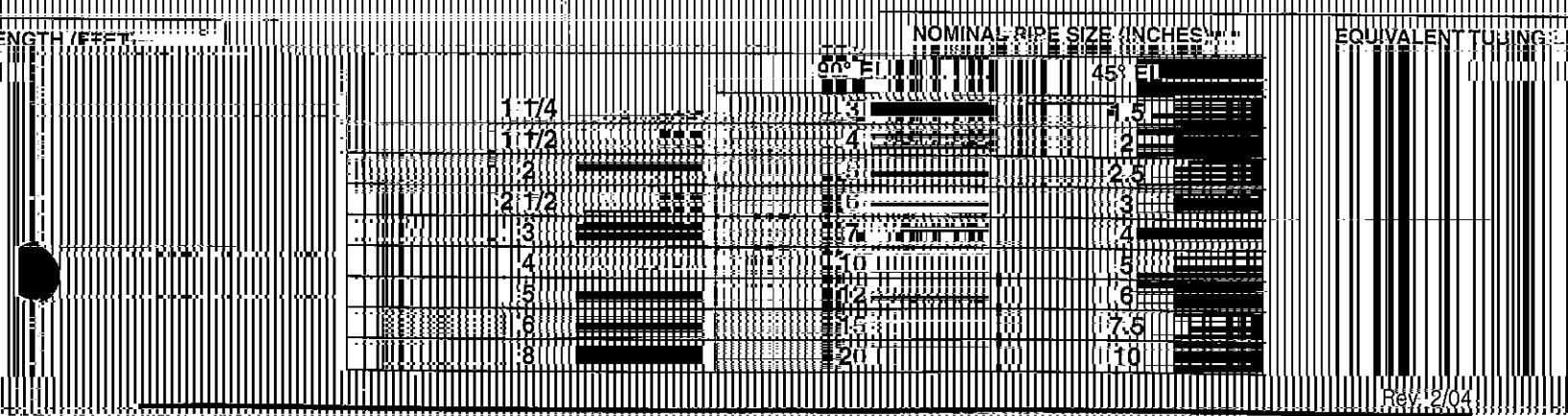
Applications Engineering Data

Friction Loss Per Foot of Tubing



Friction Loss In Fittings

To calculate friction loss in fittings use chart below. This chart will yield equ
lengths (in feet) of tubing. Use this length with graph above to find friction loss in
inches of water colum



Measurement

Blower Connection Key
NPT – American National Standard Taper Pipe Thread (Male)
NPSC – American National Standard Straight Pipe Thread for Coupling (Female)
S – Slip On (Smooth – No Threads)

ories Access

eter Air Flow M

in SCFM
drop (2-4" typical) across the
low impedance air stream

BENEFITS

• OPTIMIZE SYSTEM EFFICIENCY
Measuring the correct air flow can assist you in fine-tuning to your system's optimal efficiency.

• BALANCE MULTI-PIPING SYSTEMS
When evacuating CFM from more than one pipe, different run lengths of end system impedance can cause one pipe to handle more CFM than the other. With an accurate CFM reading, pipes can be balanced by bleeding air in/out or by creating an [illegible] Allen key supplied for gauge adjustment.

FEATURES

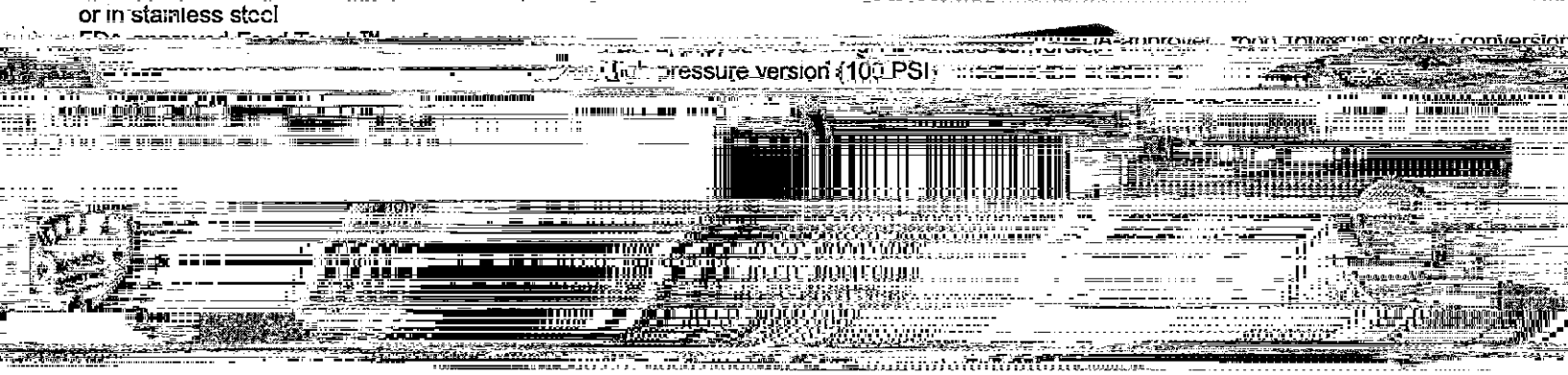
• Direct reading
• Low pressure flow meter
• Non-clogging
Light weight aluminum
• No moving parts
• Large easy-to-read dial
Accurate within 2% at standard conditions
Good repeatability
Available in 2", 3" and 4" sizes
• Factory configured for quick installation
[illegible] extra inverter tube

ING
digging can
d can help

• DETECT CHANNELING OR PLUGG
For systems in which channeling or p
occur, a change in the CFM measure
indicate the unseen changes in your system.

OPTIONS

For 4-20 mA outputs and digital readouts see page [illegible]
• High temperature version (above 140°F)
• Corrosion-resistant version with Chem-Tough™ or in stainless steel
[illegible] pressure version (100 PSI)



Current Models		Flow Range	B	C	D
Model	Part #	(SCFM)	Threads	Length	Width
FM20C030G	550599	6-30			
FM20C045G	550600	9-45			7.0"
FM20C065G	550601	13-65			
FM20C125G	550602	25-125	2" – 11.5 NPSC	7 1/8"	2.0"
FM30C175G	550603	35-175			5.6"
FM30C225G	550604	45-225			
FM30C250G	550605	50-250			
FM30C350G	550606	70-350	3" – 8 NPSC	7.52"	7.4"
FM40C475G	550607	95-475			
FM40C450G	550608	90-450			
FM40C600G	550609	120-600	4" – 8 NPSC	8.06"	7.4"

Rev. 2/01

Specification

Vent-Scrub® Adsorber Model No.	200	400	1000/2000	3000	8000
Dimensions, diameter & overall height	60" x 112"	96" x 131"	122" x 134"	152" x 138"	98" x 59" / 98" x 95"
Inlet Connection	6" Flange	6" Flange	2" FNPT	4" FNPT	4" FNPT	10" Flange
Outlet Connection	6" Flange	6" Flange	2" MPT	4" FNPT	4" FNPT	10" Flange
Access	6" top	6" top	6" top	20" top/Sidecar	20" top/Sidecar	Manway
Internal Distributor	FRP/PP	FRP/PP	FRP/PP	PVC	PVC	FRP/PP
Interior Coating	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy
Exterior Coating	Epoxy/Urethane	Epoxy/Urethane	Epoxy/Urethane	Enamel	Epoxy/Urethane	Epoxy/Urethane
Volume (cu.ft.)	6.2	14	30/60	80	180	Carbon
Cross Sectional Area (sq.ft.)	2	4	9	12	30	50
Approx. Carbon Weight (lbs)	200	400	1000/2000	3000	8000	5000
Empty Vessel Weight (lbs)	450	800	890/1190	2500	5500	5500
Max. Op. Pressure, psig (max.)	150	150	1390/1190	375	125	3000
Design Pressure, psig	15	15	15	15	15	Pressure, psig (max.)
Design Temperature, deg. F (max.)	140	140	140	140	140	140
Vacuum, in. Hg (max.)	12(2)	12(2)	12(3)	12(3)	12(3)	N/A

Available.

[1] *Carbon steel and stainless steel internals are also a*

2000 Adsorber, contact your Siemens representative.

[2] *For vacuum greater than 12 in. Hg on Vent-Scrub®*

Adsorber, contact your Siemens representative.

[3] *For vacuum service on Vent-Scrub® 3000 and 8000*

scan, email, screen, or overlay the [illegible]

[4] *For higher temperatures*

ng on or draw [illegible] contact your local Siemens sales representative.

For detailed dimensional [illegible]

Warning

The adsorption of organic compounds onto activated carbon generates heat. In rare instances, adsorbed compounds may also react on the carbon surface to generate additional heat. If these heat sources are not [illegible] the carbon bed temperature may rise to the point where the [illegible] ignition of the carbon bed can occur. For other hazardous conditions or a description of industry accepted engineering practices on safe use and operation of activated carbon beds, see [illegible]. In certain applications where the risk of ignition is significant, active gas may not be [illegible]. For more information on this technology, please contact your Technical Sales Representative for more details.

[illegible] Adsorber [illegible] Vent-Scrub® adsorbers are [illegible] closed, poorly ventilated [illegible] oxygen. Dangerously low oxygen levels may exist [illegible]. Workers should follow [illegible] state and federal safety guidelines for entering oxygen depleted areas.

All information presented herein is believed reliable and in accordance with accepted engineering practices. Siemens makes no warranties as to the completeness of this information. Users are responsible for evaluating individual product suitability for specific applications. Siemens assumes no liability whatsoever for any special, indirect or consequential damages arising from the sale, resale or misuse of its products.

Siemens
Water Technologies
2430 Rose Place
Roseville, MN 55113
800.525.0658 phone

Chang, Belssi

From: Nolan Penney -MDE- <nolan.penney@maryland.gov>
Sent: Tuesday, September 22, 2015 5:42 AM
To: Chang, Belssi
Subject: Re: Air Permit for Sub-Slab Depressurization System

At an extraction rate of 1 lb per day, that would still qualify for deminimus exemption under COMAR 26.11.02.10X. No permit will be needed.

On Mon, Sep 21, 2015 at 3:44 PM, Chang, Belssi <Belssi.Chang@tetratech.com> wrote:

> Hello Nolan,
>
> We are currently operating a sub-slab depressurization system at a site in Baltimore, MD which extracts less than 0.5 pounds of VOCs per day and uses two 400-pound granular-activated carbon drums in series to treat the extracted soil-vapors prior to discharge to the atmosphere. At the time that system was installed in 2008, I spoke with David Mummert at the MDE who confirmed that a permit was not required to construct and operate the system based on the low emission rates. We are planning to expand the system with additional extraction points and expect the total combined VOC mass extraction rate will be less than 1 pound per day. Would you let me know if a permit is required for the system expansion? Let me know if you require additional information.
>
> Thank you,
>
> **Belssi Chang Lee** | Senior Engineer | Project Manager
>
> Office: 410.990.4607 | Fax: 410.990.4749
>
> belssi.chang@tetratech.com
>
> **Tetra Tech** | Complex World, Clear Solutions Ê
> 51 Franklin Street, Suite 400, Annapolis, MD 21401 | tetratech.com
>
>

Agenda – December 8, 2015

- Charter Review / Kickoff – Tom Blackman (if available)
- FMEA Process – Lynnette Drake/Jeff Thomas
- Review Previous FMEAs; some relevant failure modes are in today's matrix
- Kick-off FMEA
  - Define potential failures
  - Recommended actions
- Event schedule – 8:30 am-5:00 pm ET, virtual conference

SSDS Performance Requirements

- MDE guidelines for indoor air concentrations (derived from U.S. EPA)
- NO release of untreated VOCs or condensate water to the environment or building
- 24/7 operation
- Timely notification of system failure and/or system shutdown to Tetra Tech operators and then to CDM Smith and LMC
- Availability for purchase, spare parts for rapid repairs
- Maintaining the design vacuum at the vapor monitoring points
  - With rare exceptions due to periodic subsurface moisture or heterogeneity

Property Owner / Tenant Requirements

LOCKHEED MARTIN

- Design:
  - Locations have been selected in coordination with the Plant
    - Allows for limited impact to occupied spaces for OMM.
    - Limit intrusiveness of the system. (Physical, Visual and Noise)
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Definitions of Significant Failures

- Vacuum below slab (< -0.01 inch H_2O)
- Release of VOCs to building air
- Release of condensate to environment or building
- Spill of other materials (coolant, etc) to building or Env.
- System shutdown > 4 hrs (goal), 1 day maximum
- Indoor air: greater than 8.8 ug/m^3 industrial TCE exposure; greater than other chemical exposure thresholds
- Fire originating with the treatment system
- Significant release of Carbon dust to environment
- Any Reportable event
- System operation with spent carbon condition (untreated VOCs to the environment)
- Leak in piping system (vacuum side is less effective; pressure side is released to building air or environment)
- Tenant physically damages the system to the point that it would affect the performance of the system (forklift driver)
- Safety incident
- Utility breach/damage

One-Page Summary –

List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
1	Extraction trench construction	Intercepting a live high voltage electrical line	Loss of life disruption of operations; loss of life if utility is electrical; environmental release	5	Concrete sawcutting, hand digging under slab	3	Subsurface survey by Enviroscan within 1 foot.	4	**60**	Coordinate with local LMCPI electrician. Lineman gloves and electric hazard rated boots are required during sawcutting. Enviroscan will deploy more sensative antenna for shallow depth interrogation and provide written report. TT modified H&S plan to include the above comments.	Tetra Tech						
29	Filter Effectiveness	Filters do not restore indoor air quality to required concentration	insufficient protection of air quality	4	1. Insufficient filter capacity 2. Increased source	3	semiannual air monitoring	4	**48**	More frequent monitoring conducted Pursuing source investigation in 2016	Performing Contractor, RTO Team, LMC Team						
5	Extraction Points	Water accumulation in the sub slab	Loss of flow from extraction points	2	High groundwater levels (usually 10" below the bottom of the concrete)	4	Inspection conducted every two week, flow measurement from each extraction point	4	**32**	Tetra Tech will install the system expansion and operate to see if problem occurs fequently. Periodic inspection based on vacuum flow.	Tetra Tech						
22	Moisture Separator	Drain Valve on Moisture Separator left open	potential to release contaminated air and water to environment	4	Operator error or MRAS employee tampering	2	Every two week inspection (potential to see leaking water is more likely than to hear the air release)	4	**32**	Added as checklist item for verification of completion. No further action.	Tetra Tech						
32	Moisture Separator	Level Switch High fails to indicate high water with															

List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
4	400 pound GAC drums (two in series)	Inadvertent installation of spent carbon	potential release to environment	2	operator error	4	label drums for shipment, post changeout sampling results reviewed by supervisor.	3	**24**	No further action required per update of O&M manual							
25	Power connection	Water damage	Damage to filter	3	Flooding in basement above 2 inches	2	Filter are elevated above floor on casters (appx 9 in.)	4	**24**	No Further Action							
38	Temperature Switch	Temperature Switch fails to trip on high temperature	Desorbs volatiles from carbon bed and potential release to	4	Mechanical failure	2	Every two week inspection, quarterly test	3	**24**	No Action							
6	400 pound GAC drums (two in series)	Seal on the rim fails	release to environment	2	Manufacturer defect (not sealed properly) or Rust	2	Nothing	5	**20**	Inspection at time of delivery, reject on visual. Confirm that this procedure is clearly defined in the O&M manual. No further action.	Tetra Tech						
27	Replacing filters	Power not disconnected	Shock hazard	5	Operator does not observe O&M Manual procedure to close disconnect switch	2	Operator acting in accordance with the O&M Manual	2	**20**	When filters are connected by							

List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
23	Moisture Separator	Break of sight glass on Moisture Separator	potential to release contaminated air and water to environment	4	Operator error or MRAS operator tampering	1	Every two week inspection	4	**16**	Continue inspection every two weeks	Tetra Tech						
26	Replacing filters	Decreased air flow; excess noise	Filter not operating effectively, potentially additional VOCs in indoor air	2	Excessive dust in basement	2	System check every 2 weeks	4	**16**	Extra HEPA pre-filters available for potential change prior to planned quarterly frequency	Tetra Tech Performing Contractor						
30	Filter Effectiveness	Filters restore air quality, are disconnected and subsequent six month monitoring round shows unacceptable air quality	insufficient protection of air quality	4	belief that the problem is solved	1	semiannual air monitoring	4	**16**	No plan to turn off filters unless they are replaced with a more robust system	Tetra Tech Performing Contractor						16
8	4" Hose to GAC following Flow Indicator	Hose failure (crack or fatigue)	release of untreated air to environment	2	stress points (short radius bends)	2	visual inspection every two weeks	3	**12**	Hose lengths minimized as							

List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
42	Influent Filter System	One of the vacuum gauges across the filter system is faulty	Inability to read the delta P across the filter	2	Mechanical failure	2	Every two week inspection	3	**12**	Gauge and other readings reviewed bi-weekly and guage replaced immediately if the data does not look right	Tetra Tech						12
45	Skid	Damaging new skid during															

List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
2	Sample taps	Left open	release to environment	2	Operator error or MRAS operator tampering with sample taps	2	Every two weeks inspection. Quick connects installed (2010), Auto Dialer.	2	**8**	Two independent valves are installed at each location. Quick disconnect automatic shutoff valve systems installed by Tetra Tech to minimize operator error. No further action.	Tetra Tech						
14	Extraction point	Silt clogging of point	Loss of flow from these points	2	Native soil collecting into the extraction point	2	Inspection conducted every two week, flow measurement from each point, trends can detect.	2	**8**	Continue bi-weekly monitoring.	Tetra Tech						8
19	Post heat exchanger high temp. switch	failure of high switch point to occur	premature breakthrough of carbon	2	defective switch or operator adjustment of switch	2	bi-weekly inspection of manual temp. gauge	2	**8**	Continue bi-weekly monitoring and quarterly testing of switch.	Tetra Tech						
20	Heat Exchanger operation	The fan on heat exchanger	effluent temp. would rise	2	motor failure	2	temp. switch that detects high temp. which will cause	2	**8**	temp. switch that detects high temp. which will cause system shutdown . No additional action.							
21	Level switch on air water separator	Water accumulation in separator	saturation of upstream carbon vessels.	2	defective switch	2	high pressure alarm on lower discharge	2	**8**	Continue to conduct quarterly inspections.	Tetra Tech						
24	Extraction Points	Concrete Shrinkage and Cracks	Potential to have loss of vacuum and reduced capture of VOCs	2	Physical damage or intentional breach of concrete	1	GE contract requires notification of LMCPI to do building mods, every two week inspection	4	**8**	Tony attends meetings - dialogue improved							
46	Piping	Utility damage while hanging pipe	Distruption of facility ops	4	Installer error/careless ness	2	Visual - immediate	1	**8**	Coordinated with facility to help avoid utility issues.							
9	4" Hose to GAC following Flow Indicator	Camlock connection fails	release of untreated air to environment	2	Operator error or MRAS operator tampering	3	Cotter Pins to ensure camlocks are in place. Zip ties installed to prevent tampering (2010)	1	**6**	Zip ties installed. No further action.							
12	4" Hose to GAC following Flow Indicator	Camlock barb and hose joint failure	release of untreated air to environment	2	wear or over tightening	1	Every two weeks inspection visual inspection Hoses replaced as necessary	3	**6**	Continue bi-weekly monitoring of hoses and replace as necessary.	Tetra Tech						

List Nbr	Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Causes	Prob	Detection	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Response	Actions Taken	New Sev	New Occ	New Det	New RPN
13	4" Hose to GAC following Flow Indicator	Material incompatibility between PVC, CPVC and aluminum	release of untreated air to environment	2	wear or over tightening	1	Every two weeks inspection visual inspection Hoses replaced as										

APPENDIX G—PRELIMINARY CONSTRUCTION SCHEDULE

ID	Task Name	Duration	Start	Finish	Predecessors
1	**100% Design Package Approval**	1 day	Mon 2/15/16	Mon 2/15/16	
2	**SSD System Expansion Construction**	**85 days**	**Tue 2/16/16**	**Mon 6/13/16**	
3					
4					
5					
6					
7					