FINAL REMEDIAL DESIGN
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

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Prepared for

Transwestern Pipeline Company
6381 North Main Street
Roswell, New Mexico 88201

Prepared by

Tetra Tech EM Inc.
6121 Indian School Road, NE, Ste. 205
Albuquerque, New Mexico 87110

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1.0 INTRODUCTION

On behalf of Transwestern Pipeline Company, Tetra Tech EM Inc. (Tetra Tech) has prepared this Final Remedial Design (RD), Volume 2, Plans and Specifications, to address soil and groundwater contamination at Transwestern Pipeline Company's Compressor Station Number 9 – Roswell (Roswell Station). The Roswell Station is located approximately 9 miles north of the city of Roswell along U.S. Highway 285 (Drawing G-1). A site plan is provided on Drawing G-1.

This RD Volume 2 is a companion document to the Conceptual RD (Volume 1) (Tetra Tech 2002), and provides specifications, plans, and manufacturer cut-sheets for specified equipment. The remediation systems described herein consists of multi-phase extraction (MPE), a combination of soil vapor extraction (SVE) and total fluids (groundwater and PSH) recovery. The goals of the MPE phase are (1) removal of PSH from the subsurface and (2) reduction of soil and groundwater constituents to levels more amenable to passive bioremediation.

This Final RD is divided into 4 Sections, of which this introduction is Section 1. Section 2 provides a narrative of the remedy, including description of the remediation system, and basis of design. An operation, maintenance, monitoring, and reporting plan, including annual evaluation of remediation in accordance with 20 NMAC 5 §1224 is provided in Section 3. Finally, Section 4 provides a list of references.

Specifications for constructing the system are provided in Appendix A. Manufacturers cut-sheets are supplied in Appendix B. Finally, Appendix C contains design drawings for the system.

2.0 REMEDIATION SYSTEM NARRATIVE

The proposed remedy for soil and ground water contamination and phase-separated hydrocarbon recover is soil vapor extraction and (SVE) and multi-phase extraction (MPE). The distribution of contaminants in the subsurface is shown on Drawings G-2 and G-3.

2.1 Description of Remediation System

Detailed elements of the remediation system are shown on Drawings C-1 through C-8, P-1 through P-3, and E-1 (Appendix C). The proposed system features include the following:

- Two Baker furnace 200-cfm thermal oxidizers
- Carbonair COWS 25 oil-water separator
- Carbonair STAT 80 stacked-tray air stripper
- Pneumatic total fluids recover system including pump controller
- Day tank and irrigation system for discharge of treated effluent.
- Conveyance piping consisting of SDR 11 high-density polyethylene (HDPE) in dedicated conveyance runs from each well to the manifolds.

2.2 Basis of Design

The design is based on several factors, including the following:

- The maximum air flow rate from a single MPE well is 20 CFM as indicated in the SVE pilot test (AcuVac 1996).
- The maximum sustainable total fluids flow rate from a single MPE well is 0.5 gallons per minute based on evaluation of aquifer permeability and thickness.
- Fifteen MPE wells will be fitted with pneumatic pumps at any given time.

Discussions regarding the design factors are provided below.

Pneumatic Design - SVE Conveyance

Conveyance piping shall be sloped to the extraction wells at a rate of 0.5 feet of drop per one hundred feet of run. Natural terrain will be used to extent practicable to achieve this specification. The 1.5-inch conveyance pipe is designed to provide adequate pipe velocities (e.g., 2,500 to 4,000 feet per minute [ft/min]) to clear fluids and sediment while maintaining acceptable head losses (USCOE 1995, WDNR 1993). The four-inch manifold header is designed to experience minimal head loss at the compounds.

Hydraulic Design

Conveyance piping for the hydraulic system is based on anticipated flow rates and standard piping sizes. Conveyance lines to individual wells are 3/4-inch SDR 11 HDPE and are designed to carry 0.5 gpm. Header lines are 1-inch in diameter and designed to carry a maximum of 5.5 gpm (from Circuit A, Drawing C-2). The conveyance line from the air stripper to the day tank is 1-inch in diameter and designed to convey 15 gpm. Finally, the conveyance line to the sprinklers is 2-inch and designed to carry 50 gpm.

3.0 OPERATION, MAINTENANCE, AND MONITORING PLAN

Operation, maintenance (O&M), and monitoring of the remediation system, troubleshooting, and system performance evaluation are presented in this section. O&M activities include the startup phase and the long-term O&M phase.

3.1 Startup Phase

One week of startup testing is scheduled to ensure the remediation system is operating as specified. Startup testing will include ensuring the system is properly constructed, that equipment and monitoring devices are working are as specified, and that flow rates, vacuums, and vapor concentrations are within anticipated ranges.

Table 1 provides a checklist for final construction inspection of the remediation system, to be performed prior to operating the system. This checklist will be completed during final inspection. Table 2 provides a functional performance checklist to be competed each day during the startup phase to ensure all systems are working as designed. Tables 3 and 4 provide a summary of parameter measurements to be evaluated for system performance assessment during the startup phase.

3.2 Long-Term O&M Phase

Data must be collected during the long-term O&M to evaluate several factors, including:

- Mass removal rates
- Cumulative mass removed
- Emission rates and Permit compliance
- Deviations in flow rate or vacuum over time
- Establishment of vacuum throughout zone of remediation
- Progress toward achieving final site cleanup goals

Long-term O&M testing requirements, frequencies, and method of measurement are provided in Table 4. Table 5 consists of a form for logging field data during site inspections.

3.3 Reporting and Performance Assessment

Routine reports on operation of the remediation system will be prepared. The reports will include:

- Groundwater quality and fluid gauging data.
- Evaluation of system performance, including emission rates, mass removal rates, system run-time, and establishment of vacuum within the zone of remediation.
- Calculations and graphs demonstrating that cleanup goals are being achieved on schedule.
- A summary of all O&M activities performed.
- Recommendations for improving system performance, if warranted.

4.0 REFERENCES

AcuVac Remediation. 1996. Pilot Test: Roswell Compressor Station, Roswell, New Mexico. Letter Report to Mr. Bob Marley, Daniel B. Stephens & Associates. September 30.

American Society for Testing and Materials (ASTM). 1998. "Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites." ASTM E 1943-98. August.

Cypress Engineering. 2001. Annual Report of Groundwater Remediation Activities Compressor Station No. 9 – Roswell, New Mexico, Transwestern Pipeline Company. February 20.

Environmental Protection Agency (EPA). 1995. How to Evaluate Alternative Cleanup Technologies for Underground Storage Sites – A Guide for Corrective Action Plan Reviewers. EPA 510-B-95-007. May.

EPA. 1999. Multi-Phase Extraction: State of the Practice. EPA 542-R-99-004. June.

Hinchee,Robert E. 1994. Bioventing Petroleum Hydrocarbons *in* Handbook of Bioremediation, Robert D. Norris, Editor. Lewis Publishers. Pp. 39-59.

New Mexico Oil Conservation Division. 1993. Unlined surface impoundment closure guidelines (February 1993). Tab 7b. In Environmental Regulations, State of New Mexico Energy, Minerals, and March 13.

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United States Army Corps of Engineers. 1995. Soil Vapor Extraction and Bioventing. Engineer Manual 1110-1-4001. November 30.

Wisconsin Department of Natural Resources, 1993. Guidance for Design, Installation, and Operation of Soil Venting Systems. Publication SW185-93, July.

TABLES

TABLE 1
PRECOMMISSIONING CHECKLIST
ROSWELL COMPRESSOR STATION, ROSWEL, NEW MEXICO

Checklist Item	*Responsible Person*	*Initials*	*Inspection Date*
Subsurface			
Wells/trenches installed per specification			
Wells purged/cleaned			
Pneumatic pumps installed to specification			
Piping Installation			
Piping complete (including from wells/trenches)			
Valves installed and operation verified			
Pressure test complete			
Remediation Compound and Equipment			
Foundations / slab complete			
Buildings installed to specification			
Fence installed to specification			
Headers built to specification			
Blower connections installed/tested			
Air compressor installed to specification			
Oil water separator installed to specification			
Air stripper installed to specification			
Monitoring points functional			
Valves, meters, and gauges installed and functional			
Electrical			
Grounding installed/checked			
Lighting functional			
Lockouts/covers/panels in place			
Blower rotation verified			
Disconnects in sight of unit being controlled			
Controls/alarms and interlocks functional			
Other			

Modified from USACE 1995

TABLE 2
FUNCTIONAL PERFORMANCE CHECKLIST FOR STARTUP TESTING
ROSWELL COMPRESSOR STATION, ROSWELL, NEW MEXICO

Checklist Item	*Responsible Person*	*Initials*	*Inspection Date*
Subsurface			
No piping/well pneumatic leaks			
Monitoring point vapor concentrations within limits of air quality permit			
Vacuum observed at all monitoring points within zone of remediation			
Extraction well vacuums within expected ranges based on blower curves and anticipated head losses			
Remediation Equipment			
All switches and safety interlocks functioning			
Operating points match blower curve specification for flow rate vs. vacuum through start-up			
Pneumatic pumps operating within anticipated range for pressure, discharge, and well drawdown			
Current draw and voltage balance match manufacturers specifications			
No excessive vibration/noise/temperature rise			
Monitoring Systems			
Magnehelic and Capsuhelic gauges recording within specified range.			
Vacuum gauges recording within specified range			
FID / LEL / O_2 meters hold calibration			
Stack emission rates within limits of air quality permit			

NOI = Air Quality Bureau Notice of Intent
FID = Flame ionization detector
LEL = Lower explosive limit
O_2 = Oxygen
Modified from USACE, 1995

TABLE 3
ROUTINE EQUIPMENT OPERATION AND MAINTANANCE TASKS
ROSWELL COMPRESSOR STATION, ROSWELL, NEW MEXICO

Activity	Activity Description	Frequency
1	Monitor system performance	Weekly
2	Inspect system for leaks	Weekly
3	Record operating parameters	Weekly
4	Record volume of fluids in knock-out pot	Weekly
5	Test GFCI devices	Weekly
6	Re-torque terminal screws & tighten loose hardware	Monthly
7	Calibrate or zero instrumentation	Monthly
8	Treat air stripper to prevent scaling	Monthly
9	Inspect, clean or replace filters, valves, equipment	Monthly
10	Site cleanup	Monthly
11	Inspect, clean or replace knock-out pot filter	Quarterly
12	Clean high-level switch & sight glass	Quarterly

Notes:

[a] The frequency of these activities is estimated; the actual frequency will be determined by actual conditions

[b] Bearing should be changed after 15,000 to 20,000 hours on average as per service and parts manual

TABLE 4
SYSTEM MONITORING REQUIREMENTS
ROSWELL COMPRESSOR STATION, ROSWELL, NEW MEXICO

SYSTEM STARTUP TESTING			
Monitoring Parameter	**Frequency**	**Monitoring Point**	**Method of Measurement**
Vapor and Water Flow Rates	Daily	SVE Manifolds (Individual Wells)	Pitot tube and Capsuhelic Gauge
		Upstream of SVE Blowers	Pitot tube and Capsuhelic Gauge
		Downstream of SVE Blowers	Pitot tube and Capsuhelic Gauge
		Pneumatic Pump Manifolds (Individual Wells)	Bucket fill time
		Downstream of Oil/Water Separator	Totalizing Flow Meter
Well Vacuum	Daily	Monitor Well Heads	Magnehelic Gauge and Expansion Cap
		Manifolds (Individual Wells)	Vacuum Gauge
Vapor Concentrations	Daily	Manifolds (Individual Wells)	Peristaltic pump / FID
		Upstream of SVE Blowers	Peristaltic pump / FID
		Downstream of SVE Blowers	FID
Groundwater Discharge Concentrations	Daily	Upstream of Air Stripper	Sample collection/analysis by EPA method 8015 for TPH
		Downstream of Air Stripper	Sample collection/analysis by EPA method 8015 for TPH
Oxygen Content	Daily	Manifolds (Individual Wells)	Peristaltic Pump / LEL / O_2 Meter
		Upstream of SVE Blowers	Peristaltic Pump / LEL / O_2 Meter
		Downstream of SVE Blowers	LEL / O_2 Meter
LONG-TERM OPERATION TESTING			
Monitoring Parameter	**Frequency**	**Monitoring Point**	**Method of Measurement**
Vapor and Water Flow Rates	Monthly	SVE Manifolds (Individual Wells)	Pitot tube and Capsuhelic Gauge
		Upstream of SVE Blowers	Pitot tube and Capsuhelic Gauge
		Downstream of SVE Blowers	Pitot tube and Capsuhelic Gauge
		Pneumatic Pump Manifolds (Individual Wells)	Bucket fill time
		Downstream of Oil/Water Separator	Totalizing Flow Meter
Well Vacuum	Monthly	Monitor Well Heads	Magnehelic Gauge and Expansion Cap
		Manifolds (Individual Wells)	Vacuum Gauge
Field Vapor Concentrations	Monthly	Manifold (Individual Wells)	Peristaltic pump / FID
		Upstream of SVE Blowers	Peristaltic pump / FID
		Downstream of SVE Blowers	FID
Lab Vapor Concentrations	Monthly	Downstream of SVE Blowers	Peristaltic pump and Tedlar bags; VOCs & TPH by EPA 8260 and EPA 8015
Groundwater Discharge Concentrations	Monthly	Upstream of Air Stripper	Sample collection/analysis by EPA method 8015 for TPH
		Downstream of Air Stripper	Sample collection/analysis by EPA method 8015 for TPH
Oxygen Content	Monthly	Manifold (Individual Wells)	Peristaltic Pump / LEL / O_2 Meter
		Upstream of SVE Blowers	Peristaltic Pump / LEL / O_2 Meter
		Downstream of SVE Blowers	LEL / O_2 Meter
Fixed Gases	Monthly	Downstream of SVE Blowers	Peristaltic pump and Tedlar bags; Analyze by ASTM D 1946

Notes:
ASTM = American Society for Testing and Materials
FID = Flame ionization detector
PID = Photoionization detector
LEL = Lower explosive limit
O_2 = Oxygen
EPA = U.S. Environmental Protection Agency
VOCs = Volatile organic compounds
TPH = Total petroleum hydrocarbons

TABLE 5
ROUTINE MONITORING DATA FORM
ROSWELL COMPRESSOR STATION

Date: _____ Time: _____ Operator: _____

Monitoring Parameter	**SVE Data Monitoring Point**													
			Header	MPE/SVE Well Number										
	T.O.1	T.O.2												
System Vacuum														
Vapor Measurement														
Flow Rate Data														
Oxygen (percent)														
LEL (percent)														

Monitoring Parameter	**Total Fluids Data Monitoring Point**													
	Compound		Header	MPE/SVE Wells										
Flow Rate														
PSH Recovered														
Flow Meter Reading														

Other Notes:

APPENDIX A
SPECIFICATIONS

SPECIFICATION 1

SUMMARY OF WORK

PART 1—GENERAL

1.1 SUMMARY

This section includes basic identification of the work and other related activities.

1.2 PROJECT DESCRIPTION

The project includes, but is not limited to, the following:

A. Installation and startup testing of a multiphase extraction (MPE) system at the Transwestern Pipeline Company Compressor Station 9 in Roswell, New Mexico. The construction will take place on an active plant – therefore, adherence with all plant protocols and procedures specific to on-site contractors must be strictly adhered to throughout the course of the project.

B. Much of the earthwork for installing conveyance lines for the system will take place on open grazing land. As such, trenching will be performed with a trenching machine, pipes laid, and the trenches backfilled and compacted by wheel rolling. The goal is to expedite installation of conveyance systems and minimize the level of effort accordingly.

C. Several conveyances will cross a 10-inch natural gas pipeline (very high pressure). Contractor shall coordinate with Engineer and plant engineering department to coordinate location and potholing the gas line to avoid accidents. Regardless of Engineer supplied plans as drawn, Contractor shall coordinate with Engineer to minimize pipeline crossings. It will be desirable to cross the pipeline once if possible.

D. In trafficked areas on the plant proper, trenching and backfill will be to more rigorous specifications and will require the use of a backhoe. The exception to this requirement will be installation of natural gas line and water line from the main plant area to the remediation system area (about 1,200 feet).

E. Manifolds and conveyance piping connections shall be constructed on pipe supports (e.g., UniStrut) set to elevation and concreted in place in shallow post-holes prior to pouring permanent building slabs.

F. Remediation buildings, concrete pads, and electrical service will provided by the Engineer via a separate subcontract.

G. Remediation equipment to a large extent will be supplied by the Engineer. This is called out clearly throughout the specifications where applicable.

H. The work shall include the following as shown on the plans and as specified herein:

1. Procure and install conveyance systems to each of 37 MPE wells and 7 soil vapor extraction (SVE) wells.

2. Install Engineer provided pneumatic pumps.
3. Procure and install wellheads and extensions as indicated in plans.
4. Procure and construct SVE, total fluids, and pneumatic manifolds as specified.
5. Procure and install piping from manifold to the remediation equipment as indicated.
6. Install and provide power to all remediation equipment and controllers as indicated.
7. Install natural gas and water service to the equipment compound as indicated.
8. Retrofit an existing day tank to become an integral component of the treated water effluent system as indicated.
9. Hook-up all remote telecommunications systems for water treatment control panel and thermal oxidizers.
10. Restore all impacted site surfaces, as specified, whether directly or indirectly related to the Contractors completion of the work.
11. Perform seven (7) days of system startup testing in accordance with Operation and Maintenance requirements stated in the Remedial Design.

1.3 CONTRACTOR'S USE OF PREMISES

A. LIMITED USE

1. Limit use of the Owner's property to that required for execution of the work. Limit storage of materials and equipment to the Owner's property only. Portions of the site beyond areas in which construction operations are indicated are not to be disturbed.
2. Conduct operations to ensure the least inconvenience to adjoining property owners and to the general public.

1.4 OWNER'S USE OF PREMISES

The Owner and the Company will require access to the site during the entire construction period. The Contractor shall cooperate with the Company and the Owner during construction operations to minimize conflicts and to ensure access to existing groundwater monitoring wells.

1.5 WORK SEQUENCE

A. GENERAL: Construction sequence shall be determined by the Contractor, subject to the Company's approval.

B. SCHEDULED EVENTS: Schedule the work to conform to the following events and dates:

1. All construction work shall be completed by December 31, 2002.
2. Placement of remediation equipment and start up testing shall be performed in spring 2003.

1.6 PRECONDITION PHOTOGRAPHIC SURVEY

Prior to the start of construction, the site and all structures which may be affected by the construction may be photographed by the Company in the presence of the Contractor. Attention will be paid to existing

defects. Photographs will indicate date, time, weather conditions, and all the Contractor's and the Company's staff present. Original photographs will remain with the Company. Copies can be provided to the Contractor upon request.

1.7 COORDINATION WITH UTILITIES

The Contractor shall coordinate all work involving either public or private utilities and shall satisfy himself as to the existing conditions for the areas in which he is to perform his work. The Contractor shall also be responsible for coordinating any and all work performed by his Subcontractors on or adjacent to either public or private utilities.

1.8 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

During all construction activities, the Contractor shall be solely responsible for the protection of all private or public buildings, structures, and utilities whether or not shown on the plans and should be responsible for their support as necessary. Any damage resulting from the Contractor's operations shall be repaired immediately by him at his expense.

1.9 COPIES OF DOCUMENTS

A. FURNISHED COPIES: The Contractor will be provided (at no cost) three (3) sets of full-size drawings, including revised drawings, and one (1) set of the Remedial Design Report following issuance of the Company's written contract.
B. ADDITIONAL COPIES: Additional copies of above documents will be supplied at printing and delivery cost upon request.

PART 2—PRODUCTS

NOT APPLICABLE

PART 3—EXECUTION

NOT APPLICABLE

END OF SPECIFICATION 1

SPECIFICATION 2

CONCRETE, FORMS AND REINFORCEMENT

PART 1—GENERAL

1.1 SUMMARY

A. DEFINITION: This Section includes concrete, forms, and steel reinforcement.

B. RELATED WORK SPECIFIED ELSEWHERE

1. None

1.2 REFERENCES

A. APPLICABLE STANDARDS

1. American Concrete Institute (ACI)

a. 304 Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
b. 305 Committee Report on Hot Weather Concreting
c. 306 Committee Report on Cold Weather Concreting
d. 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
e. 318 Building Code Requirements for Reinforced Concrete

2. American National Standards Institute (ANSI)

a. B18.2.1 Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Lag Screws
b. B18.2.2 Square and Hex Nuts

3. American Society for Testing and Materials (ASTM)

a. A36 Structural Steel
b. A82 Cold Drawn Steel Wire for Concrete Reinforcement
c. A185 Welded Steel Wire Fabric for Concrete Reinforcement
d. A307 Low Carbon Steel Externally and Internally Threaded Standard Fasteners
e. A615 Deformed and Plain Billet Steel Bars for Concrete Reinforcement, Grade 60
f. C31 Making and Curing Concrete Compression and Flexure Test Specimens in the Field
g. C33 Concrete Aggregates
h. C39 Compressive Strength of Cylindrical Concrete Specimens
i. C94 Ready Mixed Concrete
j. C143 Slump of Portland Cement Concrete
k. C150 Portland Cement

l. C172 Sampling Fresh Concrete
m. C260 Air Entraining Admixtures for Concrete
n. C309 Liquid Membrane-Forming Compounds for Curing Concrete
o. C494 Chemical Admixtures for Concrete
p. C1116 Fiber-Reinforced Concrete and Shotcrete
q. C138, C173, or C231 Testing for Air Content

PART 2—PRODUCTS

2.1 CONCRETE MATERIALS

A. CEMENT: Conform to ASTM C150. Portland cement Type I or III.

B. WATER: Clean and free from injurious amounts of oil, acids, alkalies, or other deleterious substances. Any potable water is acceptable.

C. FINE AGGREGATES: Clean natural sand. Manufactured sand may be used upon written approval of Company. Conform to ASTM C33.

D. COARSE AGGREGATES: Clean crushed stone or processed gravel, not containing organic materials. Conform to ASTM C33.

E. WATER-REDUCING ADMIXTURE: Conform to ASTM C494, Type A.

F. WATER-REDUCING ADMIXTURE: Conform to ASTM C260.

G. FIBER REINFORCEMENT: Conform to ASTM C1116, Type III Synthetic Fiber-Reinforced Concrete.

2.2 CONCRETE MIX PROPORTIONS

A. MIX DESIGN SHALL BE PREPARED WITH THE FOLLOWING PROPORTIONS AND LIMITATIONS:

1. Minimum compressive strength of 3,500 psi at 28 days
2. Minimum cement: 564 pounds per cubic yard
3. Slump: 5 inches maximum
4. Air Entrainment:

Maximum Size Coarse Aggregate (inches)	Air Content (percent by volume)
3/8	6 - 10
1/2	5 - 9
3/4	4 - 8
1	3.5 - 6.5
1.5	3 - 6
2	2.5 - 5.5
3	1.5 - 4.5

B. READYMIXED CONCRETE

1. Concrete shall meet requirements of ASTM C94 and of materials and proportions specified.
2. Ready-mixed concrete plant shall be subject to approval of the Company.

2.3 FORMS

A. FORM MATERIALS: Use one of the following:

1. Exterior grade 5/8-inch-thick plywood (use only plywood or steel for all exposed concrete work).
2. Steel.
3. Approved wood fiberboard.
4. Dressed lumber free of loose knots.

B. FORM TIES: Approved break back-type.

2.4 STEEL REINFORCEMENT

A. REINFORCEMENT BARS: Conform to ASTM A615 of A706, Grade 60 for all bars number 4 or larger.

B. TIE ALL BARS, NO. 3 AND LARGER: Conform to ASTM A615, Grade 40.

C. WELDED WIRE FABRIC: Conform to ASTM A185, using bright basic wire conforming to ASTM A82. Wire gauge number 11 or smaller shall be galvanized.

D. BOLSTERS, CHAIRS, AND ACCESSORIES: Conform to ACI 315.

2.5 FIBER REINFORCEMENT

A. 100 percent virgin polypropylene, fibrillated fibers containing no reprocessed olefin materials and specifically manufactured for use as concrete secondary reinforcement.

B. Volume per cubic yard shall equal a minimum of 0.1 percent (1.5 pounds).

C. Fibers are for the control of cracking due to drying shrinkage and thermal expansion/contraction, reduction of permeability, increased impact capacity, shatter resistance, abrasion resistance, and added toughness.

2.6 GROUT

A. PLAIN GROUT

1. One (1) part portland cement to two (2) parts sand by volume.
2. Keep water to a minimum as required for placing by the dry packing method.
3. Place after the mixed grout has been allowed to stand for two (2) hours.

B. GROUT FOR BONDING

1. One (1) part cement to 1-1/2 parts sand by weight.
2. Keep water to a minimum.
3. Place immediately.

2.7 ANCHOR BOLT

A. Provide all anchor bolts required for complete installation.

B. Anchor bolts and accessories shall conform to ASTM A307 using A36 steel.

C. Use hexagonal bolts and nuts conforming to ANSI B18.2.1 and B18.2.2.

PART 3—EXECUTION

3.1 FIELD TESTING

A. FIELD TESTING OF CONCRETE AND MAKING OF CONCRETE TEST CYLINDERS

1. Test concrete conforming to ASTM C143 and C172.
2. Perform slump tests throughout any placement as required to maintain constant quality of fresh concrete, and as requested by the Company.

3.2 PLACING OF CONCRETE

A. PREPARATION

1. Clean bonding surfaces free from laitance and foreign materials.
2. Place concrete on properly prepared and unfrozen subgrade and only in dewatered excavations.
3. Do not deposit partially hardened concrete or concrete contaminated by foreign materials.

B. PLACING CONCRETE

1. Conform to ACI 304.
2. Place on prepared subgrade using hand placement methods and screed to final grade.
3. Place within 45 minutes after mixing, unless the Company extends the period to 90 minutes (maximum) dependent upon weather conditions.
4. Place in horizontal layers not exceeding 18 inches.
5. Vibrate concrete to produce solid mass without honeycomb or surface air bubbles.
6. After initial set, finish and neatly edge concrete.

C. CURING CONCRETE

1. Cure exposed surfaces with liquid membrane-forming compound conforming to ASTM C309, Type I. Apply according to manufacturer's recommendations.
2. Apply curing compound immediately after removing form or after finishing concrete.
3. Keep formwork wet until stripped.

D. COLD WEATHER PLACING: Conform to the practice recommended in ACI 306 when the temperature is below 40 degrees F or is likely to fall below 40 degrees F during 24 hour period after placing.

E. HOT WEATHER PLACING: Conform to practices recommended in ACI 305 when temperature is 90 °F or above or is likely to rise above 90 °F within 24 hours after placing.

3.3 CONSTRUCTION JOINTS

A. Locate as recommended by the Contractor and where indicated. Conform to ACI 318.

B. Clean and break laitance or other foreign material from bonding surface. Bed with 1 inch of grout for bonding in horizontal joints.

3.4 SURFACE FINISHES

A. FLOAT FINISH

1. Compact, accurately screed, and wood float all slabs to a true uniform surface.
2. Test surface with straight-edge and eliminate high and low spots of more than 1/8 inch in 10 feet.
3. Use this finish in addition to the finishes specified below for all surfaces as indicated.
4. Use as final finish for slabs not exposed.

B. BROOM FINISH

1. Finish surface as in "Float Finish" and, draw a stiff bristled broom across the previously floated surface.
2. Make corrugations uniform in appearance, not more than 1/16 inch in depth, and perpendicular to direction of traffic.
3. Use this finish on all outdoor slabs subject to vehicular or pedestrian traffic.

C. HARD TROWLED FINISH

1. Finish surface as in "Float Finish" and trowel with steel trowel to obtain smooth, dense finish after concrete has hardened to ring under the trowel.
2. Use this finish on all floors, slabs, and equipment bases not specifically designated for a different finish.

D. BURLAP FINISH

1. Apply burlap surface treatment to exposed edges of slabs, curbs, and foundations.
2. Wet and fill all voids using mortar with the same sand-cement ratio as original concrete. Use approximately 20 percent white cement to match concrete color.
3. In a circular motion, use a burlap or canvas cloth to strike off all excess mortar flush with the surface.
4. Remove all rough spots and rub with cloth to leave a surface of uniform texture and appearance.
5. Finish shall result in a coating of mortar that will fill all small voids and air holes, leaving a smooth surface.
6. Cure as specified under "Curing Concrete".

E. DEFECTIVE SURFACE TREATMENTS

1. After removal of forms, remove all fins, projections, and form ties.
2. Grout and cure all voids, damaged areas, and tie holes.

3.5 FORMS

A. Treat forms with an approved oil or lacquer prior to placing reinforcement.

B. Wet forms with clean, clear water prior to placing concrete.

C. Adequately brace and stiffen forms to prevent deflection and settlement.

3.6 STEEL REINFORCEMENT

A. Place accurately, tie at intersections, and support on chairs. Conform to ACI 318.

B. Tie securely with 16-gauge or larger annealed iron wire.

C. Unless otherwise indicated, the minimum length of lap for tension lap splices shall be as required for Class B splices as defined by ACI 318.

D. Lap-welded wire fabric not less than the length of one (1) mesh.

E. Manual lifting during or after concrete placement is not permitted.

END OF SPECIFICATION 2

SPECIFICATION 3

SITE PREPARATION AND EARTHWORK

PART 1—GENERAL

1.1 SUMMARY

A. DEFINITION: This section includes all trenching, excavating, construction, backfilling, compacting, grading, and all related items necessary to complete the work indicated or specified.

B. RELATED WORK SPECIFIED ELSEWHERE

1. Specification for Piping and Accessories

1.2 REFERENCES

A. APPLICABLE STANDARDS

1. American Society for Testing and Materials (ASTM)

a. C88—Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
b. D698—Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 Pound (2.49 kg) Rammer and 12 Inch (304.8 mm) Drop
c. D1241—Materials for Soil-Aggregate Subbase, Base and Surface Courses
d. D4253—Maximum Index Density of Soils Using a Vibratory Table
e. D4254—Minimum Index Density of Soils and Calculation of Relative Density

PART 2—MATERIALS

2.1 MATERIALS ENCOUNTERED

A. SUITABLE BACKFILL MATERIAL: Excavated materials suitable for use as compacted backfill include cohesive and cohesionless material, as defined below, that are free of debris, roots, organic matter, frozen matter, and stones or solid rubble (brick and/or concrete or asphalt pavement) having any dimension greater than 4 inches and which have not been placed in the contaminated soils stockpile.

1. Cohesionless materials include gravel, gravel-sand mixture, sands, and gravelly sands generally exclusive of clayey and silty materials; materials which are free-draining and for which impact compaction will not produce a well-defined moisture-density relationship curve, and materials for which the maximum density by impact methods will generally be less than by vibrating methods.
2. Cohesive materials include silts and clays generally exclusive of sands and gravel, and materials for which impact compaction will produce a well-defined moisture-density relationship curve.

B. UNSUITABLE BACKFILL MATERIAL: Materials unsuitable for use as compacted backfill include all Material that contains debris, roots, organic matter, frozen matter, stones (with any dimension greater than 4-inch diameter), materials which have been placed in the contaminated

soils stockpile, or other materials that are determined by the Company as too wet or otherwise unsuitable for providing a stable subgrade.

C. CONCRETE OR ASPHALT: In general, concrete or asphalt pavement removed during construction will not be allowed for use as trench backfill. Final disposal and/or recycling of concrete or asphalt pavement rubble will be the responsibility of the Contractor. The Contractor must obtain the Company's approval of his intended disposal and/or recycling plan for these materials before hauling any of the material off-site.

2.2 BORROW MATERIALS

A. BORROW MATERIALS INCLUDE THE FOLLOWING:

1. Acceptable backfill materials and granular material obtained from locations arranged for by the Contractor (off the job site), required to the extent that sufficient suitable materials is not encountered and available from on-site excavations.

2.3 GRANULAR MATERIAL

A. Crushed stone or gravel indicating a loss of not more than 15 percent after 5 cycles when tested for soundness with sodium sulfate, as described in ASTM C33 Graduation 67, as follows:

Percent Passing	Sieve Size
100	0.75-inch
60B100	0.5-inch
0B5	Number 4

B. Granular material shall not contain vegetation, root masses, organic matter, fine or harmful substances.

PART 3—EXECUTION

3.1 SITE CLEARING

A. TREES AND VEGETATION: The Contractor shall not cut or injure any trees or other vegetation outside the limits of the area on which work is to be done without permission to do so, and he shall guard against like action by his employees.

B. GROUND SURFACE: All stumps, roots, foreign matter, topsoil, loam, sludge piles, and unsuitable earth shall be stripped from the ground surface. The topsoil and loam shall be used insofar as possible, for finished surfacing. Loam shall not be removed from the site.

3.2 EXCAVATION

A. GENERAL

1. Open trenches and excavations shall be kept to a minimum to allow access to site facilities at all times. No open trenches or excavations will be allowed at the end of each day or over weekends, unless thoroughly barricaded and protected.
2. Steel plates, fences, barricades and other measures necessary shall be used to maintain access to the site and to protect all site occupants and visitors.
3. If required due to soil type, classification, depth of excavation, or other criteria, sheeting and bracing shall be designed, installed, and maintained in full compliance with applicable laws and regulations including, but not limited to, 20 CFR, Part 1926. Excavation support shall be solely the Contractor's responsibility and shall be installed at no additional cost to the Company.
4. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other approved material.

B. EXPLOSIVES

1. Blasting will not be permitted.

C. TRENCHING

1. Trenching shall be dug to the depths shown on the drawings or as directed by the Company. Trench depth shall be increased as necessary to remove unsuitable supporting materials.
2. Trenching will be performed with a trenching machine (e.g., "Ditch Witch" to the extent possible.
3. Trenching in segments containing a high density of conveyance pipe shall be performed with a backhoe equipped with a 2-foot bucket.
4. The Contractor shall excavate the trench to a minimum of 4 inches below the pipe barrel for placement of embedded material.
5. Trenches shall be dug to accommodate a pipe slope from manifolds to extraction wells of a minimum of 6-inches per 100 feet of run.

3.3 EARTHWORK

A. COMPACTION

1. General.

    a. Excavate or backfill as required to construct subgrades to the elevations and grades indicated.
    b. Remove all unsuitable material and replace with acceptable fill material and perform all wetting, drying, shaping, and compacting required to prepare subgrade.
    c. Trenches in un-trafficked areas will be compacted by wheel rolling only
    d. Trenches in trafficked areas and around and under concrete slabs and foundations shall be compacted to 95% standard proctor.

2. Subgrades for Trench Areas

    a. Emplace dry, cohesionless granular materials (e.g., coarse sand or pea gravel) in trench subgrades to set slope for piping. This material shall not be compacted.
    b. Conveyance piping shall be covered with 4-inches of dry, cohesionless granular materials prior to backfilling and compacting.

B. BACKFILLING

1. Construct backfill to the contours and elevations indicated, using suitable approved material.

    a. Place fill material in 0.5- to 1.0-foot layers
    b. Place backfill only on subgrades approved by the Company
    c. Do not place snow, ice, or frozen earth in fill and do not place fill on a frozen surface

2. Obtain compaction by the controlled movement of equipment or as required during the placing and grading of layers and to the minimum density specified for indicated locations.
3. Remove all debris from excavation prior to placement of material.
4. Exercise extreme care in the use of heavy equipment in areas adjacent to structures. Equipment operated within 9 feet of any wall shall not exceed 17,000 pounds gross.

C. SITE GRADING

1. Excavate, fill, compact fill, and rough grade to bring project area to subgrades as follows:

    a. For areas to be paved, to underside of respective surfacing or base course
    b. When rock is encountered in grading areas, overexcavate to depth specified and backfill to grade with earth compacted in place
        i. Under areas to be paved, to 6 inches below top of respective subgrades for such areas.
    c. Finish all ditches, swales, and gutters to drain readily
    d. Unless otherwise indicated, slope the subgrade evenly to provide drainage as indicated in all directions at a grade not less than 0.25 inch per foot

3.4 MAINTENANCE

A. Protect newly graded areas from actions of the elements.

B. Fill and repair settling or erosion and reestablish grades to the required elevations and slopes.

3.5 CARE AND RESTORATION OF PROPERTY

A. TREES: The Contractor shall enclose the trunks of trees adjacent to his work and not to be cut as needed to protect them from injury by piled material, equipment, work operations or otherwise.

B. PAVED SURFACES: If wheel treads will cut or otherwise injure paved surfaces, the Contractor shall not use or operate tractors, bulldozers, or other powered equipment on these surfaces.

C. RESTORATION: All surfaces which have been injured by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately before work was begun. The restoration of existing property or structures shall be done as promptly as practicable and shall not be left until the end of the construction period.

END OF SPECIFICATION 3

SPECIFICATION 4

PIPING AND ACCESSORIES

PART 1—GENERAL

1.1 SUMMARY

A. This Section includes pipe and fittings, strainers, piping specialties, hangers and supports, valves, steam traps, vibration isolators, meters and gauges, and other basic materials.

B. General

1. All special valves, controllers, fittings, and equipment shall meet the following requirements:

    a. Furnished, installed, tested, and put into successful operation.
    b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, and auxiliaries whether indicated or not, but required.
    c. Be insulated and covered in accordance with the pipe system to which they attach.

2. Furnish and install piping connected to accessories which must vary from the drawings because of requirements peculiar to the particular equipment furnished, as required to make a complete and workable installation at no additional cost to the Owner. This requirement shall include changes required in the piping systems because of design changes made by the manufacturer between the time of design and the time of installation or because of equipment furnished by a different manufacturer than that specified.

3. Furnish control valves complete, including pilot lines, solenoid valves, shutoff valves, and operators whether or not specific mention was made of these items. All control valves shall be by the same manufacturer.

4. Furnish the necessary pipe and fittings required to install all safety and relief valves vertically. Furnish and route tail pipes to a place where the discharge will not injure personnel, or as indicated.

5. Where spare, replacement, or additional parts are required for the equipment specified herein, deliver these items to the Owner immediately upon receipt at the job site. Parts shall be packaged and sealed for long storage, securely and visibly labeled as to part, function, and name of equipment to which they apply.

6. Equip all Y-type strainers, 4 inches and larger, with blowdown valves and piping.

C. Related Work Specified Elsewhere

1. Excavation and Backfill Specification

1.2 REFERENCES

A. Applicable Standards

1. American National Standards Institute (ANSI)

    a. B2.1—Pipe Threads (Except Dry Seal)
    b. B16.12—Cast-Iron Threaded Drainage Fittings
    c. B16.22—Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
    d. B16.29—Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV
    e. B31.1—Power Piping
    f. B36.10—Welded and Seamless Wrought Steel Pipe

2. American Petroleum Institute (API)

    a. 5L—Plastic-Coated Steel Pipe

3. American Society of Mechanical Engineers (ASME)

    a. B361—Code for Pressure Piping

4. American Society for Testing and Materials (ASTM)

    a. A53—Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
    b. A74—Cast-Iron Soil Pipe and Fittings
    c. A105—Forgings, Carbon Steel, for Piping Components
    d. A120—Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
    e. A307—Carbon Steel Externally Threaded Standard Fasteners
    f. B32—Solder Metal
    g. B88—Seamless Copper Water Tube
    h. B306—Copper Drainage Tube (DWV)
    i. D1248—Polyethylene Plastic Molding and Extrusion Materials
    j. D1330—Rubber, Sheet Gaskets
    k. D1693—Environmental Stress-Cracking of Ethylene Plastic
    l. D1784—Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
    m. D1785—Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
    n. D2146—Propylene Plastic Molding and Extrusion Materials
    o. D2241—Poly(Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
    p. D2464—Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
    q. D2466—Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
    r. D2564—Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
    s. D2657—Heat Joining of Polyolefin Pipe and Fittings

t. D2665—Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings
u. D2846—Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
v. D2855—Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
w. D3350—Polyethylene Plastic Pipe and Fittings Material
x. F104—Nonmetallic Gasket Materials
y. F493—Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

5. American Water Works Association (AWWA)

    a. C203—Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied

6. Cast Iron Soil Pipe Institute (CISPI)

    a. 301—Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary System
    b. 310—Cast Iron Soil Pipe Institute's Patented Joint for Use in Connection with Hubless Cast Iron Sanitary System
    c. HSN—Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

7. Federal Specification (FS)

    a. QQ-L-201—Lead Sheet

8. Military Specification (MIL)

    a. F-1183G—Fitting, Tube, Cast Bronze, Silver-Brazing

9. Manufacturers Standardization Society (MSS)

    a. SP-58—Pipe Hangers and Supports—Materials, Design and Manufacture
    b. SP-69—Pipe Hangers and Supports—Selection and Application

10. National Sanitary Foundation (NSF):

    a. 14—Plastic Piping System Components and Related Materials

11. Pipe Fabrication Institute (PFI)

    a. ES5—Cleaning of Fabricated Piping

12. Society of Automotive Engineers (SAE)

    a. J514—Hydraulic Tube Fittings

13. Steel Tank Institute (STI):

    a. Sti-P3—3-way Corrosion Protection

14. Underwriters Laboratories (UL)

    a. 58—Steel Underground Tanks for Flammable and Combustible Liquids

1.3 PRODUCT STORAGE AND HANDLING

A. Except for hub-and-spigot, clay, and similar units of pipe, provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps in place through shipping, storage, and handling to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible, store pipe, valves, fittings, and equipment inside and protected from weather. Where necessary to store outside, elevate well above grade and enclose with durable waterproof wrapping.

PART 2—EQUIPMENT AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers and model numbers specified herein are to establish quality and performance only. Products of manufacturers regularly engaged in their manufacture are acceptable if proven to the Engineer as equal or better quality and performance and as stated in the General Conditions.

2.2 PIPE AND FITTINGS

A. Pipe furnished under this contract shall conform to ASTM material specifications herein referenced. All wrought-steel pipe shall meet the standards set forth in ANSI B36.10.

B. Drainage System Soil, Waste, Sparge, and Vent Piping Materials:

1. Polyvinyl Chloride (PVC) Pressure Pipe:

    a. PVC pipe for pressure applications for underground installation shall be of the type and size designated on the drawings, minimum Schedule 40 with solvent-weld joints. Provide threaded joints with Teflon tape or flange joints with nitrile or urethane gaskets as indicated on the drawings.
    b. All fittings shall be of the same manufacturer, material, class, and schedule as the pipe.
    c. Solvent cement joints for the pipe shall be made in accordance with the manufacturer's recommendations and ASTM D2855.
    d. Stop valves shall be 150-pound, true-union PVC ball valves with TFE O–rings, 150-pound PVC butterfly valves, or 150-pound non-rising stem bronze gate valves with screw-in bonnets as indicated.
    e. Applicable System Piping:

i. All below-grade, non-exposed, compressed air piping up to within 20 feet of riser or outside of manholes as indicated.

2. Polyvinyl Chloride (PVC) Pressure Pipe With Pressure Fittings:

   a. PVC fittings shall be Schedule 40 or Schedule 80 as indicated and conform to ASTM D2466. Joints shall be made with solvent cement in accordance with the manufacturer's recommendations. Stop valves and piping between fittings shall be Schedule 40, PVC pressure pipe as specified above.
   b. Applicable System Piping: All soil vapor extraction (SVE) and groundwater recovery (GW) containment system piping.

3. Galvanized Carbon Steel Pipe:

   a. All exposed pipe and fittings for the compressed air piping within 20 feet of and including piping riser and within manholes and all piping for the natural gas service line shall be Schedule 40, hot-dipped galvanized carbon steel pipe.
   b. Stop valves shall be 150-pound, non-rising stem bronze gate valves.
   c. Piping joints to be screwed with Teflon tape or flange with nitrile or urethane gaskets as indicated.
   d. Applicable System Piping:
      i. Compressed air piping as indicated and specified.

4. High Density Polyethylene (HDPE) Thermoplastic Pipe:

   a. Pipe shall conform to ASTM D3350, PE3406 Type III, Grade P34, SDR11.
   b. Applicable System Piping
      i. Below-grade natural gas piping.
      ii. Soil vapor extraction conveyance piping, groundwater extraction and injection conveyance piping, and air sparging conveyance piping.
      iii. The natural gas pipe within five (5) feet of the gas meter and within five (5) feet of the equipment compound will be plastic-coated steel or an approved gas line adapter.

C. Natural Gas System Materials (2 inches and smaller):

1. Pipe:

   a. Schedule 40, seamless or electric-resistance welded carbon steel ASTM A53, Grade A.
   b. Pipe underground: Factory-applied plastic-coated pipe, X-TRU-COAT plastic-coated API-5L, welded carbon steel, Schedule 40, line pipe by Republic Steel. All field joints and damaged areas shall be protected by X-TRU-COAT primer and pressure-sensitive tape.
   c. Pipe underground: Where not prohibited by local codes or utilities or by pressure limitations, black polyethylene thermoplastic piping may be

used. Pipe shall conform to ASTM D3350, PE3406, Type III, Grade P34.

2. Joints: Screwed or butt-welded for steel pipe. Socket-fusion type as outlined in ASTM D2657 for polyethylene pipe.
3. Fittings: 150-pound, malleable iron screwed fittings and unions or butt-weld carbon-steel fittings for steel pipe. Polyethylene fittings shall be of the same material as the pipe.
4. Stop Valves:

    a. Cocks — 125-pound, bronze, threaded ends, square head, Crane No. 254 or equal by Stockham, Jenkins, Walworth, or Lunkenheimer.

2.3 PIPING SPECIALTIES

A. Gaskets:

1. Rubber gaskets for flanged joints, ASTM D1330:

    a. 1/16-inch-thick, full-faced red rubber for all pipe sizes 10 inches and smaller in diameter.
    b. 1/8-inch-thick, full-faced red rubber for all pipe sizes 12 inches and larger in diameter.
    c. 1/16-inch-thick, full-faced neoprene or equal for fuel oil and natural gas service.
    d. Furnish with bolt holes and pipe openings punched.

2. Synthetic fiber gaskets for flanged joints, ASTM F104 (F712400-A9B4E44K5M9):

    a. Garlock 3200 or 3400 synthetic fiber gaskets with SBR binder, manufactured by Chicago Wilcox Mfg. Co.
    b. 1/16-inch-thick, full-faced for flat faced flanges.
    c. 1/16-inch-thick, ring for raised-faced flanges.
    d. Furnish with bolt holes and pipe openings punched.

3. Grooved-End Mechanical Joint Gaskets:

    a. Victaulic "Triple Seal" Grade H synthetic, or Gustin-Bacon Style "C" Type II butyl.
    b. Lubricate gaskets with a lubricant compatible with gasket material and service conditions.
    c. Flange Bolt Thread Lubricant: An antiseize compound and thread lubricant designed for 1,000 °F.

B. Insulating Flanges and Unions:

1. Insulating Flanges: Maloney-flanged insulating set, or approved equal, consisting of Type "E" neoprene laminated phenolic gaskets, integral sleeves, washers, and flat washers.

2. Unions: Insulating type, Epco or approved equal, installed in a position to take pipe line expansion as an axial thrust.

C. Instrument Needle Valves:

1. 3,000-pound, bronze, globe or angle needle or Kel-F, stainless-steel stem, "O" ring or Teflon seal, and screwed ends. Hoke Series 300 or Whitey. Install an instrument needle valve with each pressure gauge.

2.4 PIPE HANGERS AND SUPPORTS

A. Pipe hangers and supports shall meet the requirements of Section 5, ChapterII of ANSIB31.1 and shall be types as given for MSS Standard Practice SP-58 and SP-69.

B. Constant Support, Spring, and Rigid Hangers: Bergen, Blaw Knox, Fee and Mason, Grinnell or NAVCO.

C. Pipe hanger and supports shall be of the types listed in Table 1 "Hanger and Support Selection," MSS Standard Practice SP-69 except that the following figure types given in Fig. 1 will not be acceptable: Types 5, 6, 11, 12, 7, 9, 10, and 25.

D. Hangers supporting bare copper pipe shall be copper plated.

E. All hangers shall have electrogalvanized finish unless copper plated.

F. All hanger rods shall be galvanized or cadmium plated.

G. Concrete Inserts and Expansion Shields:

1. Type A:

a. Unistrut Corporation, Series P-3200 inserts or Brinkley Company.
b. Inserts shall be galvanized and have a recommended load capacity of 2,000 pounds per foot of length in average good concrete with a safety factor of 3.
c. Inserts shall be continuous and located as required.
d. Provide end caps at each end. End caps shall have attached anchor if spacing from end of insert to next anchor is greater than 2 inches.
e. Inserts shall be 5⁄8 inches wide outside by 1⅜ inches deep outside and constructed of minimum 12-gauge galvanized steel, adequate for a ⅞-inch rod and nut.
f. The Contractor shall furnish Unistrut galvanized nuts with or without springs required for work under this contract.

2. Type B: Concrete inserts shall be malleable iron Type 18 listed in MSS Standard Practice SP-69, Grinell, Fig. 282 or Fee and Mason.

3. Type C: Concrete inserts shall be malleable iron, Grinell Fig. 152, Fee and Mason or approved equal.

2.5 METERS AND GAUGES

A. General:

1. Provide all instruments, meters, gauges, and thermometers, complete with interconnecting tubing, piping, valves, as specified and as indicated.
2. Provide gauge cock (shutoff/isolation valve) in the instrument piping connection for all gauges. Gauge cock shall be of the same design requirements as the lines they serve. Quarter-turn brass plug or ball valves are acceptable.

B. Indicating Pressure Gauges and Flow Meters:

1. Vacuum gauges:

   a. Ashcroft 2.5-inch size Model 1490, low-pressure diaphragm gauge or Company-approved equal.
   b. Polysulfone case with ¼-inch NPT lower connection.
   c. Gauges shall be installed into PVC riser with a brass threaded bushing, ½ NPT O.D. by ¼" NPT ID.
   d. Range:0" to 100" W.C. in 1" W.C. increments

2. SVE flow meter:

   a. Each SVE riser pipe shall be fitted with a Dwyer A160 Thredolet, forged steel, 3,000 psi with 3/8-inch NPT brass plug.
   b. Flow measurements shall be made with a Dwyer DS-200-1.5" Flow Sensor pitot tubes installed into the thread-o-let fitting. Measurements shall be made with Dwyer Capsuhelic differential pressure gauges, Model 4000 and Model 4002.
   c. Range:Model 4000 - 0"-0.5" W.C. vacuum, 0-20 SCFM Model 4002 - 0.1" - 2" W.C. vacuum, 10-70 SCFM

3. SVE Manifold Sample Ports:

   a. Each SVE riser pipe shall be fitted with a vapor sample port.
   b. Sample ports shall consist of ¼" threaded brass nipples, ¼" brass ball valve, and a ¼" brass hose barb fitting.
   c. Samples shall be collected with a peristaltic pump and dedicated silicon surgical tubing.

4. Total Fluids Manifold Sample Ports:

   a. Each Total Fluids riser pipe shall be fitted with a fluid sample port.
   b. Sample ports shall consist of 3/4" slip by 3/4" slip by FNPT tee cut into riser, connected to a 3/4-inch bronze ball valve connected in turn to a 3/8-inch brass hose barb fitting.

5. Total fluids flow metering:

    a. Individual multiphase extraction wells will be metered by bucket gauging flow at the sample tap on individual well risers
    b. Cumulative total flow measurements will be made under pressure between the oil-water separator and the air stripper using a Hayes 1-inch totalizing flow meter

2.5 VALVES

A. PVC Valves Specified

1. Ball Valves:
    a. 1.5 Inch, George Fischer MIP type 350 or approved equivalent, FNPT x FNPT
2. Butterfly Valves:
    a. 4-inch NIBCO LD2000 or approved equivalent
3. Check Valves
    a. 3/4-inch PVC check valve, TEEL spring type, FNPT x FNPT

B. Brass Valves

1. Pneumatic ball valve, 3/4-inch, DynaQuip VMH2.A9 3/4 or equivalent, FNPT x FNPT
2. Pneumatic ball valve, 1.5-inch, DynaQuip VMH2.A9 1 1/2 or equivalent, FNPT x FNPT
3. Pneumatic ball valve, -inch, DynaQuip VMH2.A9 2 or equivalent, FNPT x FNPT

C. Bronze Valves

1. Bronze ball valve, 3/4-inch, Conbraco Apollo 7010401 or equivalent, FNPT x FNPT

PART 3—PERFORMANCE

3.1 INSTALLATION

A. General:

1. Furnish all labor, materials, and equipment necessary to make a complete installation as indicated and specified.

    a. Provide all necessary supports, brackets, or foundations for properly installing all equipment.
    b. Coordinate with the other trades before installation of materials.
    c. Properly align, adjust, and lubricate all equipment before final acceptance.
    d. Provide vents and drains at high and low points of water systems.
    e. All connections to equipment shall be made with unions or flanges.

f. Provide dielectric-type unions where copper piping is connected to ferrous material.
g. Piping indicated on the plans is diagrammatic and not necessarily the exact routing. Provide all necessary bends that may be required to avoid conflicts.
h. Provide sleeves and flashings for all piping penetrating walls or the roof. Provide all required openings in walls and floors.
i. Test, flush, and balance all systems. Install all vents, test tees, test connections and other items required by local practice, codes, and regulations.

B. Piping Installation:

1. General:

a. Install pipe and fittings in accordance with recognized industry practice which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure.
b. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment.
c. Reduce sizes (where indicated) by use of reducing fittings.
d. Align pipe accurately at connections within 1/16-inch misalignment tolerance.
e. Comply with ASME — Code for Pressure Piping.
f. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible.
g. Orient horizontal runs parallel with walls and column lines.
h. Locate runs as indicated or described by diagrams, details, and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
i. Hold piping close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building.
    i. Limit clearance to 0.5-inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any.
j. Where possible, locate insulated piping for 1.0-inch clearance outside insulation.
k. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction, or above suspended ceilings.
    i. Do not encase horizontal runs in solid partitions except as indicated.

C. Electrical Equipment Spaces:

1. Do not run piping through transformer vaults or other electrical or electronic equipment spaces and enclosures.

D. Piping System Joints:

1. Threaded joints:

    a. Thread pipe in accordance with ANSI B2.1.
    b. Cut threads full and clean using sharp dies.
    c. Ream threaded ends to remove burrs and restore full inside diameter.
    d. Apply pipe joint compound or pipe joint tape (Teflon) on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Flanged joints:

    a. Match flanges within piping system and at connections with valves and equipment.
    b. Clean flange faces and install gaskets.
    c. Tighten bolts to provide uniform compression of gaskets.

3. Glued PVC joints:

    a. Screen, pipe and fittings will be joined with PVC glue (solvent cement) that meets ASTM D2564 specifications. Interior and exterior surfaces shall clean and free of dirt, grease, oil, and other foreign materials. Surfaces to be glued will be further cleaned with PVC primer and allowed to dry to touch.
    b. Pipe gluing will take place at temperatures above 40 degrees Farenheit. A thin surface of glue will be applied to interior and exterior surfaces. The pipe will then be immediately joined with a ¼-turn twisting motion until the pipe seats completely in the fitting.
    c. Joined pipe will be held a minimum of 1 minute. Joined pipe will rest a minimum of 15 minutes before placement in the trenches.

4. HDPE joints:

    a. Sections of polyethylene pipe shall be joined into continuous lengths on the job site above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturers recommendations. Butt fusion equipment used in the joining procedures shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment, and fusion pressures.
    b. HDPE to galvanized steel or PVC transition fittings shall be male nipple by male NPT carbon steel. HDPE shall be heat shrinked onto the nipple end of the fitting.

E. Cleaning and Protection:

1. Cleaning: Clean all fabricated assemblies, according to the provisions of the Pipe Fabrication Institute Standard ES5 prior to shipping to the job site.
2. Protection: Protect all pipe ends of fabricated sections with heavy metal pipe end-protectors, tack welded to the pipe, and do not remove until pipe is in

position for final welding. The removal or damaging of these protectors to assist in moving the pipe in the field will not be tolerated.

3. Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings, if any.
4. Unless otherwise specified, flush out piping systems with clean water for a minimum of 10 minutes before proceeding with required tests.
5. Inspect each run of each system for completion of joints, supports, and accessory items.

F. Hangers, Supports, and Anchors:

1. General:

a. The design, selection, spacing, and application of pipe hangers, supports, and anchors shall be in accordance with the codes and standards specified except that ANSI B31.1 — Code for Power Piping shall take precedence over the MSS SP-69 standard.
b. Hanger class and selection of components shall be in accordance with those specified.
c. Furnish and install all rigid and spring supports, whether or not they are shown and detailed, but are required to adequately support the piping system.
d. Furnish and install for all pipe installed under this contract.
e. Include all necessary structural steel, brackets, and concrete inserts which are not a part of the building, or specified, but required to properly support the piping systems.
f. Include necessary temporary supports, and pins for the hydrostatic testing of steam lines and other lines that are spring supported.
g. Install piping and provide necessary supports and anchors to prevent the forces and mounting imposed on equipment from exceeding the limits specified by the equipment manufacturer.
h. The Contractor shall note that a maximum rod size of ⅞-inch can be used with Type A concrete insets. Maximum horizontal pipe hangers and support spacing shall be reduced for 14-inch and larger lines supported from new and existing Unistrut P-3200 type concrete inserts.

3.2 ADJUSTMENT:

A. Prior to putting the piping systems into service, adjust all spring hangers to the correct cold load, adjust all solid hangers to correct position and remove all temporary hangers used in erection and testing.

B. After and during the time the piping systems are being put into service, adjust all spring hangers for the current hot load and align all hanger rods to the vertical position.

C. Hanger Assemblies, Anchors, and Sway Braces Not on Drawings: Pipe hanger assemblies, anchors, and sway braces other than those indicated on the drawings shall be designed, selected, and located by the Contractor or hanger manufacturer in accordance with the following:

1. Make accurate weight balance calculations to determine the required supporting force on each hanger and to show the reaction and forces on equipment on the shop drawings. Calculate expansion and movement of all pipe installed under this contract and select hanger type and components to allow for pipe expansion and movement.

D. Submit detail shop drawings of each hanger assembly for review and comments.

PART 4—EXECUTION

4.1 TRANSPORTATION AND DELIVERY

A. Every precaution shall be taken to prevent injury to the pipe during transportation and delivery to the site and handling prior to and during installation. Extreme care must be taken in loading and unloading the pipe and fittings. Under no conditions shall the pipe be dropped, bumped, dragged, pushed, or moved in any way which will cause damage to the pipe.

B. If in the process of transportation, handling, or laying, any pipe is damaged, such pipe or pipes shall be replaced or repaired by the Contractor at his own expense.

4.2 PIPE LAYING—GENERAL

A. Laying and jointing pipelines shall include the installation of all pipelines. Pipeline materials shall be as specified or shown. Piping shall be installed where shown or specified.

B. Proper and suitable tools and appliances for the safe and convenient cutting, handling, and laying of the pipe and fitting shall be used.

C. Before being laid, all pipe, fittings, and specials shall be examined for defects, and no piece shall be installed which is known to be defective.

D. Any defective pieces discovered after having been installed shall be removed and replaced.

E. The pipe and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until final acceptance. Care shall be exercised to avoid leaving bits of wood, dirt, and other foreign particles in the pipe. All lines shall be kept clean during construction and shall be capped off with appropriate caps, tape, or wooden bulkheads at the end of each day's work. Exposed ends of uncompleted lines shall be capped or otherwise temporarily sealed at all times when the pipe laying is not in progress. Pipelines shall be laid accurately to line and grade shown in the drawings.

F. Contractor shall provide all necessary joint gaskets, lubricants, solvents, cements, and all special tools and accessories that may be required to assemble the pipe or fittings. Pipe jointing materials shall be stored in a cool place and protected from light, sunlight, heat, oil, or grease until installed.

4.2 PIPE LAYING IN TRENCHES

A. Pipeline in trench excavation shall be properly secured against movement and pipe joints shall be made in the excavation as shown, specified, or directed by the Company.

B. Pipe laying will be permitted only in dry trenches having a stable bottom. Where groundwater is encountered, the Contractor shall undertake the necessary dewatering operations as specified.

C. Where concrete encasement of a pipeline is specified, the pipe shall be encased with a minimum of 6 inches of concrete.

D. .As soon as the excavation is completed to normal grade of the bottom of the trench, the Contractor shall immediately place screened gravel bedding conforming to the requirements specified under Specification 3. Bell holes or female couplings shall be excavated so that only the barrel of the pipe shall bear upon the bedding over the trench bottom. Blocking under the pipe will not be permitted. Bedding material shall be placed to mid-diameter and thoroughly compacted to give firm support to the pipe. The spigot or male end shall be pushed home into the adjacent bell or female couplings to form a closed joint. The interior of each pipe shall be inspected while joined to see that the alignment is preserved. Once the pipe has been joined and tested, bedding material shall be placed to a level of 6 inches above the top of the pipe. Then backfilling shall begin and shall be carried out as specified in Specification 3.

E. No pipe shall be laid in water or when weather and trench conditions are unsuitable for pipe laying.

F. Before lowering, and while suspended, the pipe shall be inspected for defects. Any defective, damaged, or unsound pipe shall be rejected. All foreign matter, such as dirt, shall be removed from the inside and outside of the pipe before it is lowered into position in the trench.

G. The cutting of pipe for inserting fittings or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe. In general, pipe shall be laid with bell ends, if applicable, facing in the direction of laying. Whenever necessary to deflect pipe from a straight line, either in the vertical or horizontal plane to avoid obstructions or for other purposes, the maximum degree of deflection shall be as recommended by the manufacturer. Pipes shall be furnished in standard laying lengths. Random short lengths shall be used only as required to connect manholes and cleanouts.

H. Joining shall be accomplished in strict accordance with manufacturers' recommendations. When solvent-weld joints are required, solvent for pipe jointing shall be as recommended by the manufacturer of the pipe.

4.3 ERECTION AND INSTALLATION OF ABOVE-GRADE PIPING

A. General

1. Erect and install all above-grade piping and accessories required to complete the piping systems as indicated on the drawings, as specified, and as required for a proper installation.

2. Above-grade piping erection and installation includes the following:

    a. Connections to the remediation equipment building.
    b. Connections to existing soil vapor extraction wells.
    c. Testing of piping systems.

B. Installation of above-grade piping

1. Contractor shall fabricate and erect the above-grade portions of the piping in accordance with the following:

    a. The specific arrangements shown on the mechanical and piping detail drawings for the piping shall not be appreciably varied.
    b. Field-route piping in a manner to avoid interference with work by this purchase order and to provide a neat and accessible installation.
    c. Piping shall be installed in a rectangular form either perpendicular to, or parallel to the building structure, the floor, or to the major equipment except in cases required or approved by the Company.
    d. Pipe shall be routed to avoid aisleways, and equipment maintenance access areas, and shall satisfy the Company's operation and maintenance requirements which include locating valves, specials, and instruments at a point where they are easily accessible. Improperly located piping shall be removed and rerouted as directed and approved by the Company with all labor and material furnished by the Contractor.
    e. Pipe routing shall avoid interference with required electrical conduit. The Contractor shall preplan his electrical conduit routing schedule to avoid such interferences before routing the piping.
    f. Access shall not be blocked around equipment, particularly access to motors.
    g. Piping shall not interfere with maintenance access for removal of valves, flow indicators, motors, motor rotors, process instrumentation, or any other device which may be required to be removed from piping or equipment for maintenance.
    h. Provide offsets, fittings, unions, drip pockets, vents, drains, hangers, and supports to make a complete installation.
    i. Furnish and install unions in piping systems using screwed joints as follows:

        i. Install so lines may be broken for maintenance, valves or piping may be removed and equipment disconnected.
        ii. Install in lines which are erected without unions and which, in the opinion of the Company, cannot be properly maintained.

4.5 TESTING

A. All vapor extraction piping shall be pressure tested by the Contractor prior to acceptance. All below grade pipe must be tested prior to backfill.

1. Vacuum Testing: requires that all Soil Vapor Extraction (SVE) process piping and hose be isolated as necessary and a minimum vacuum of 100 inches water be applied and the vacuum source disconnected from the piping. The test vacuum is

to be monitored for one hour with an appropriate gauge on the piping system. The piping and hose must remain at the test vacuum (±2%) to pass the test procedure.

2. Pipe systems or sections thereof shall be repaired or replaced by the Contractor at no cost to the Company until they pass the required test.

B. All pressure piping (e.g, total fluids and pneumatic lines) shall be pressure tested by the Contractor prior to acceptance. All below grade pipe must be tested prior to backfill.

1. Pressure Testing: requires that all pressure process piping and hose be isolated as necessary and a minimum pressure of 100 PSI be applied and the pressure source disconnected from the piping. The test pressure is to be monitored for one hour with an appropriate gauge on the piping system. The piping and hose must remain within 2 % of the test pressure to pass the test procedure.
2. The integrity of continuous HDPE piping (e.g., no welded joints) may be determined prior to its use. HDPE that passes may be used without further testing so long as no welded joints will be placed below grade. All strands of pipe with welded joints shall be tested prior to backfilling as described above.

END OF SPECIFICATION 4

SPECIFICATION 5

SOIL VAPOR EXTRACTION SYSTEM

PART 1—GENERAL

1.1 DESCRIPTION OF WORK

This specification prescribes the requirements for the installation of the soil vapor extraction and treatment system. The General Contractor shall provide labor, supervision, materials, equipment, tools, permits, and services that are required to install, startup, and test the soil vapor extraction and treatment system as shown on the drawings and as covered in this specification including, but not limited to, the following:

A. Pipe, pipe fittings, and appurtenances necessary for connecting the SVE well to conveyance piping.

B. Pipe, pipe fittings, valves, flow meters, and appurtenances necessary to construct the SVE manifold.

C. Natural gas supply line (estimate 1,200 feet) and pressure regulators to operate thermal oxidizers.

D. Underground and aboveground electrical conduit (as appropriate) and wire from the service panel to each thermal oxidizer.

E. Piping from the SVE wells to the SVE manifold.

F. Piping from the SVE manifold to the thermal oxidizer manifolds.

G. Thermal oxidizers, moisture separators, automatic transfer pumps, piping, pipe fittings, and appurtenances necessary to install the vapor extraction unit.

H. Piping from the moisture separator to the wastewater treatment system.

1.2 DEFINITIONS

A. CFR—Code of Federal Regulations
B. SVE—Soil Vapor Extraction
C. OSHA—Occupational Health and Safety Administration

1.4 SUBMITTALS

A. The General Contractor shall submit product specifications for alternate piping, pipe fittings, airflow meters, vacuum gauges, etc. Products must be approved by the Engineer prior to installation.

B. Copies of OSHA 40-hour training certificates and current 8-hour annual refresher training course completion certificates for the General Contractor's employee or proposed subcontractor employee. These copies will be submitted to the Engineer before an employee performs on-site activities. Copies must also be maintained by the General

Contractor on site.

C. PART 2—PRODUCTS

2.1 QUALITY ASSURANCE

A. All electrical work and material shall be in compliance with the ordinances of the city, state, federal, or other political subdivision having jurisdiction. In the absence of other more stringent authority, the work shall conform to the requirements of the National Electric Code (NEC).

B. The General Contractor shall arrange and pay for all necessary official inspections and permits and shall install or change work as required by official inspection. All such indicated drawings shall be documented by the General Contractor and reported to the Engineer to allow for construction options to be exercised.

2.2 PIPING

All piping that will be used in the SVE system shall be in accordance with design drawings and Specification 4.

2.3 FLOW CONTROL AND MEASUREMENT DEVICES

The SVE system shall be provided with flow control valves, vacuum gauges, flow meters, and other pipe fittings as shown on design drawings and in accordance with all related specifications.

A. Airflow shall be metered by pitot tube in accordance with specification 4.

B. Vacuum shall be gauged using Ashcroft Model 1490 vacuum gauges. Gauges shall be capable of measuring vacuums from 0 to 100 inches water column. Each riser shall be equipped with a vacuum gauge upstream of the header. The gauges shall be 2.5 inches in diameter with a 0.25 inch lower mount NPT connection. Contractor may substitute an Engineer-approved equivalent.

C. Flow rates at the thermal oxidizer shall be measured by the Baker Furnace 200-cfm thermal oxidizers provided by Transwestern Pipeline Company. Contractor is not responsible for performance flow control and measurement devices associated with the thermal oxidizers.

2.4 MECHANICAL DEVICES

A. Thermal Oxidizers — The blower assembly will consist of a liquid ring pump, a flow meter, a moisture separator fitted with an automatic transfer pump, and logic controls. The blower assembly shall be purchased from Travaini Pumps, USA, or an Engineer-approved equivalent.

B. Moisture Separators — The moisture separator shall be a 120-gallon cylindrical tank of type and dimensions suitable for use upstream of the liquid ring pump, and shall be

capable of operating at vacuums between 17 and 29.5 inches Hg and airflow rates up to 150 ACFM. The moisture separator shall be capable of achieving 99 percent moisture removal of all liquid droplets 10 microns and larger from the influent stream. The moisture separator shall be purchased from Travaini Pumps USA, or an Engineer-approved equivalent.

C. Transfer Pumps — The transfer pump shall provide automatic transfer of collected liquid in the moisture separator to the wastewater treatment plant. The transfer pump shall be driven by a logic controller to enable automatic startup and shutdown, but shall also be fitted with a manual override. The pump shall be capable of producing suction heads high enough to drain the liquid from the moisture separator during operation against a vacuum between 17 and 29.5 inches Hg. The pump will be capable of transferring the liquid against a delivery head of approximately 20 psig. The transfer pump will also be fitted with a check valve to prevent airflow into the moisture separator.

D. Sensiphone Data Transmitters

PART 3—EXECUTION

3.1 INSTALLATION

A. The installation of the Baker Furnace thermal oxidizers shall be in strict compliance with the manufacturer's technical data and printed instructions. Installation shall include furnishing the required manufacturer's recommended lubricants for initial operation. Inspection and calibration of all Baker Furnace supplied metering and measurement devices necessary for proper performance shall be performed by contractor. Devices include but are not limited to:

1. Oxygen sensor
2. Lower explosive limit (LEL) sensors
3. Temperature sensors
4. Flow meters
5. Chart recorders
6. Remote data transmission devices

B. Contractor shall not be responsible for replacing malfunctioning devices on thermal oxidizers. Contractor shall identify faulty or potentially faulty devices and advice Engineer of necessary or recommended repairs and replacements. Engineer shall develop a separate scope of work and budget with Contractor to effect repairs and replacements to thermal oxidizers as necessary.

C. Contractor shall provide moisture separators to be installed before thermal oxidizers as shown on plans. Contractor shall submit manufacturer and model to Engineer for approval prior to installation. Contractor shall install provide and install oil-less pneumatic transfer pumps as shown in plans.

D. All pipe, pipe fittings, flow control and measurement devices, and appurtenances shall be installed in accordance with design drawings and Specification 4.

E. All electrical work shall be performed in accordance with Specification 7.

3.2 TESTING

A. Following oil water separator, thermal oxidizer, header and piping installations, the General Contractor shall demonstrate the system performance and shall certify that the system has been installed to conform with the design drawings and specifications and subsequent revisions and approvals. The period for startup testing shall be 7 days.

B. Leak Testing

1. Leak testing shall be performed for all exposed and buried pipe. All buried and exposed pipe shall withstand a pressure of 5 psig for a period of not less than 2 hours without a drop in pressure greater than 0.25 psig. Pressure shall be measured with a pressure gauge (ANSI Grade B, 2% of full scale accuracy, or better) or equivalent device, calibrated to read in increments not greater than 0.1 psig. The source of pressure shall be isolated before the pressure tests are made. All joints shall be sprayed with a soap water solution and visually inspected for leaks. If the joint leaks, testing shall be discontinued, the joint shall be repaired, and the pipe retested. Testing shall be conducted with compressed air or inert gas.

C. Startup and performance testing shall be of sufficient complexity and duration to fully demonstrate the operability of all equipment and systems with respect to functionality, rate, and capacity over the specified operating ranges of the equipment provided.

END OF SPECIFICATION 5

SPECIFICATION 6

MULTI-PHASE EXTRACTION SYSTEM

PART 1—GENERAL

1.1 DESCRIPTION OF WORK

A. The General Contractor shall provide labor, supervision, materials, equipment, tools, permits, and services that are required to install, startup, and test the ground water recovery system as shown on the drawings and as covered in this specification including, but not limited to, the following:

a. Pneumatic pumps (15), down-hole pneumatic lines, exhaust lines, and fluid return lines for each dual-phase extraction well.
b. Wellhead penetrations for lines as noted on drawings.
c. Pipe, pipe fittings, and appurtenances necessary for connecting the pneumatic and fluid return lines to the conveyance piping.
d. Well boxes and pressure treated wood extensions as depicted on drawings.
e. Pipe, pipe fittings, valves, and appurtenances necessary to construct the total fluids recovery and pneumatic manifolds.
f. Conveyance piping from wellheads to the manifolds.
g. Piping from the total fluids recovery manifolds to the oil-water separator.
h. Piping from the pneumatic manifolds to the air compressor.
i. Piping, valves and appurtenances necessary to connect to total fluids recovery manifolds to the oil-water separator and the oil water separator in turn to the air stripper.
j. Piping valves and appurtenances to connect the air stripper effluent to the 90-bbl day tank
k. Transfer pump, conveyance piping, and sprinklers to discharge treated water
l. High and low level switches and auto-shutoff interlocks to connect the day tank transfer pump to the main control panel
m. Heat tracing and insulation on all exterior exposed total fluids lines
n. Electrical service to the service panel.
o. Underground and aboveground electrical conduit (as appropriate) and wire from the service panel to each piece of remediation equipment (air stripper, thermal oxidizers, transfer pumps, controllers, heat tracing, etc.).

1.2 DEFINITIONS

A. CFR—Code of Federal Regulations

B. OSHA—Occupational Health and Safety Administration

1.3 REFERENCES

A. Regulations

1. 29 CFR 1910.120, OSHA Regulations, Hazardous Waste Operations and Emergency Response

B. Guidance

1. ASTM D3299, Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
2. ASTM D5421, Standard Specification for Contact Molded AFiberglass@ (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
3. ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Material
4. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
5. ASTM F441/F441M, Standard Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80
6. ASTM F493, Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
7. ASTM F438, Standard Specification for Socket-Type Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40
8. ASTM D3915, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Compounds for Plastic Pipe and Fittings Used in Pressure Applications

1.4 SUBMITTALS

A. Copies of OSHA 40-hour training certificates and current 8-hour annual refresher training course completion certificates for the General Contractor's employee or proposed subcontractor employee. These copies will be submitted to the Engineer before an employee performs on-site activities. Copies must also be maintained by the General Contractor on site.

B. Copy of New Mexico General Contractors license (GB-98) or New Mexico Remediation Contractors license (GS-29).

C. Copies of all subcontractor licenses as applicable (e.g., electrical, plumbing).

PART 2—PRODUCTS

2.1 QUALITY ASSURANCE

A. All electrical work and material shall be in compliance with the ordinances of the city, state, federal, or other political subdivision having jurisdiction. In the absence of other more stringent authority, the work shall conform to the requirements of the NEC.

B. The General Contractor shall arrange and pay for all necessary official inspections and shall install or change work as required by official inspection. All such indicated

drawings shall be documented by the General Contractor and reported to the Engineer to allow for construction options to be exercised.

2.2 EXISTING SITE CONDITIONS

A. Existing natural gas supply at the plant is located about 1,200 feet south of the remediation equipment compound. Contractor shall run 2-inch HDPE gas line in a trench from gas line. Contractor shall run 1-inch HPDE water line in same trench.

2.3 GENERAL

A. The total fluids pumps and controllers shall be supplied by Engineer.
B. The air compressor shall be supplied by Engineer.
C. The oil-water separator, air stripper, and manufacturer supplied transfer pumps shall be supplied by Engineer as shown on manufacturer supplied cut-sheets.
D. Main building, outbuildings, electrical supply, and 200-amp and 60-amp service panels shall be provided a separate contractor.
E. All well boxes, well box extensions pipe, pipe supports, valves, sample ports, meters and other equipment specified and shown on drawings shall be supplied by Remediation Contractor.
F. The General Contractor shall comply with all laws, ordinances, codes, rules, and regulations of the local, state, and federal authorities having jurisdiction over any of the work specified in this section.

2.4 TOTAL FLUIDS PUMP SYSTEMS

A. The total fluids recovery system shall consist of 15 top-loading Clean Environment Engineers model AP-2/TL pneumatic pumps, rated from 0 to 2 gpm, with controllerless operation and stainless steel outer casing, or an Engineer approved equivalent.

B. The pneumatic pump system shall have the following major components.

1. 75-feet of ½-inch discharge tubing
2. 75-feet of 3/8-inch air supply tubing
3. 75-feet of 3/8-inch air exhaust tubing
4. 75-feet of suspension cable
5. 5-micron filter regulator
6. 4-inch well cap with appropriate couplings for tubing
7. Wellhead piping, fittings, and appurtenances as indicated on the drawings.
8. Pneumatic and total fluids recovery manifolds as indicated on the drawings.
9. Well boxes and extensions as shown on drawings.
10. Installation of the air compressor provided by Engineer as shown on drawings.
11. Electrical conduit, control wiring, and service to the control panel as shown on the drawings.

2.5 OIL-WATER SEPARATOR

A. Oil-water separator shall be a Carbonair COWS 25 or Engineer approved equivalent.

B. The oil-water separator system shall have the following major components.

1. 25 gpm capacity
2. 178 gallon working volume
3. 105 gallon capacity sump
4. 68" long x 28" wide x 46" high FRP vessel
5. 3" inlets and water outlet
6. 2" oil outlet
7. Coalescing media
8. Vapor tight cover
9. Solids collection sump
10. Adjustable oil skimmer
11. Sight glass with pump operation switches
12. Mounted on common steel stand
13. 100 gallon UL 142 Product drum with H/L switch
14. Myers CT centrifugal transfer pump, rated at 15 gpm with 30-feet TDH, ¾-hp, 230V, XP motor
15. Valves, fittings, and appurtenances as indicated on the drawings.
16. Heat tracing and insulation on all exposed piping.
17. The oil-water separator shall be set on a angle iron frame bolted to the concrete slab such that it is raised 18" as shown on the drawings.
18. Gravity drainage system for collection of separated fluids into 55-gallon drum as shown on drawings.
19. 55-gallon drum with secondary containment equal to 100 gallons capacity.
20. Electrical conduit and service to the transfer pump between the oil-water separator and the air stripper as shown on the drawings.

2.6 AIR STRIPPER

A. Air stripper shall be a Carbonair STAT 80 or Engineer approved equivalent.

B. The air stripper system shall have the following major components.

1. SST sump with high level alarm and pump operation switches
2. 5-trays with demister and fasteners
3. 5-hp, 3-phase, TEFC blower (300 cfm @40" wc)
4. Blower low pressure alarm switch
5. Blower pressure gauge
6. 1-hp, 230V, 3-phase, XP transfer pump (20 gpm @ 50' TDH)
7. Mounted on common skid
8. Effluent totalizing flowmeter with transmitter
9. Valves, fittings, and appurtenances as indicated on the drawings.
10. Heat tracing and insulation on all exposed piping.
11. The air stripper shall be placed on concrete as shown on the drawings.
12. The treated effluent discharge system will consist of a transfer pump (supplied) and one-inch underground HDPE conveyance line (approximately 250 feet) to the existing day tank.
13. Electrical conduit, control wiring, and service to the air stripper and effluent transfer pump as shown on the drawings.

2.7 CONTROL PANEL

A. Control panel shall be provided by pneumatic pump and remediation equipment supplier. The control panel shall be a Carbonair Series 1000 control system in a NEMA 4 enclosure to mount on a Unistrut frame on the skid. For operation on 115/230 volt, 3Ø, 4 wire incoming electrical service. To provide control for the ¾ HP transfer pump, 7.5 HP STAT low profile air stripper blower, 1 HP air stripper discharge pump. With all required control pilot devices, alarms and interlocks.

B. The control panel shall have the following major components.

1. Enclosure, NEMA 4, 30"h, 30"w, 12"d with padlock handle, data pocket (small), swing-out panel and sub-panel
2. Disconnect, non-fusible, 100A with lockable operating handle and shaft
3. Distribution block, 3 pole; L1, L2, L3
4. Distribution block, 1 pole; Neutral
5. 3-Motor starters: Contactor 23A FLA with 1 aux. contact/Overload relay 3.7-12A, 3Ø, manual reset; 1 and 1.5 HP pumps, 7.5 HP blower
6. Motor starter: Contactor 60A FLA with 1-aux. contact/Overload relay 26-85A, 3Ø, manual reset; 20 HP LRP
7. 4-Overload reset pushbutton (through door)
8. 1-Circuit breaker 230V 1P10A 10K; control power
9. 1-Circuit breaker 230V 1P15A 10K; vent fan, lights, and heater
10. 2-Circuit breaker 230V 3P15A 10K; pumps
11. 1-Circuit breaker 230V 3P20A 10K; STAT blower
12. 5-Switch; three position; Hand-Off-Auto with integral Run indication
13. 6-Light (red/LED); alarms
14. 1-Pushbutton (red/NC); alarm Reset
15. 2-Intrinsically safe dual pump level control with dual level alarms
16. 2-Intrinsically safe barrier, two channel, 120 VAC; alarms
17. Relay/timer logic
18. Engraved laminated legends for all door mounted devices
19. Terminal blocks for customer connections and fusing as required
20. Color-coded wiring with wire markers at all terminations
21. Serialized UL508 Industrial Control Panel label
22. Fully documented, assembled, wired and pre-shipment test
23. 1- Sensaphone model 1108 autodialer
24. Electrical conduit and wiring to the service panel.

2.8 DAY TANK AND IRRIGATION SYSTEM

A. The day tank is an existing 90-bbl (approximately 3,800 gallon) vertical above ground storage tank in secondary containment located 40 feet west of MW-2 as shown on drawings. The day tank shall be used for water storage prior to discharge by transfer pump to irrigation sprinkler heads.

B. The day tank will be fitted with high-level and low-level switches. When the high level switch is contacted, the transfer pump shall start discharging water to the sprinkler heads. When the low level switch is contacted, pumping shall cease. A second high-level switch

B. Pumps and ancillary equipment shall be installed in accordance with the design drawings and as covered in this specification.

3.2 TESTING

A. Following completion of the total fluids recovery system, day tank retrofit, and irrigation system installations, the General Contractor shall demonstrate the system performance and shall certify that the system has been installed to conform with the design drawings and specifications and subsequent revisions and approvals.

B. Startup and performance testing shall be of sufficient complexity and duration to fully demonstrate the operability of all equipment and systems with respect to functionality, rate, and capacity over the specified operating ranges of the equipment provided. The period of startup testing shall be not less than 7 days.

C. All piping shall be leak tested per Specification 4.

END OF SPECIFICATION 6

SPECIFICATION 7

ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

Provide all labor and material for installation of the following:

A. 120/240 volt, three-phase, 4-wire, 200 ampere overhead service drop to equipment compound

B. 2-60 ampere subpanels (1-per shed)

C. Feeder circuit and NEMA 3R load center.

D. Branch circuits to receptacles, lights, and equipment as indicated.

E. Grounding.

1.2 REFERENCES

A. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. C80.1 — Rigid Steel Conduit, Zinc-Coated.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. B3 - Soft or Annealed Copper Wire.
2. B8 - Concentric Lay Stranded Copper Conductors, Hard, Medium - Hard, or Soft.

C. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

1. AB1 - Molded Case Circuit Breakers.
2. FB1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. FU1 - Low Voltage Cartridge Fuses.
4. ICS6 - Enclosures for Industrial Control and Systems.
5. KS1 - Enclosed Switches.
6 .PB1 - Panelboards.
7. RN1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
8. ST20 - Dry-type Transformers for General Applications.

D. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

1. 70 - National Electrical Code (NEC).

E. UNDERWRITERS LABORATORIES (UL)

1. 6 - Rigid Metal Electrical Conduit.
2. 50 - Cabinets and Boxes.
3. 67 - Panelboards.
4. 360 - Liquid-tight Flexible Steel Conduit, Electrical.
5. 467 - Electrical Grounding and Bonding Equipment.
6. 489 - Molded-case Circuit Breakers and Circuit-Breaker Enclosures.
7. 514A - Metallic Outlet Boxes, Electrical.
8. 514B - Fittings for Conduit and Outlet Boxes.
9. 651 - Schedule 40 and 80 Rigid PVC Conduit.
10. 844 - Electric Lighting Fixtures for use in Hazardous (Classified) Locations.
11. 1010 - Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
12. 1561 - Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

A. SUBMIT CATALOG CUT SHEETS FOR THE FOLLOWING EQUIPMENT:

1. Wiring devices.
2. Wire and cable.
3. Safety switches (disconnects).

B. DRAWINGS AND DATA SHEETS: Submit drawings and data sheets with equipment outline dimensions, weight, electrical ratings, and wiring diagrams for the following equipment:

1. Load centers and panelboards.
2. Motor starters.
3. Control devices, including level and pressure switches.

1.4. SITE CONDITIONS

Unless indicated otherwise, the site is classified Class I, Division 1 below grade and Class I, Division 2 from grade elevation to 18 inches above grade. Areas above grade near well heads are classified as indicated. Equipments shall be located outside the hazardous areas whenever possible.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

A. CONDUIT: Conduit shall be rigid galvanized steel conforming to ANSI C80.1 and UL 6. Minimum size shall be ¾ inch unless indicated otherwise.

B. FITTINGS: Fittings and outlet bodies shall be cast gray iron alloy or cast malleable iron bodies and covers with a cadmium plated finish. Units in damp or wet areas or outdoors shall be gasketed and watertight. Fittings and outlet bodies shall conform to NEMA FB1 and UL514B.

2.2 WIRE AND CABLE

A. All conductors shall be copper conforming to ASTM B3 and B8. Minimum insulation rating for power and control wiring shall be 600 volts. Conductors No.10 AWG and smaller shall be solid, No.8 AWG and larger shall be stranded, and instrumentation and control cable shall be stranded regardless of size.

B. Wire and cable No.4 AWG and larger shall be NEC Type XHHW. No.6 AWG and smaller shall be NEC Type THHN/THWN.

C. Wire and cable for grounding shall be bare copper, Type BC. Equipment ground conductors shall be either bare copper or an identified "green" conductor.

2.3 WIRING DEVICES

A. RECEPTACLES FOR NON-HAZARDOUS AREAS

1. Specification grade, rated 20 amperes, 125 volts, NEMA configuration 5-20R.
2. Back and side wired with heavy duty, triple wipe "T" contacts.
3. Cover plates shall be galvanized steel for indoor and dry locations and Crouse-Hinds Type WLRS for outdoor and wet locations.

B. RECEPTACLES FOR HAZARDOUS AREAS

1. Dead front, delayed action circuit breaking type, rated for Class I, Group D locations.
2. Receptacle shall be deenergized until the plug is fully inserted and rotated.
3. With the receptacle switch closed, the plug shall be locked in the receptacle to prevent disengagement while under load.
4. Receptacle shall be rated 20 amperes, 125 volts, NEMA configuration 5-20R.

C. SWITCHES

1. Specification grade, quiet type, rated 20-amperes at 277 volts. Switch shall be mounted in FS or FD boxes with galvanized metal cover plate. Switches located outdoors or in damp and wet locations shall be furnished with a Crouse-Hinds Catalog No.DS128 or DS185 raintight cover.

D. BOXES

1. Cast gray iron alloy or cast malleable iron, with a cadmium finish.
2. Type FS or FD.

2.4 DISTRIBUTION

A. PANELBOARDS

1. Shall conform to NEMA PB1, UL 50 and UL 67. Arrangement shall be as indicated.
2. Provide with copper bas bars, solid neutral bar.

3. Enclosure shall be NEMA 3R. Provide with door lock.
4. Circuit breakers shall be molded case, thermal magnetic type, with the trip ratings and number of poles as indicated. Breakers shall be manufactured by the same manufacturer as the panelboard and conform to NEMA AB1.
5. The branch circuit interrupting capacity shall be 10,000 amperes symmetrical unless indicated otherwise.

B. MANUAL MOTOR STARTERS

1. Provide integral horsepower, full voltage, non-reversing manual motor starters.
2. The contactors shall be horsepower rated, NEMA sizes M-O, M-1, and M-1P. The contact mechanism shall be quick-make, quick-break.
3. Provide with manually reset thermal overload relays. The overload mechanism shall be trip-free from the operating handle.
4. Provide with low voltage protection where indicated.
5. Enclosure shall be NEMA 4 stainless steel or NEMA 7 for Class 1, Group D areas as indicated.
6. Acceptable manufacturers:

    a. Allen-Bradley, Bulletin 609
    b. Cutler-Hammer, 9115 Series
    c. Furnas, Class II
    d. General Electric, CR1062 Series
    e. Siemens
    f. Square D, Class 2510
    g. Westinghouse, Type B100

C. MAGNETIC MOTOR STARTERS

1. Provide combination magnetic motor starters as indicated.
2. NEMA rated starters. Minimum starter size shall be size O.
3. Disconnecting handle shall be lockable in the OFF position. Enclosure door shall be interlocked with the disconnecting means to prevent opening the door with the disconnect on. Provide a defeat mechanism for the interlock to allow authorized personnel access while the starter is energized.
4. Provide three overloads in three-phase starters. Overloads shall be manually reset from the outside of the enclosure.
5. Control voltage shall be 120 volts maximum. Provide control power transformers as required.
6. Provide auxiliary contacts required for the control indicated. As a minimum provide 1N.O. and 1 N.C. contact.

D. CONTACTORS

1. Provide as indicated.
2. NEMA rated. Minimum size shall be size O.
3. Control voltage shall be 120 volts maximum.
4. Provide contacts required for the control indicated.
5. Control voltage shall be 120 volts maximum.

6. Provide auxiliary contacts required for the control indicated. As a minimum provide 1N.O. and 1 N.C. contact.

2.5 DISCONNECT SWITCHES

A. Provide horsepower rated, heavy duty, single throw switches with visible blades.

B. Switches shall be nonfused or fused as indicated.

C. Number of poles shall be as indicated.

D. Conform to NEMA KS 1.

E. Enclosures shall be NEMA 12 for dry indoor locations and NEMA 4X for outdoor and damp or wet indoor locations.

F. Provide where indicated and where required by the NEC.

2.6 LIGHTING

A. LAMPS

1. Fluorescent lamps shall be rapid-start, 48 inch, cool white, F40CW.
2. High pressure sodium lamps shall have a mogul base and a diffuse coating. Wattage shall be as specified for specific luminaires.
3. Incandescent lamps shall be as specified for specific luminaires.

B .BALLASTS

1. Fluorescent: High power factor, thermally protected Class P. Power factor shall be 0.9 or higher. Units installed in unheated areas shall have a minimum starting temperature of 0°F.

C. LIGHTING FIXTURES

1. Type L - 1:

a. 1X4 ft. industrial fluorescent luminaire for dry indoor locations.
b. Shall be constructed of 20-gauge (minimum) steel, formed to provide a rigid wiring channel. Finish shall be white, baked-in enamel.
c. Reflector shall be 20-gauge (minimum) steel with a porcelain enamel finish that provides a minimum reflectance of 85 percent. Reflector shall provide 10 percent uplight.
d. Designed for pendant or chain mounting.
e. Provide with 2 lamps.
f. Operate from 120 volts.

2. Type L - 2:

a. 1X4 ft. industrial fluorescent luminaire for wet locations.

3. Type L - 3:

a. HID, enclosed and gasketed rated for Class I, Division 2 locations.

4. Type L - 4:

a. Incandescent, emergency lighting unit.

5. Type L - 5:

a. Incandescent exit light.

6. Type L - 6:

a. Wall mounted, vandal resistant, HPS outdoor luminaire
b. Die-cast aluminum housing with bronze finish
c. Polycarbonate prismatic lens
d. Full front access
e. Provide with 70 watt, HPS lamp
f. Integral photocontrol
g. UL listed, suitable for wet locations
h. Acceptable manufacturers:

(1) Day-brite, Cat. No.WL70HS-DT-PEC.
(2) Hubbel, Cat. No.PVL-0070S-118 with accessories PBT-1 and PVL-PK.

2.7 GROUNDING

A. Equipment and materials for grounding shall conform to UL 467.

B. Ground rods shall be copperclad steel, ¾-inch-diameter, 10-feet-long.

C. Connectors shall be copper-alloy, compression-type, specifically designed for the connection to be made.

2.8 SUPPORT SYSTEM

A. Fabricated from manufactured framing members equal to Unistrut P-3000 series as manufactured by Unistrut Corporation.

B. Construct as required to rigidly support all conduit runs and boxes.

C. Hot-dip galvanized steel or cast-aluminum conduit clamps, sized for the specific conduit size, to support all exposed metallic conduit.

D. Nonmagnetic clamps to support nonmetallic conduits.

E. Provide stainless steel rods, anchors, inserts, bolts, washer and nuts with all other support hardware electrogalvanized steel.

F. Channel hot-dipped galvanized after all manufacturing operations are completed.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION

A. GENERAL REQUIREMENTS

1. Shift locations as required to avoid interference with other equipment and piping being installed.
2. Where routing of conduit is not indicated, route conduit as specified subject to approval by Engineer.
3. Do not use conduit in sizes smaller than ¾ inch, except ½inch may be used for connections to control devices and thermocouples (where necessary).
4. Holes and Sleeves:

    a. Provide through floors, walls and roofs as necessary for conduit runs, including approved flashing and weather proofing at outside walls and on roofs.
    b. Install sleeves or forms for all openings in new work.
    c. Provide the required inserts and holes, completely sleeved, bonded, curbed, flashed and finished off in an approved manner, whether in concrete, steel grating, metal panels or roofs.
    d. Core-drill all holes required in existing building work using a dustless method.
    e. Place nonshrinking grout or Dow Corning 3-6548 Silicone RTV or equivalent General Electric RTV 851 foam as specified in all holes in concrete, walls, floor and roof slabs after installation of conduit.
    f. Install wall entrance seals where conduit enters the building or vaults from exterior underground.
    g. Install fire and smoke stop fittings at all conduit penetration of fire rated walls, ceilings and floors.

5. Make connections to boxes, panels and other equipment as follows:

    a .Double locknuts, one inside and one outside.
    b. Bushings:

        1. Threaded malleable iron or steel.
        2. Insulated with Bakelite, molded and bonded into the bushing.
        3. Placed on end of conduit in addition to locknuts.
        4. Install with integral grounding connector and conductor where all conduits pass through multiple concentric panel knockouts and where the conduit must be bonded to equipment to which it is not attached.
        6. Running threads will not be permitted.
        7. Coat all field cut threads in galvanized conduit with aluminum paint.

8. Place drainage fittings or weep holes at unavoidable low points where moisture can collect.
9. Install an entire conduit system that is electrically continuous with bonding jumpers provided as necessary to conform to NEC.
10. Provide suitable protection for conduit risers against damage during construction.
11. Cap ends of all conduits before concrete is poured.
12. Cap all conduits after cleaning where conduits are to be left empty by this contract.
13. Carefully ream ends of all conduit lengths after cutting to eliminate sharp burrs.
14. Clean out all conduit before pulling wire.
15. Clean out all conduits immediately after concrete work is finished.

B. EXPOSED INSTALLATION

1. Install horizontal runs as high above floor as possible, and in no case lower than 7 feet above floor, walkway, or platform in passage area.
2. Run conduit parallel or perpendicular to walls, ceiling, beams and columns unless indicated otherwise.
3. Route to clear all doors, windows, access wells and openings.
4. Group parallel runs in neatly aligned banks where possible with minimum of 1-inch clearance between conduits.
5. Maintain 6-inch clearance between conduit and coverings on all hot lines; steam and hot water.
6. Do not exceed a distance of 8 feet between supports on horizontal or vertical runs.

C. CONCEALED INSTALLATION

1. Do not install conduit in concrete where conduit outside diameter exceeds one-third of concrete thickness.
2. Install parallel runs with a minimum spacing of three conduit diameters between conduits.
3. Use expansion and deflection fitting with bonding jumpers at all concrete expansion joints.
4. Tie securely in place to prevent movement when concrete is poured.
5. Install in floor slabs in as straight a run as possible. Conduit crossovers are not permitted unless conduit total outside diameter is one-third of the concrete thickness or less.
6. Use long radius elbows except on risers where curved portion or elbow would extend above the finished floor or foundation.
7. Make all joints watertight after installation by coating all finished joints with coal tar solution applied at 15 mils minimum dry film.

    a. Koppers — No. 50
    b. Tnemec — 46-449

D. BURIED INSTALLATION

1. Use PVC conduit.
2. Make all joints watertight with cement furnished by the conduit manufacturer.
3. Bury conduits a minimum of 24-inches below finish grade unless indicated otherwise.
4. Slope conduit away from conduit risers where possible.
5. Maintain 6-inch separation from underground piping.
6. Use long radius bends at all risers where possible.
7. After trench bottom has been finished to grade, lay conduit. Cap the ends of all conduit risers before backfilling. Backfilling shall be as specified in Division 2.

3.2 WIRE AND CABLE INSTALLATION

A. Use insulating types of pulling compounds containing no mineral oil. Pulling tension shall be within the limits recommended by the wire and cable manufacturer. Use a dynamometer where mechanical means are used. Cut off section subject to mechanical means.

B. Bending radius shall be limited to 8 times cable overall diameter.

C. Provide maximum slack at all terminal points. Support cables so that strain on cable will not be transmitted to the termination.

D. Use solderless-type connectors. For wire sizes up to No.6 AWG, use compression type, and B Sta-Kon, Burndy Hylug, or equal. For sizes No.4 and above, use either compression-type or bolted-type with silver-plated contact faces. For sizes No.250 MCM and larger, use connectors with at least 2 cable clamping elements or compression indents and provision for at least 2 bolts for joining to apparatus terminals.

E. Install cable continuous, without splice from termination to termination. Where required, splice in junction box using terminal boards for all control wiring and approved connectors as specified for all power wiring. Splices in conduits not allowed. All splices must be approved by the Engineer in advance of making said splice.

F. Identify all conductors at each end by circuit number or terminal number at each terminal in control center, panelboard, device box, junction box, pull box, manhole and terminal panel. Use pressure-sensitive labels. Record the identification of each wire and cable on drawings.

G. Install color code power cable insulation as follows:

1. 120/208 volt phase legs:
   a. Black
   b. Red
   c. Blue
2. 120/208 volt neutrals - White
3. 277/480 volt phase legs
   a. Yellow
   b. Brown
   c. Orange

4. 277/480 volt neutrals - Gray
5 Ground conductors - Green

Where conductor insulation cannot be furnished, color impregnated conductors shall be color coded at all accessible locations with colored plastic adhesive tapes suitable for the application. In all cases, color-coding shall be as indicated in the schedule above.

H. Shielded cable shall be installed in conduit separate from power cables. Ground shield at one end only or as recommended by instrument manufacturer. Terminate stranded conductors with preinsulated crimp type spade or ring tongue terminals.

I. Minimum wire sizes shall be No.12 AWG for power and lighting, No.14 AWG for control and No.18 AWG for instrumentation.

3.3 GROUNDING INSTALLATION

A. Ground all electrical equipment as indicated and to comply with the NEC.

B. Provide separate stranded copper green insulated ground conductors with all branch circuit and feeder wiring installed in conduit. Connect to ground bus where service originates and to equipment being served. Size ground conductors in accordance with the National Electrical Code if not indicated.

C. Connect ground conductors to conduit with copper clamps, straps or with grounding bushings.

D. Connect to metal piping by welding or brazing. Use copper bonding jumpers on all gasketed joints.

E. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use anchor bolts. Where grounding provisions are not included, drill suitable holes in locations designated by the Engineer.

F. Connect to service water piping by means of copper clamps.

G. Ground instruments and conductor shields and drain wires in accordance with the recommendations of the instrument manufacturer.

H. Scrape bolted surfaces clean and coat with oxide-resistance compound.

3.4 LIGHTING AND DEVICES INSTALLATION

A. Fixture mounting heights and locations indicated are approximate and are subject to revision in the field where necessary to clear conflicts and obstructions.

B. Suspended fixtures shall be pendant mounted using ½-inch conduit stems. Ground to outlet box. Attach mounting to building structure with anchors of the type required for the construction surface.

C. Surface mounted fixtures shall be attached to appropriate outlet boxes.

D. Boxes and Fixtures

1. For units mounted against steel, masonry or concrete walls, provide suitable 1.5-inch spacers to prevent mounting back of box directly against wall.
2. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers or Unistrut.
3. No boxes to be installed with open conduit holes.
4. Label each circuit and identify with tag.

E. Mounting heights or elevations are to bottom of fixture or to centerline of device.

1. Fixtures: As indicated.
2. Wall Switches: 4 feet, 6 inches above finished floor.
3. Outlets: 1 foot, 6 inches above finished floor in nonhazardous areas, or as indicated.

3.5 FIELD TESTING

A. WIRE AND CABLE TESTS (FEEDER, BRANCH AND CONTROL CIRCUITS ONLY)

1. Megger all 600V insulated wire with a 500V megger for one minute, and record the values. Determine the values with all panelboards, fuse holders, switches, and overcurrent devices in place. Do not connect motors and transformers during meggering. Megger wire and cable after installation, not on the cable reel.
2. Check all control cable by megger tests similar to those described for 600V insulated wire. Check all control wiring for tightness of terminal contacts and continuity through each run of control circuiting. Thoroughly verify all wiring. Provide all phasing tests and make all changes necessary to assure proper rotation of all motors, the correct phasing and phase sequence of all circuits susceptible to being paralleled, the proper polarity on all instrument transformer wiring, and such other phasing tests as may be required for the equipment being connected.

B. GROUNDING TESTS

1. Measure resistance of ground system at each ground riser.
2. Record results and notify Engineer if any reading exceeds 5 ohms.
3. Test by one of the following methods for resistance measurement:

a. 3-point method, using an ammeter and voltmeter with AC or DC power supply
b. Commercial instrument method

END OF SECTION 7

APPENDIX B
MANUFACTURER CUT SHEETS

AIR COMPRESSOR

POWER IGNITION INDUSTRIAL EQUIPMENT - 6614 Long Drive - Houston, TX 77087

T04950A-26

COMPRESSED AIR SYSTEM QUOTATION

(1) CURTIS, Model R/S10-T Rotary Screw Air Compressor

- 10 HP, 460 Volt, 3 Phase, 60 Hz
- TEFC motor
- NEMA 4 electrical
- Capacity: 42 CFM @ 100 PSI
- Mounted on 80 gallon ASME receiver

PRICE.....$5,785.00

X (1) **CURTIS, Model R/S15-T Rotary Screw Air Compressor**

- 15 HP, 460 Volt, 3 Phase, 60 Hz
- TEFC motor
- NEMA 4 electrical
- Capacity: 67 CFM @ 100 PSI
- Mounted on 80 gallon ASME receiver

PRICE.....$6,575.00 YES

accepted 4/24/98

Engineer Provided

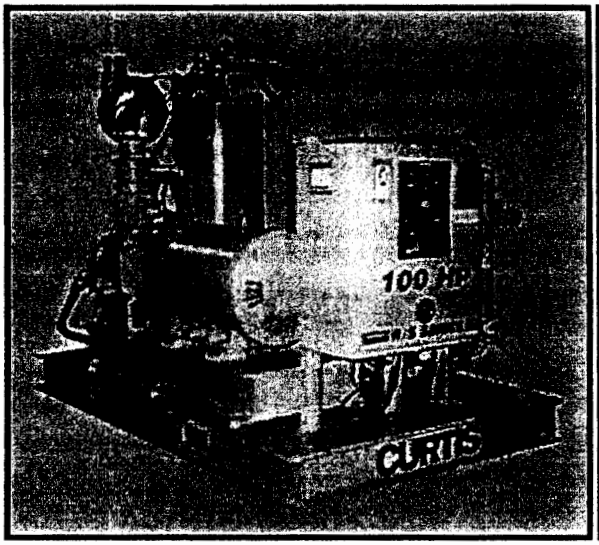
TERMS FOR SHIPMENT IN U.S.

Pricing:	**Tax not included in price. If tax exempt, please supply your tax exempt information to our accounting department with your purchase order.**
Valid:	**For 90 Days from date of this quotation.**
Terms:	**Net 30 Days upon approval of credit.**
Delivery:	**F.O.B. St. Louis, MO**
	Add incoming freight to quoted prices. Allow 2 to 3 weeks for shipment, after receipt of order.

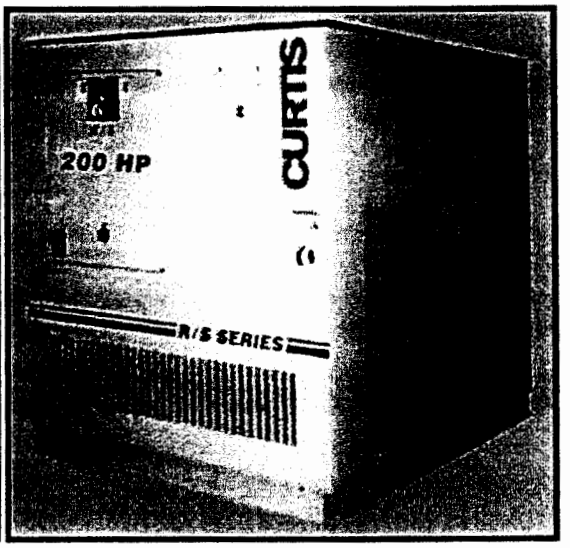
CURTIS-TOLEDO

Phone: 800-925-5431 Fax : 314-381-1439
E-mail: CurtisComp@aol.com

CURTIS *R/S SERIES*
ROTARY SCREW AIR COMPRESSORS
5-300 Horsepower



BASE MOUNTED
OPEN
5-300 HP



BASE MOUNTED
ENCLOSED
5-300 HP

HIGH PERFORMANCE - ENERGY EFFICIENT
100% DUTY CYCLE - BASE AND TANK MOUNTED

Features Standard Equipment Specifications

"CURTIS REDEFINES WHAT IT TAKES TO MAKE A SUPERIOR COMPRESSOR"

SINCE 1854 CURTIS has been synonymous with quality products and service. Curtis continues this tradition with the R/S Series Rotary Screw line.

THROUGH SUPERIOR ENGINEERING our compressors are unmatched in terms of durability and performance. Our advanced R/S air end profile along with an energy efficient control system delivers more air output per energy dollar. We challenge you to compare Curtis with any other design in the industry.

YOU'LL RECEIVE KNOWLEDGEABLE ASSISTANCE from your local Curtis distributor along with our in-house customer service and engineering staff. This combination of outstanding quality products and service has made Curtis a leader in the compressed air industry.

BUILT WITH THE LATEST TECHNOLOGY

OPEN DESIGN OR ACOUSTICAL ENCLOSURE - Depending on your preference, Curtis offers high quality optional enclosures. Metal cabinet is lined with oil resistant sound-proof padding. Durable powder coated finish ensures your Curtis compressor will look great many years down the road. Removable lid and service access doors provide for easy maintenance.

BASE OR TANK MOUNTED - For your convenience, Curtis offers both configurations to meet your installation requirements. ASME tank mounted units can also offer reduced system floor space.

AIR OR WATERCOOLED - If ambient temperature could be excessive consider our watercooled package. Curtis offers both air and watercooled designs to meet most applications.

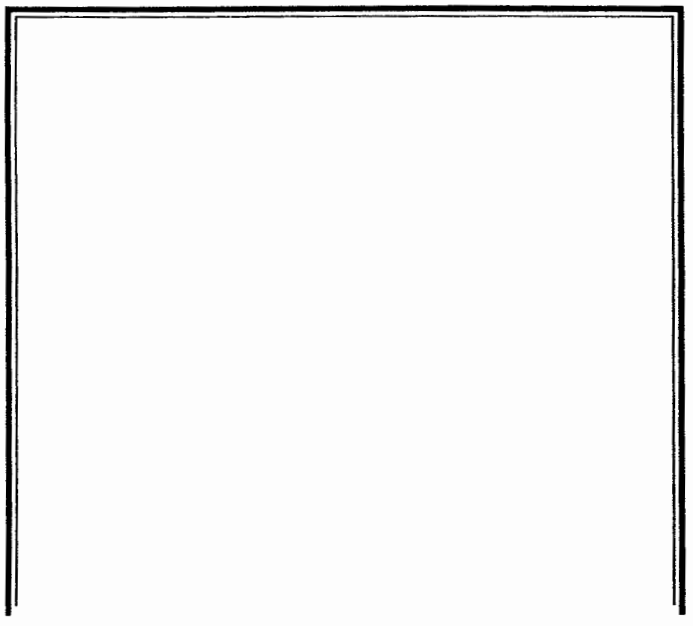
SIMPLE INSTALLATION, EASY MAINTENANCE - No foundation required. All compressors come wired, pre-piped, pre-tested and "ready to run". Unit design is virtually vibration free and operates at **low dBA levels**. Each compressor is fully crated to avoid shipping damage. All components and service points are conveniently located for ease of maintenance.

FACTORY TRAINED SERVICE NETWORK - Curtis continually conducts comprehensive service training schools available for all distributors. This ensures quality service support for all Curtis customers.

LOADED WITH THE FEATURES YOU NEED

ENERGY EFFICIENT CONTROL SYSTEM
For proven maximum energy savings Curtis offers on line-off line or start-stop control with delay off timer. Optional modulation may also be added (Modulation is standard on 25 HP+). During unload cycle sump drops to low pressure resulting in an additional 10-12% electrical savings over conventional sytems when in idle mode.

INSTRUMENTATION
Display includes discharge and sump pressure gauges, temperature gauge, hour meter, dual high air/oil shutdown switches with light, start-stop/reset buttons, dual control switch, no load start switch, standby light, and power-on light.



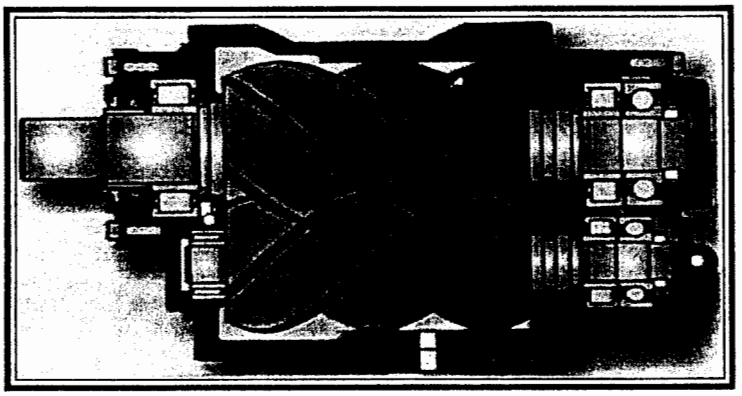
CONTROL CABINET
Conveniently located with hinged access door. Built-in across the line magnetic motor starters with thermal overload protection ensures long motor life. 115 volt control circuit transformer is provided for safe operation. Standard NEMA 1 Rated cabinet and electrical controls are U.L. and CSA listed. All electrical components are standard off the shelf for easy replacement.

ELECTRIC MOTORS
The R/S Series is designed using off the shelf motors and drive train parts. Heavy duty NEMA design motors with a 1.15 to 1.25 service factor are used to ensure dependable long life.

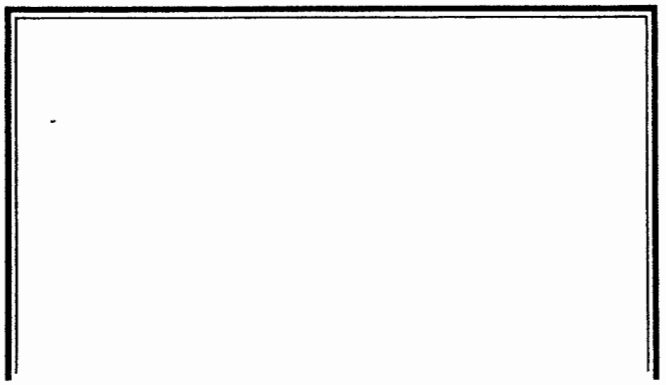
SIDE BY SIDE AIR/OIL COOLERS
This arrangement allows for very low approach temperatures vs. less efficient "stacked" design. This increases overall efficiency and provides for a cooler running compressor. Thermostatically controlled oil bypass valve insures proper oil temperature to extend air end life. Side by side coolers also offer easy access for cleaning.

"R/S" ROTOR PROFILE
INCREASED EFFICIENCY - The CURTIS "R/S" Profile with it's high precision finish offers the shortest possible sealing line to ensure minimal internal losses. This design along with low rotational speeds give you **maximum CFM output per energy dollar.** The "R/S" profile allows for extra CFM output even at pressures as

RUGGED AIR END DESIGN
All Curtis Air Ends are manufactured to ISO 9001 Certification and are **built for 100% duty cycle**. Zero wear Curtis rotors run in an oil bath and have no metal to metal contact. In most cases, our rotors and bearings are larger by horsepower range than competitive units.



LEAK FREE DESIGN
With substantially reduced fittings along with high quality steel tubing and o-ring sealed hydraulic connections, Curtis units are designed to eliminate potential leaks.



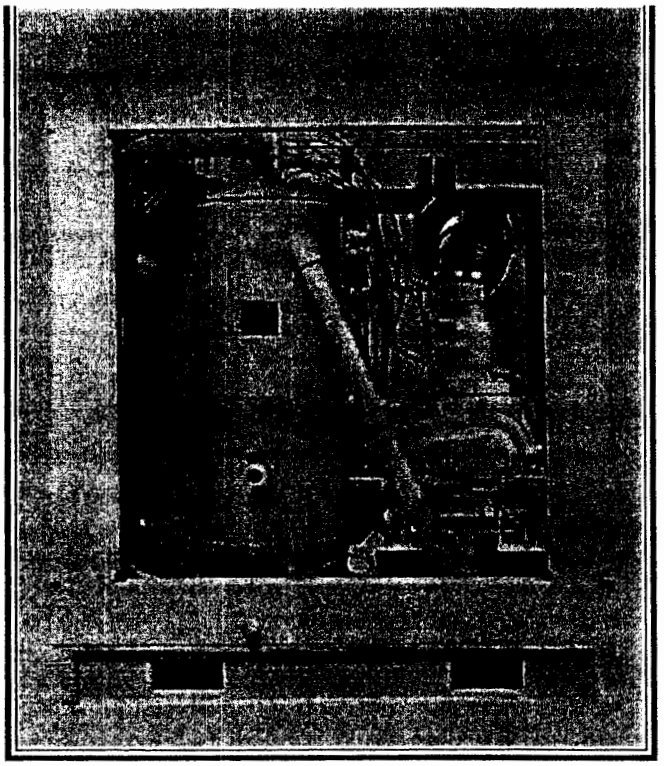
nign as 175 PSIG.

LONG LIFE-LARGE DIAMETER BEARINGS
Large cylindrical roller bearings are designed for years of continuous service. **Precision ball bearings with angular thrust contact provides twice the needed thrust loading**. Bearings are a significant part of any air end and Curtis puts an emphasis on their long life bearings.

OIL SEPARATORS
VERTICAL MULTI-STAGE SEPARATION - First stage separation is achieved by offset air/oil inlet and special baffling which centrifugally separates 95% of oil from air.

Second stage separator element is sized so that even under maximum capacity flow, the velocity through the filter is less than 1 ft./sec. for maximum efficiency. Our separator element will last longer due to our unique oversized design. This oil separation system provides virtually oil-free air.

ASME CODED, VERTICAL SEPARATOR TANK saves space and reduces turbulence to prevent oil carryover. Separator tank is equipped with oil-fill vent plug, oil level sight glass, safety relief valve, and minimum pressure check valve.



TANK MOUNTED UNITS AVAILABLE 5-50 HP

R/S SERIES

Rugged Design

Factory Tested

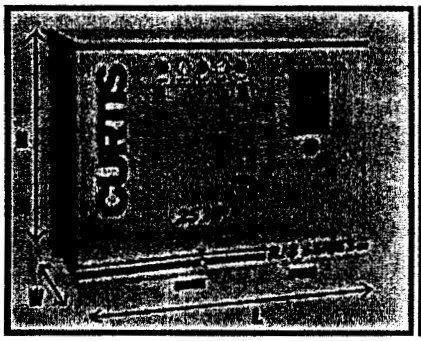
Ready to Run

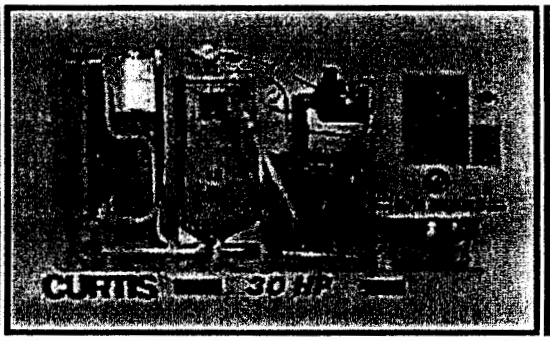
STANDARD EQUIPMENT

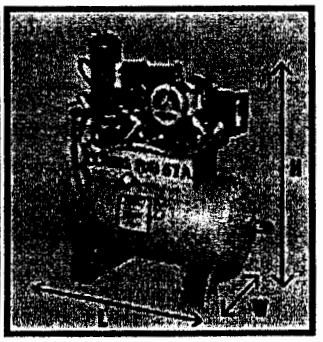
- **Air End Manufactured To ISO 9001 Standards**
- **Heavy Duty NEMA Design Motors**
- **NEMA 1 Control Panel With Starters**
- **115 Volt Control Transformer**
- **Vibration Isolators On Sub-Base 50-300HP**
- **Drive Guard**
- **Thermostatic Oil Temp Valve**
- **Minimum Pressure Valve**

- Dual High Temp Shutdown Switches
- Temperature Gauge
- Liquid Filled Pressure Gauges
- Hour Meter
- Start-Stop/Reset Buttons
- Load/Unload Switch
- Start-Stop Control 5-7 1/2 HP
- Timed Dual Control 10-20 HP
- Timed Dual Control with Modulation 25-50 HP
- On line-Off line with Modulation 50-300 HP
- Side by Side Coolers
- Multi-Stage Oil Separator Unit
- Safety Valve On Separator Tank
- ASME Code Air Receiver For Tank Mounts
- Low dBA, 100% Duty Cycle
- Intake Filter 5-30 HP
- Heavy Duty Intake Filter 40-300 HP
- Heavy Duty Oil Filter with Bypass
- Factory Fill Synthetic Lubricant

SPECIFICATIONS







BASE MOUNTED 5-50 HP

		CFM/PSI				WT LBS		DIMENSIONS		
MODEL	HP	100	125	150	175	w/encl	no/encl	L "	W "	H "
R/S-5A	5	19	18	15	--	N/A	165	32	22	20
R/S-7A	7.5	27	26	23	--	N/A	175	24	22	20
R/S-10	10	42	39	34	28	350	N/A	27	27	34
R/S-15	15	67	58	48	44	790	640	60	30	43
R/S-20	20	88	82	71	61	1135	985	60	30	43
R/S-25	25	108	104	92	80	1210	1060	60	30	43
R/S-30A	30	125	118	106	100	1375	1100	60	30	43
R/S-30	30	140	130	118	97	1425	1150	60	30	43
R/S-40	40	191	173	150	129	1630	1425	72	42	50
R/S-50	50	225	212	186	172	1955	1750	72	42	50

BASE MOUNTED 50-300 HP

		CFM/PSI				WT LBS		DIMENSIONS		
MODEL	HP	100	125	150	175	w/encl	no/encl	L "	W "	H "
R/S 50-AD	50	225	215	186	170	2030	1825	42	72	46
R/S 50-D	50	240	222	195	165	2130	1925	42	72	46

R/S 60-D	60	280	275	236	212	2570	2170	48	76	62
R/S 75-D	75	365	329	305	270	3140	2690	54	84	62
R/S 100-D	100	465	458	363	340	3400	2950	54	84	62
R/S 125-D	125	600	570	516	440	5320	4520	66	84	71
R/S 150-D	150	760	706	583	546	5550	4750	66	84	71
R/S 200-D	200	960	860	770	680	5985	5285	70	90	71
R/S 250-D	250	1170	1073	970	-	9700	9000	75	96	80
R/S 300-D	300	1450	1298	1150	-	10000	9300	75	96	80

PNEUMATIC PUMPS, OIL/WATER SEPARTOR, AND AIR STRIPPER

C

1322 Space Park Drive, Suite #A200
Houston, Texas 77058
800 526.4999 *Toll Free*
281 333.5271 *General*
281 333-4782 *Fax*
sales@carbonair.com

Visit our web site: *http://www.carbonair.com*

Service Office
4105 Hunter Road #10
San Marcos, TX 78666
800 893 5937
512 392 0066

Wednesday, September 11, 2002

Tetra Tech EMI
6121 Indian School Road, NE
Suite #205
Albuquerque, NM 87110
Attn: Bob Marley

Phone: 505-881-3188
Fax: 505-881-3283

Re: Roswell GW Project

Dear Mr. Marley,

Thank you for the opportunity to provide pricing information for the above referenced application. Please review the following and feel free to call with questions or comments.

Groundwater Pumps

(37) Clean Environment Engineers model AP-2/TL pneumatic pump
- 0-2 gpm
- Controllerless operation
- Top loading
- SS outer casing
- 75' of 1/2" discharge tubing
- 75' of 3/8" air supply tubing
- 75' of 3/8" air exhaust tubing
- 75' of suspension cable
- 5 micron filter regulator
- 4" well cap with appropriate couplings for tubing

Groundwater Treatment

(1) Carbonair COWS 25S oil/water separator
- 25 gpm capacity
- 178 gallon working volume
- 105 gallon capacity sump
- 68" long x 28" wide x 46" high FRP vessel
- 3" inlets and water outlet
- 2" oil outlet
- Coalescing media
- Vapor tight cover
- Solids collection sump
- Adjustable oil skimmer
- Sight glass with pump operation switches
- Mounted on common steel stand (4' high maximum, actual height to be determined)
- 100 Gallon UL 142 Product drum with H/L switch

(1) Myers CT centrifugal transfer pump
- 15 gpm @ 30' TDH

- ¾ hp, 230V, 3 phase, XP motor

Low-Profile Air Stripper Option

(1) Carbonair STAT 80 low profile air stripper
- SST sump with high level alarm and pump operation switches
- 5 trays with demister and fasteners
- 5 HP, 3 phase, TEFC blower (300 cfm @ 40" wc)
- Blower low pressure alarm switch
- Blower pressure gauge
- 1 hp, 230V, 3 phase, XP transfer pump (20 gpm @ 50' TDH)
- Mounted on a common skid
- Effluent totalizing flowmeter with transmitter

Liquid Phase Carbon Option

(2) Krystal Kleer model 88 bag filters
- Carbon steel housing
- 2" side inlet and bottom outlet connections
- 100 psi maximum design pressure
- Manifold for parallel operation
- Valves, gauges, sample ports, etc.

(2) Carbonair PC 5 liquid phase carbon adsorbers
- 2.5 ft. diameter x 7.3 ft. high steel vessels
- 575 lbs. of liquid phase carbon each
- Maximum design pressure 100 psi

Both vessels will require changeout every 90 days, approximate cost for non-hazardous turnkey on-site exchange including refilling vessels with reactivated 8X30 carbon, disposal of spent carbon, labor, travel, etc. **$3,225.00 X 4 = $12,900/ year.**

Water Quality

Based on the water quality data provided, the following chemical addition system is highly recommended to prevent scaling/ fouling of the air stripper or carbon.

(1) Chemical Addition System
- LMI metering pump
- 55 Gallon drum of AN-210H Anti-scaling chemical
- Approximate usage rate of .76 gallons per day

Control System

(1) Carbonair Series 1000 control system in a NEMA 4 enclosure to mount on a Unistrut frame on the skid. For operation on 115/230 volt, 3Ø, 4 wire incoming electrical service. To provide control for the ¾ HP transfer pump, 7.5 HP STAT low profile air stripper blower, 1 HP air stripper discharge pump. With all required control pilot devices, alarms and interlocks. To include:

QTY	DESCRIPTION
1	Enclosure, NEMA 4, 30"h, 30"w, 12"d with padlock handle, data pocket (small), swing-out panel and sub-panel
1	Disconnect, non-fusible, 100A with lockable operating handle and shaft
1	Distribution block, 3 pole; L1, L2, L3
1	Distribution block, 1 pole; Neutral
3	Motor starter: Contactor 23A FLA with 1 aux. contact/Overload relay 3.7-12A, 3Ø, manual reset; 1

and 1.5 HP pumps, 7.5 HP blower

1 Motor starter: Contactor 60A FLA with 1-aux. contact/Overload relay 26-85A, 3Ø, manual reset; 20 HP LRP
4 Overload reset pushbutton (through door)
1 Circuit breaker 230V 1P10A 10K; control power
1 Circuit breaker 230V 1P15A 10K; vent fan, lights, and heater
2 Circuit breaker 230V 3P15A 10K; pumps
1 Circuit breaker 230V 3P20A 10K; STAT blower
5 Switch; three position; Hand-Off-Auto with integral Run indication
6 Light (red/LED); alarms
1 Pushbutton (red/NC); alarm Reset
2 Intrinsically safe dual pump level control with dual level alarms
2 Intrinsically safe barrier, two channel, 120 VAC; alarms

Relay/timer logic
Engraved laminated legends for all door mounted devices
Terminal blocks for customer connections and fusing as required
Color-coded wiring with wire markers at all terminations
Serialized UL508 Industrial Control Panel label
Fully documented, assembled, wired and pre-shipment test

(1) Sensaphone model 1108 autodialer
- 8 inputs
- Dials up to 8 numbers
- Dial in status reports and listen in to on-site sounds

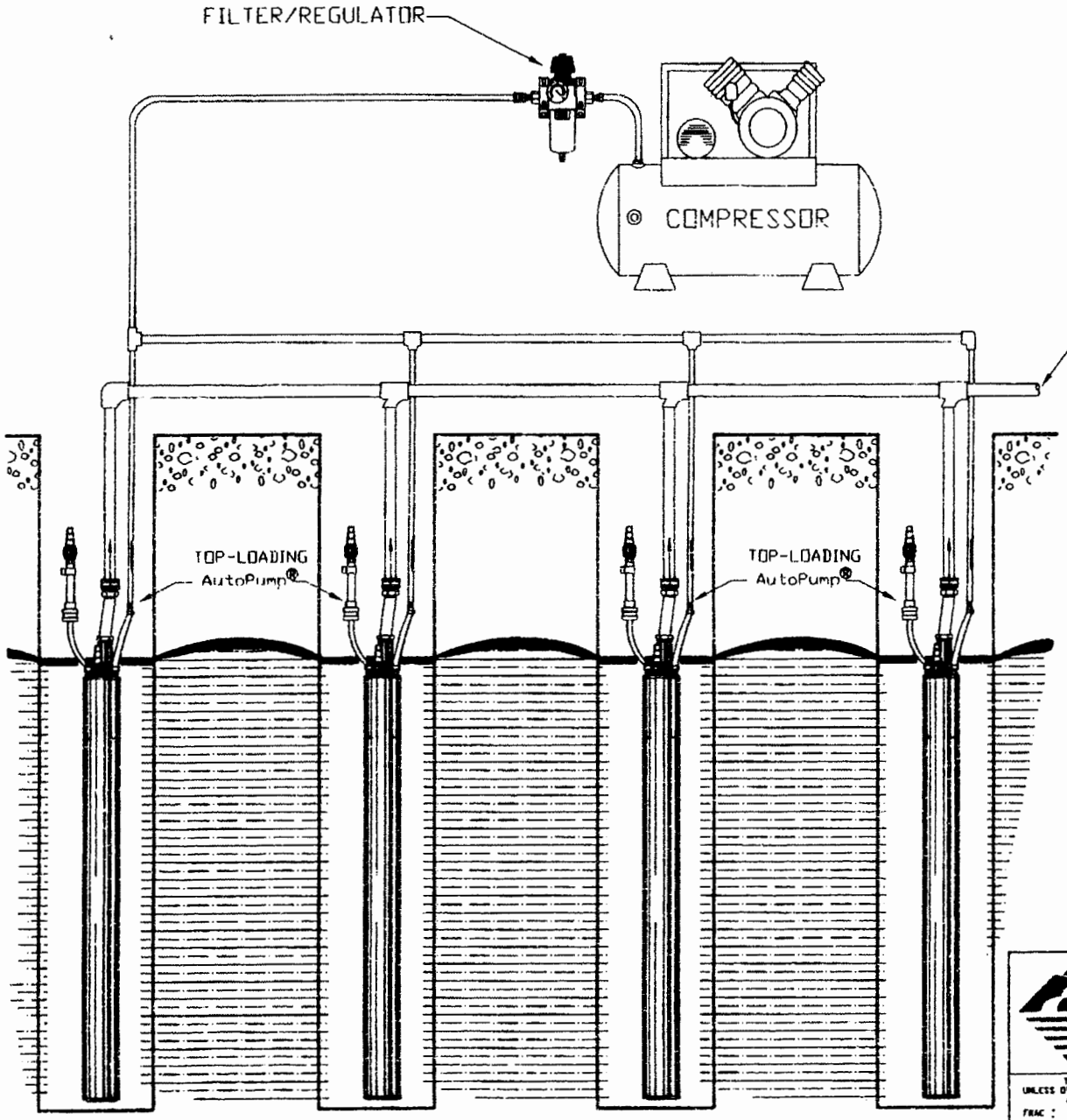
Treatment Building

(1) Carbonair building system
- 8' wide x 16' long x 10' high wood building with steel base
- 2x4 walls and rafters
- 4/12 roof pitch w/ No overhangs
- 7/16" OSB roof sheathing
- Rolled roofing
- 15# Felt on roof
- Masonite siding
- Wall and ceiling insulation
- Sheetrock inside interior walls and ceiling
- 3/16" sheet steel floor
- Structural channel floor supports
- Anchor lugs w/ lifting eyes
- Floor sump with high level alarm switch
- Water flow meter on sump pump effluent line
- Bolt down anchor lugs
- Forkliftable base w/ 4 point crane lifting eye's
- Double doors for equipment access
- Heater, vent fan, and lights rated for use in Class 1, Division 2 environment
- Interconnecting piping, valving, and conduit and wiring
- System controls mounted on the exterior of the building

(1) Estimated freight to Roswell, NM
- Assumes non-expedited, double-drop trucking

(1) Start-up supervision and training
- One technician on site for 2 days (8 hours per day)
- Includes travel, labor, mileage, and per diem expenses
- Additional over time hours (>8 hrs. per day) to be billed at $75/hr.

MULTI-WELL STANDARD AP-2/TL
CONTROLLERLESS TOTAL FLUIDS RECOVERY SYSTEM



FEATURES & BENEFITS

- A SINGLE 5 MICRON FILTER IS ADEQUATE FOR THE SYSTEM.
- EACH WELL OPERATES INDEPENDENTLY FROM ADJACENT WELLS.
- THE SYSTEM STAYS FULLY PRESSURIZED; AIR IS ONLY CONSUMED "ON DEMAND".
- NO BUBBLER SENSORS ARE REQUIRED; THEREFORE THE PUMPS CAN OPERATE UNDER A VACUUM ALLOWING SOIL VENTING.

Clean Environment Equipment
EQUIPMENT FOR GROUNDWATER REMEDIATION AND LEACHATE EXTRACTION
1133 7th ST.
OAKLAND, CA 94607
(510) 891-0880 (800) 537-1767 FAX (510) 444-6789

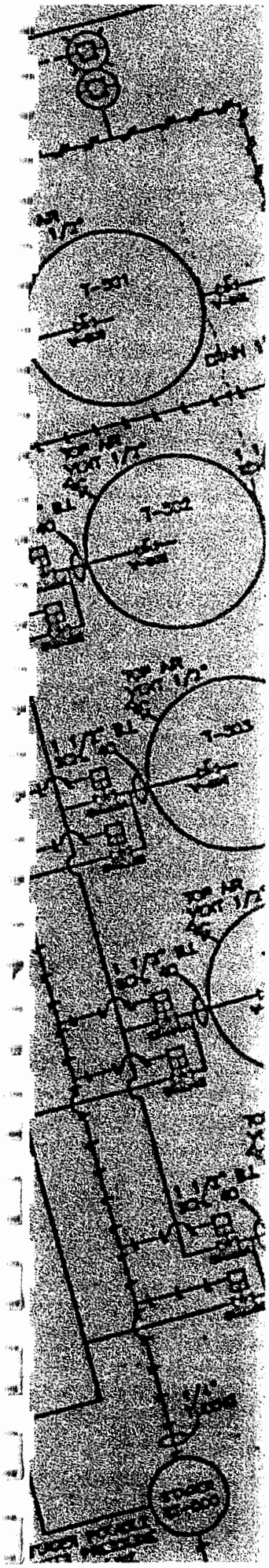
TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR : .30° FRAC : XX : .01 XXX : .005 XXXX : .0005	APPROVALS	DATE	TITLE	MULTI-WELL STANDARD AP-2/TL
MATERIAL	DRAWN TONY RAMIREZ 9-21-94		DWG No.	600297 REV
FINISH	DESIGNER		SCALE	NONE SHT 1 OF 1
	CHECKED			
	APPROVED			

CARBONAIR®
ENVIRONMENTAL SYSTEMS
2731 Nevada Avenue North
New Hope, MN 55427
800-526-4999 *Toll-free*
612-544-2154 *Voice*
612-544-2151 *Fax*
www.Carbonair.com

Specifications

Model	COWS 5	COWS 10	COWS 15	COWS 30	COWS 50	COWS 100	COWS 150
Hydraulic capacity (gpm)	5	10	15	30	50	100	150
Dimensions (LxWxH)	60"X16"X34"	60"X28"X34"	60"X40"X34"	68"X52"X46"	80"X52"X45"	96"X52"X58"	104"X52"X68"
Inlet/Outlet connections (NPT)	2"	2"	3"	3"	4"	6"	6"
Oil Out connection (NPT)	1 1/2"	2"	2"	2"	2"	2"	2"
Weight empty	85 pounds	95 pounds	170 pounds	325 pounds	400 pounds	1,350 pounds	2,150 pounds
Weight full	816 pounds	1,264 pounds	1,900 pounds	3,895 pounds	4,705 pounds	8,000 pounds	11,500 pounds
Media; cubic feet	2	4	6	16	24	48	80
Media; surface area	238	476	715	1,901	2,856	5,700	9,500
Working volume (gallons)	35	70	105	220	310	525	825
Water reservior (gallons)	25	50	70	165	165	250	275

All specifications subject to change without notice.



STAT® Series
Low Profile Air Strippers

Carbonair's exclusive STAT series represents the best choice in low profile air strippers, combining high performance, flexibility and design simplicity. Carbonair's STAT units are available with a number of tray configurations, blowers and controls, and can achieve a removal efficiency of up to 99.99% for a long list of volatile organic compounds.

Construction Materials

Air Stripper
304 series stainless steel.

Gaskets
Gasoline-resistant neoprene.

Demister
Polypropylene material capable of removing 99.5% of the droplets 10 microns or larger; 95% of the droplets 5-10 microns in size.

Design

Flanged Inlet and Outlet
Flanged (150 pound) inlet and outlet configuration to maximize the integrity of piping connections.

Anti-bypass Valve*
Eliminates need for priming prior to system start-up.

Flapper Valve (Gravity units)*
Prevents air from bypassing the sieve trays through the effluent discharge during start-up.

Downcomer
Weir type square downcomer flow distribution system ensures uniform water distribution over the trays. Minimizes back pressure and head losses.

Sieve Trays
STAT 15, 30, 80: 10.25" high. Minimum water height of 4".
STAT 180, 400, 720: 12.25" high. Minimum water height of 4".

Tray Alignment Guides
Permanently installed for proper tray alignment.

Tray Fastening
Stainless steel over-center latching clips.

Collection Sump
Minimizes pump cycling and maintains sufficient turbulence.

Regenerative Blower
Direct coupled regenerative blower maintains high air pressure at low flow rates.

Accessories

Pump-out
Incorporates float switches in an externally-mounted clear PVC sight glass.

Pressure Gauge
Installed on sight glass.

Low Pressure Switch
Mounted in blower discharge piping.

Options

- Water temperature and flow monitoring.
- Air temperature and flow monitoring.
- Explosion-proof controls.
- Enclosures and trailers.
- Off-gas carbon filtration.
- Custom control panel.
- Humidity control.
- Discharge pump.
- Carbon polish.
- Well control.
- Pump-down.
- Sample taps.

*U.S. Patent Numbers 5,478,507 and 5,378,267.

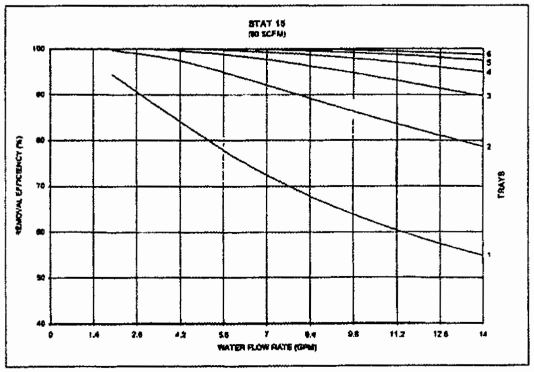
CARBONAIR®
ENVIRONMENTAL SYSTEMS
2731 Nevada Avenue North
New Hope, MN 55427-2806
800-526-4999 *Toll-free*
612-544-2154 *Voice*
612-544-2151 *Fax*
www.Carbonair.com

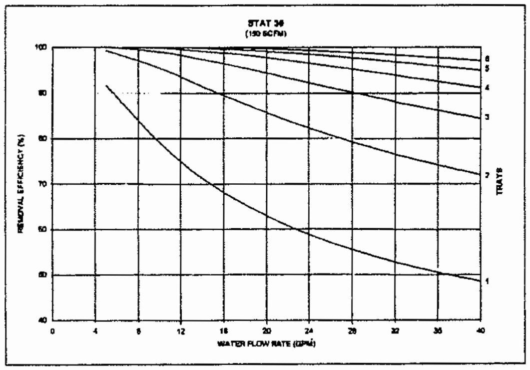
Specifications

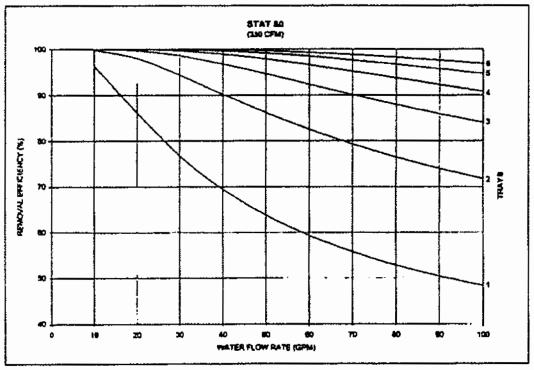
Model	STAT 15	STAT 30	STAT 80	STAT 180	STAT 400	STAT 720
Tray dimensions (LxWxH; inches)	24x9x10	36x12x10	48x24x10	72x36x12	120x48x12	144x72x12
Sump holding capacity (gallons)	13	30	70	250	560	1000
Maximum height (inches)*	93	96	97	120	122	130
Liquid flow (gpm)	0.5-12	1-35	5-80	10-200	20-400	40-1000
Minimum air flow (cfm)	60	100	300	650	1800	3000
Maximum air flow (cfm)	80	150	350	900	2100	4000

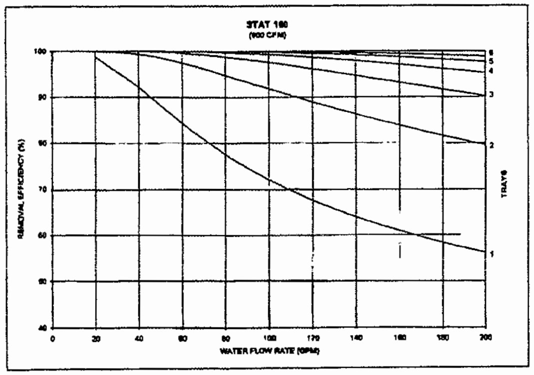
**Six-tray STAT without skid*

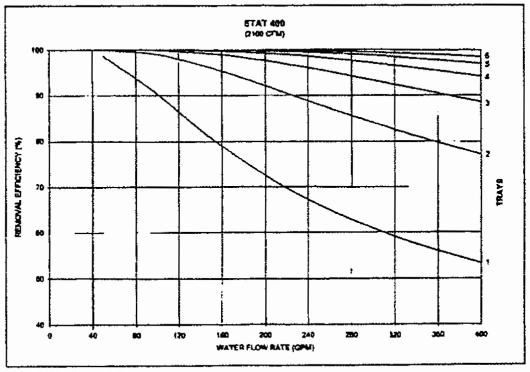
Benzene removal efficiency at 55° F predicted by computer modeling.

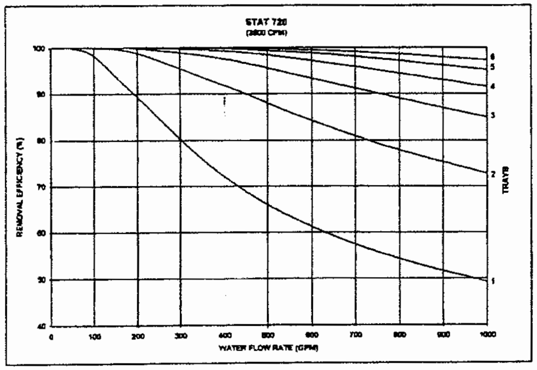




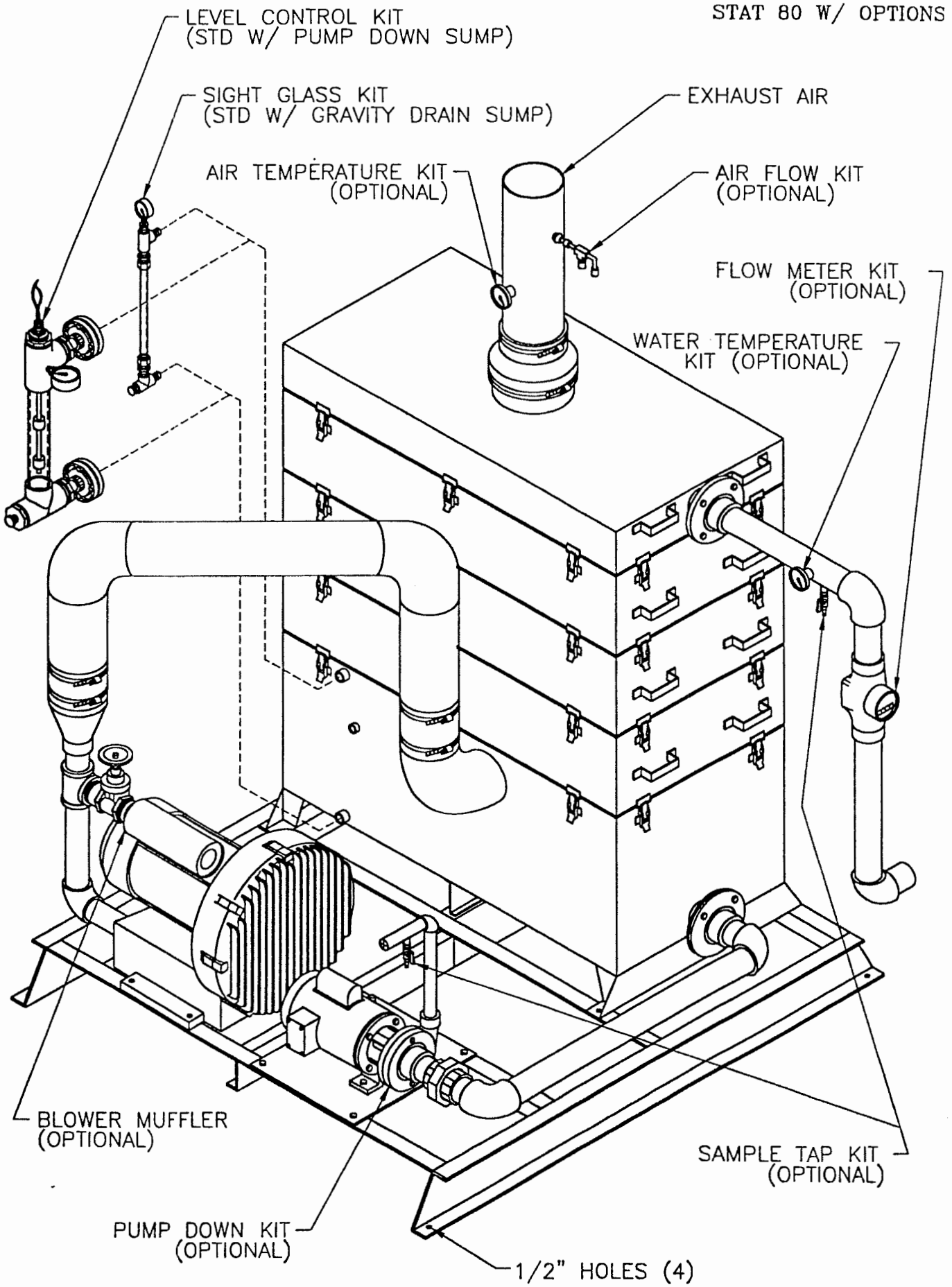








STAT 80 W/ OPTIONS



Sales Drawing #133380
96.12.06

STAT MODEL CALCULATIONS 09/11/02
VERSION 4.1 09:05:35

CARBONAIR ENVIRONMENTAL SYSTEMS
2731 NEVADA AVENUE NORTH, NEW HOPE, MN 55427
PHONE: 612-544-2154 FAX: 612-544-2151

UNIT MODEL:	STAT 80	WATER TEMPERATURE (F):	55.0
WATER FLOW RATE (GPM):	15.0	AIR TEMPERATURE (F):	55.0
AIR FLOW RATE (ACFM):	300.0	AIR-TO-WATER RATIO:	150:1
OPERATING PRESS (ATM):	1.0	SAFETY FACTOR (%):	0.0

Influent Conc. for BENZENE 5000.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	90.08621	495.6894	30.0287	0.8111
2	98.98340	50.8299	32.9945	0.8912
3	99.89540	5.2300	33.2985	0.8995
4	99.98923	0.5383	33.3297	0.9003
5	99.99889	0.0554	33.3330	0.9004
6	99.99989	0.0057	33.3333	0.9004

Influent Conc. for TPH AS GAS(ASSUME BENZENE) 15000.0 ppb

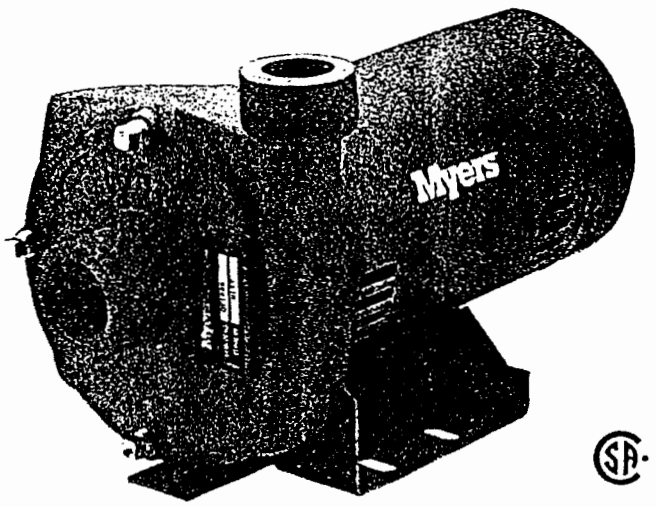
NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	90.08621	1487.0683	90.0862	2.4334
2	98.98340	152.4897	98.9834	2.6737
3	99.89540	15.6901	99.8954	2.6984
4	99.98923	1.6150	99.9892	2.7009
5	99.99889	0.1662	99.9989	2.7012
6	99.99989	0.0171	99.9999	2.7012

Influent Conc. for TOTAL VOCs 20000.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	90.08621	1982.7578	120.1149	3.2445
2	98.98340	203.3196	131.9779	3.5650
3	99.89540	20.9202	133.1939	3.5978
4	99.98923	2.1533	133.3190	3.6012
5	99.99889	0.2216	133.3319	3.6015
6	99.99989	0.0228	133.3332	3.6016

CT Series

High Pressure Centrifugal Pumps
½ - 2½ HP
Heads to 140 Feet
Capacities to 95 GPM



MYERS CT SERIES LINE OF HIGH PRESSURE CENTRIFUGAL PUMPS PROVIDES QUALITY AT A COMPETITIVE PRICE. The complete line of ½ to 2½ HP units provide strong pressures up to 140 feet and flows up to 95 gpm.

The rugged cast iron body construction is available with either a corrosion resistant composite or brass impeller. The brass impeller unit is equipped with a high temperature, viton seal for more demanding applications. The heavy duty motor features a double ball bearing, 50° C ambient, dual voltage design for dependable service. The compact, back pullout design provides easy installation and serviceability.

The quality features of the CT series will provide dependable service for a wide variety of applications.

SPECIFICATIONS

HP	Catalog No. Composite Impeller	Catalog No. Brass Impeller	Pipe Tapping Sizes Suction (NPT)	Pipe Tapping Sizes Discharge (NPT)	Motor Voltage	Phase	Approx. Wt. Lbs.
½	CT05	CT05B	1¼"	1"	115/230	1	30
	CT053	CT05B3	1¼"	1"	208/230/460	3	30
¾	CT07	CT07B	1¼"	1"	115/230	1	32
	CT073	CT07B3	1¼"	1"	208/230/460	3	32
1	CT10	CT10B	1¼"	1"	115/230	1	35
	CT103	CT10B3	1¼"	1"	208/230/460	3	35
1½	CT15	CT15B	1¼"	1"	115/230	1	40
	CT153	CT15B3	1¼"	1"	208/230/460	3	40
2	CT20	CT20B	1½"	1¼"	115/230	1	57
	CT203	CT20B3	1½"	1¼"	208/230/460	3	57
2½	CT25	CT25B	2"	1½"	115/230	1	62
	CT253	CT25B3	2"	1½"	208/230/460	3	62

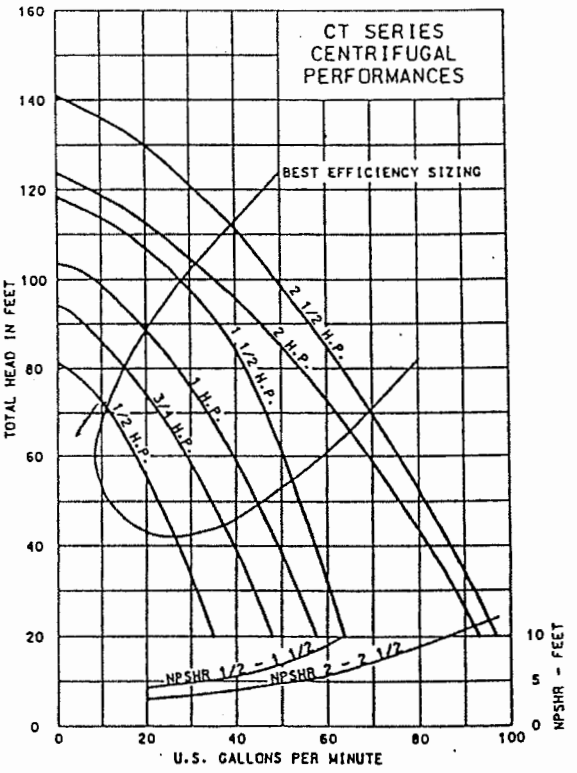
ADVANTAGES BY DESIGN

- Heavy duty cast iron construction.
- Back pull-out design.
- Dependable double ball bearing motor
- Continuous duty rating motor.
- Choice of brass or composite impeller.
- Brass impeller pumps rated 212° F.
- Composite impeller pumps rated 140° F.
- Maximum working pressure of 125 psi.
- CSA listed.

Applications

- Booster service
- Irrigation
- Circulating
- Cooling towers
- Air conditioning
- Liquid transfer
- Sprinkling systems
- General industrial service

PUMP PERFORMANCE



WHERE INNOVATION MEETS TRADITION

Myers

Wil-Flo™ TECHNOLOGY

The Wil-Flo™ patent-pending air distribution system greatly improves the performance characteristics of air-operated, double-diaphragm pumps. This innovative design incorporates an instantaneous shift mechanism and an enhanced exhaust configuration. Pressurized air is alternately routed by the air valve piston to one of the power ports, through the spring-energized sliding check valve and directly behind one of the diaphragms. The air valve piston movement is initiated by inner piston contact with one of the pressure relief valves located on each side of the center block. This causes the valve piston to shift vertically. Upon the shifting of the air valve piston, compressed air in the air chamber moves the sliding check assembly into its recess within the center block, thus exposing the exhaust channel. This vents exhaust air directly to atmosphere, bypassing the air valve and eliminating a major cause of freezing while maximizing flow rates and efficiency.

Market Position

- Superior anti-freezing
- ON/OFF reliability
- Most efficient (SCFM/GPM)
- Superior Flow rate
- Lube-free operation

Application Traits

- Maximum reliability
- Very wet air supply
- NFPA/UV stabilized
- Priority consideration =

Features

- Aluminum C-block brass air
- Plastic air valve piston (ringed)
- Pressure relief valves
- Quick air exhaust
- Dbl. Muffler configuration

Availability

- 1½" pumps
- 2" pumps
- 3" pumps

200-CFM THERMAL OXIDIZER

BAKER THERMAL/CATALYTIC OXIDIZERS
GENERAL INFORMATION - SPECIFICATION SHEET - 200 CFM

GENERAL INFORMATION	
SKID FOOTPRINT	7 FT. X 10 FT.
TRAILER SIZE	14.5' X 8' (INCLUDES TONGUE)
EXHAUST STACK HEIGHT	13 FT.
EXHAUST STACK I.D. AT OUTLET	11.5 IN.
COMBUSTION CHAMBER I.D.	21 IN.
COMBUSTION CHAMBER LENGTH	14 FT.
VAPOR INLET CONNECTION	2.5 IN. FEMALE NPT
SUPPLEMENTAL FUEL CONNECTION	1 IN. FEMALE NPT
SUPPLEMENTAL FUEL REQUIREMENTS	630,000 BTU/HR. @ 1-5 P.S.I.
ELECTRICAL REQUIREMENTS	230 V 1 PHASE, 230/460 V 3 PHASE
OPERATIONAL INFORMATION	
RETENTION TIME	1 SECOND
BURNER TURN-DOWN	14:1
TEMPERATURE - THERMAL MODE	1450°F
TEMPERATURE - CATALYST MODE	700°F
VELOCITY IN COMBUSTION CHAMBER	10 FT./SEC
DESTRUCTION EFFICIENCY:	
THERMAL MODE	99.5%
CATALYTIC MODE	97.0%
APPROXIMATE ALLOWABLE INFLUENT CONCENTRATION	
THERMAL MODE	50-60% L.E.L.
CATALYTIC MODE	20% L.E.L.
STANDARD FEATURES/COMPONENTS	
AUTOMATIC L.E.L.DILUTION	
COMBUSTIBLE SENSOR/TRANSMITTER	
AUTOMATIC TEMPERATURE CONTROL	
FIVE SAFETY INTERLOCKS	
COMBUSTION BLOWER	89 CFM, 1.5 HP
POSITIVE DISPLACEMENT V.E.S. BLOWER	5 HP @ 4" Hg
ELECTRONIC AIRFLOW TRANSMITTER AND PITOT TUBE	
MOISTURE KNOCKOUT TANK	12 IN. DIA., 12 GALLONS
FOUR P.I.D. CONTROLLERS	
THREE PEN CHART RECORDER	L.E.L., TEMPERATURE, AIRFLOW
F.M. APPROVED FLAME ARRESTER	
U.L. CLASSIFIED CONTROL PANEL	
OPTIONS	
TRAILER	
BLOWER SILENCE PACKAGE	TYPICAL 10 DbA REDUCTION
VACUUM UPGRADE	10 HP @ 10" Hg
"BAKER-FAX" TELEMETRY	
AUTO-DRAIN KNOCKOUT TANK	
CATALYTIC MODULE (PLATINUM BASED)	.5 CUBIC FEET

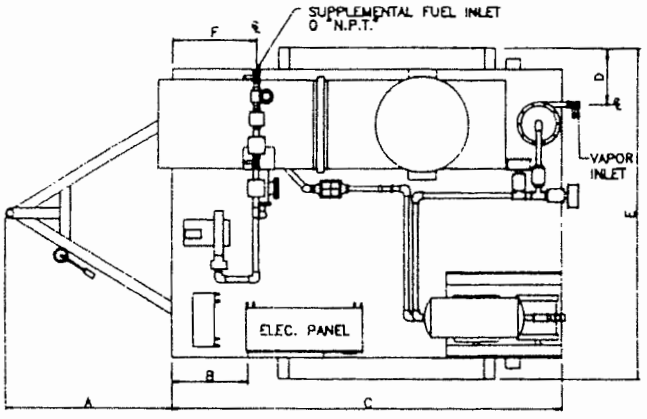
BAKER FURNACE INC.

TRAILER MOUNTED THERMAL OXIDIZERS
dimensions in inches

OXIDIZER	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
100 CFM	51	20	120	20	91	18	82.5	171	19.5	162	56	60.5	2	1	8	75
200 CFM	51	20	120	20	91	18	82.5	171	19.5	162	56	60.5	2.5	1	8	75
300 CFM	60	20	144	20	97	18	87	204	24	162	56	60.5	3	1	8	81
400 CFM	60	20	168	20	97	18	87	204	24	162	70	75.5	4	1.5	8	81
500 CFM	60	20	168	20	97	18	87	228	24	162	70	75.5	5	1.5	8	81

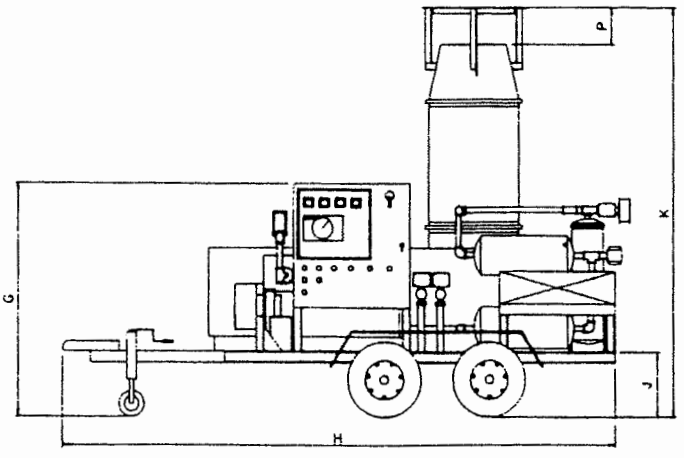
SKID MOUNTED THERMAL OXIDIZERS
dimensions in inches

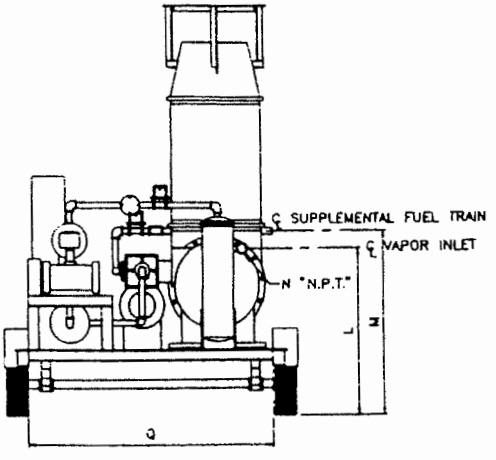
OXIDIZER	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
100 CFM	N/A	20	120	18	N/A	18	69	N/A	6	162	39	39	2	1	8	84
200 CFM	N/A	20	120	18	N/A	18	69	N/A	6	162	39	39	2.5	1	8	84
300 CFM	N/A	20	132	18	N/A	18	69	N/A	6	162	39	42	3	1	8	84
400 CFM	N/A	20	168	18	N/A	18	69	N/A	6	162	53	45	4	1.5	8	96
500 CFM	N/A	20	168	18	N/A	18	69	N/A	6	162	53	50	5	1.5	8	96



OXIDIZER
Weights in lbs. (approximate)

TYPE	100 CFM	200 CFM	300 CFM	400 CFM	500 CFM
Skid	4600	4800	5100	5700	5900
Trailer	5800	5900	6500	6800	7100





CES
Cypress Engineering Services, Inc.

16300 Katy Freeway, Suite 210
Houston, Texas 77094-1609
(713) 578-3115
fax (713) 578-3491

George C. Robinson, P.E.
Environmental Engineer
Cypress Engineering Services, Inc.

c/o: Environmental Affairs Dept.
ENRON Operations Corp.
Room 3AC-3142
P.O. Box 1188
Houston, TX 77251-1188

(713) 646-7327
fax (713) 646-7867

Memorandum

To: **Randy Smith**

Date: **June 13, 1996**

From: **George C. Robinson**

Subject: **WT-1 Dehy Area Remediation (Revision #1)**

George Kneisley has pointed out to me that the previous memo which I distributed on this subject contained an error in the calculation of monthly fuel gas use. Therefore, please trash the previous memo. The following is a corrected version of the same memo.

I contacted George Kneisley last week regarding fuel gas use at the WT-1 station for the SVE blower/incinerator equipment which has been installed for remediation purposes in the former dehy area. George said that we could estimate fuel gas use rather than meter it as long as we could provide a reasonably accurate estimate. In addition, George indicated that the Team would be required to include the estimated fuel gas use on the monthly "Unmetered Gas Report".

Based on the equipment manufacturer's specifications, the SVE incinerator will require approximately 400,000 BTU/hour to maintain the stack temperature at 1450°F, assuming the inlet vapor stream does not provide any BTU value. Therefore, for estimation purposes, we will assume the inlet vapor stream will, on average, reduce the BTU requirement by 10%. In addition, we will assume a downtime of 10% for both routine equipment O&M and non-routine shutdowns. As a result, the estimated fuel gas use is as follows:

Monthly Fuel Gas Use = 400,000 BTU/hr × 90% (adjustment for BTU value of inlet vapor) × 90% (adjustment for downtime) × 24 hr/day × 30 day/month ÷ 1,000,000 BTU/MSCF

= 233 MSCF/month

This allocation should be used beginning on June 20, 1996, when the equipment is scheduled for startup and should continue until the allocation is modified or until remediation is complete which is anticipated in approximately 12-18 months.

If anyone has any questions or concerns regarding this estimate please contact me at (713) 646-7327.

xc:	George Kneisley	TW Operations	Roswell, NM
	Larry Campbell	TW Tech. Ops.	Roswell, NM
	Ernesto Rios (Team Leader)	TW Operations	Carlsbad, NM
	Bill Kendrick	EOC/OTS/EAD	3AC3148

Baker Thermal Oxidizer Specifications

100 through 500 CFM Units ***(600 through 10,000 CFM quoted on request)***

Baker Thermal Oxidizers are designed for vapor extraction based soil remediation projects and other VOC destruction applications where burning the volatiles has been specified as the most cost effective method. Baker Oxidizers feature fully automatic operation, and use either natural gas or propane as supplemental fuel. The VOC destruction rates achieved by our Direct Fired and Catalytic units are excellent. (Please refer to the section on destruction rates for actual quantified rates.) The units are equipped with 6 separate safety interlocks and feature U.L. (Underwriters Laboratory), F.M. (Factory Mutual) and C.S.A. (Canadian Standards) approved components where applicable. Our 100 – 500 CFM units have been approved by A.G.A. (American Gas Association) Laboratories. Selected units have been granted general approval by the South Coast Air Quality Management District (responsible for greater Los Angeles area.) Baker Furnace was the first oxidizer manufacturer to secure this type of approval. Each unit is carefully sized for the correct volume of air and correct residence time for the vapors being oxidized. We size our Thermal Oxidizers for 1 full second of residence time to ensure a thorough destruction of the vapors being introduced into the Oxidizer.

Dimensions

For specific dimensions on the #100 through #500 CFM Thermal Oxidizers (either skid or trailer mounted), please refer to our general arrangement drawing #101212 enclosed with these specifications.

Oxidizer Weights in lbs.

TYPE	100CFM	200CFM	300CFM	400CFM	500CFM
Skid	3400	3600	4100	4300	4300
Trailer	4200	4300	4900	5100	5100

Vapor Extraction Blower

A positive displacement blower with a 208/230/460 volt three phase (or 220 volt single phase) sixty (60) HZ. motor to deliver a correct volume of air at 4" of Hg. will be provided. Higher vacuums are available on request in the 10 to 12" Hg. range. The blower is belt driven and is equipped with an O.S.H.A. approved guard over the belts and sheaves. The blower also is fitted with inlet and outlet silencers and a "Kunkle" vacuum relief valve. Baker Furnace can provide a regenerative blower in lieu of the positive displacement blower if so desired.

Blower Horsepower and Amperage Ratings at 4" HG Vacuum

Oxidizer	100CFM	200CFM	300CFM	400CFM	500CFM
Horsepower	2	3	5	5	7.5
Amperage 230 V. 1 Ph.	12	17	28	28	40
208 V. 3 Ph.	7.8	11	17.5	17.5	25.3
230 V. 3 Ph.	6.8	9.6	15.2	15.2	22
460 V. 3 Ph.	3.4	4.8	7.6	7.6	11

Knock Out Pot

A 12" or 16" diameter knock out pot with a manual drain is an integral part of the vapor extraction train. The pot is equipped with a sight glass and a brass ball cock for draining off liquid. An automatic pump with level switches can be fitted to the knock out pot on request. (See also high level knockout drain/shutoff in options section).

Air Filters

Replaceable air filters are furnished with the unit and are located in the knock out pot and on the two dilution air inlets. The knock out pot filter can be readily changed by removing the top of the knock out pot. The air dilution filters are external and can also be readily changed. Baker Furnace maintains a supply of replacement filters in stock at all times.

Three Way Valving with Automatic Air Dilution

Motor actuated three-way valves are installed to supply clean air to purge the combustion system prior to ignition of the pilot and to restrict VOC laden air from entering the Thermal Oxidizer until it reaches its operating temperature. The valves automatically switch over at a preset temperature which is configured into the process temperature controller. Two of the valves are proportionally modulated and are linked to oxygen and L.E.L. sensors. The sensors are connected to digital microprocessor based P.I.D. controllers which proportionately modulate the butterfly valves around a setpoint which has been selected. L.E.L. and oxygen levels are simply set on the P.I.D. controllers and then maintained automatically by the amount of dilution air which enters the Oxidizer.

Supplemental Fuel and Vapor Inlet Pipe Sizes

Please refer to our general arrangement drawing #101212 included with these specifications for specific pipe sizes for the #100 through #500 Thermal Oxidizers.

Air Flow Measurement

Post dilution process air flow to the combustion chamber is measured via a pitot tube and electronic air flow transmitter. An averaging pitot tube measures differential pressure, which is translated into an electronic signal by the transmitter, and sent to the chart recorder. Air flow is one of the three process variables monitored and recorded continuously by our Honeywell 3-pen chart recorder.

Combustion System

An Eclipse MVTA (medium velocity tempered air) combustion burner will be supplied with the Thermal Oxidizer utilizing a combustion blower, modulating gas butterfly valve, spark ignition, piloting and FM approved flame safety relays. The combustion burner is also equipped with a FM approved gas fuel train. The burner will fire on propane or natural gas. Inlet gas pressure should be 2-5 PSI at the regulator on the fuel train. Please refer to the fuel usage charts provided with these specifications for data regarding the use of supplemental fuel versus VOC concentrations at the influent to the Oxidizer. The charts are available for both Catalytic and Direct fired operation.

Control Panel

A complete, U.L. Approved Three Phase control panel is included with a choice of 208/230/460 volts (or 220 volt Single Phase if required) and would consist of the following component parts:

1. Honeywell 3 pen chart recorder (4 pen available)
2. Honeywell digital microprocessor based process controller
3. Honeywell high limit temperature controller
4. Honeywell L.E.L. controller with alarm setpoint 4-20 output
5. Honeywell O_2 controller 4-20 milliamp output
6. Totalizing hour meter - up to 9999 hours
7. Nema four panel with 3 Phase or 1 Phase disconnect
8. Step down transformer for 120 V. circuitry (3 ph. panels)
9. Alarm contacts in process and high limit controllers
10. FM approved flame safety relays
11. Combustion purge timer
12. All necessary fuses. terminal strips, wiring
13. Complete wiring schematic
14. Locking glass enclosure over instruments

Refractory Lining

A 5" thick 2300° F. ceramic fiber lining is installed in the Thermal Oxidizer to keep the exterior surface at a safe temperature. The ceramic fiber material has a very low K value which means it is an excellent insulator (does not store or transfer heat readily). A ceramic throat is fitted within the Oxidizer at a specific location and is sized for velocity of 15 ft/sec. The combustion chamber is sized for 10 ft/sec.

Steel Construction

All components are manufactured from heavy grades of hot rolled A-36 steel plate. Weldments are accomplished under an argon CO_2 purge to assure gas free homogeneous bonding of components. The Oxidizer is to be of a cylindrical design with flanged connections for maintenance purposes in the future. All components will be skid mounted on a heavy channel base with slots for forklift access.

Operating Temperatures

Direct fired Oxidizers are designed to operate at 1450° F. (AQMD requires minimum 1400° F.) while the Catalytic units are designed to operate at 700° F. (at the entry to the Catalyst).

Residence Time for Vapors

Our Oxidizers are designed for 1 full second of residence time. Los Angeles AQMD requires 0.7 seconds for Thermal Oxidizers.

Destruction Efficiencies

Direct fired units have destruction efficiencies above 99% while the Catalytic units are advertised to have rates above 97%. We generally see higher than 97% destruction efficiency for Catalytic operation and we are still exceeding the criteria set forth by AQMD at 97% destruction.

Options:

Catalytic "Plug In" Module

aker Furnace has developed a "plug in" Catalytic Module which can be installed in our existing direct fired Oxidizer with a minimum of effort. The catalyst inside the module is monolithic material which significantly reduces the pressure drop across it and pro- des maximum surface area for the gasses which are to be catalyzed.

Each module is designed to fit down inside the Thermal Oxidizer chamber and bolt in ace between the cone and stack section. Please refer to our enclosed drawing which ows the relationship of the Catalytic Module to the Thermal Oxidizer.

Once the Module is bolted in place, the only remaining task is to reduce the temperature tting on the process temperature and high limit controllers. The entire process to install e Catalytic Module should only take 1 – 2 hours.

The use of the Catalytic Module Option will greatly reduce supplemental fuel usage when e concentrations of VOC's are at low levels because the temperature requirement for a catalyst based system is approximately one-half that of a direct fired unit. The incoming vapors need only be heated to 700° prior to the catalyst versus 1450° in the direct fired uit. The delta T (change in temperature) is reduced by almost one-half, which results in significant reduction in supplemental fuel usage.

Our Thermal Oxidation unit is configured with a "High Limit" temperature controller, as andard equipment, which will protect the catalyst in the event the catalytic process becomes overly exothermic and the temperature attempts to run away.

Paker Furnace can provide installation (on site) of the Catalytic Module at a nominal st. Please refer to the charts provided with these specifications for supplemental fuel sage at various VOC concentrations for both Catalytic and Direct Fired Oxidizers to project the savings you might achieve by using the Catalytic Module.

Trailer

e can mount the Oxidizer on a tandem axle trailer with a steel deck. Each oxidizer mponent is mounted securely with bolts, which allows the component to be removed or maintenance if required. The trailer is equipped with electric brakes and all lights cessary for licensing the unit for the road. Please refer to our general arrangement awing #101212 for specific overall dimensions on the trailer. The trailer, as well as the hermal Oxidizer, is painted with federal safety blue enamel.

elemetry "Remote Monitoring" Fax System

he Oxidizer can be equipped with a remote monitoring and reporting system which terfaces with the control instrumentation on the unit. This information can be faxed to maximum of three locations. The IBM compatible operating software is extremely user iendly and allows you to select the destination of the fax reports, the number of reports u wish to receive each day, and the time of day at which you receive them. The fax eports are typically configured to show process combustion temperature, process air low to the combustion chamber, and the percent of L.E.L. in the process vapor stream. In dition to the "routine" faxes, the system will also send an alarm fax in the event the uit shuts down for any reason. This report will specify which one of four failure condi- ons caused the unit to shut down. The addition of the telemetry system requires a dicated phone line at the site and a fax machine at the receiving end.

Silence package

If you anticipate installing the Oxidizer in an area where noise levels are a critical issue, i.e. residential area etc., the unit can be configured with a quiet design blower package. The blower inlet and exhaust silencers, as well as the blower itself are enclosed with a soundproofed material.

Vacuum Upgrade

Our standard unit will generate a maximum of 4" hg vacuum. Per your specifications we can provide up to 10" hg vacuum in 2" increments. Proper vacuum sizing is very important to ensure that your unit can operate at the engineered flow rate.

High Water Level Shutoff/Pump

If you believe that water will be a problem at the site(s) where you install the Oxidizer, we can install a shutoff switch in the knockout tank which will shut the Oxidizer down if the knockout tank fills up with water. In addition, we can also install a pump which will automatically drain the knockout tank if it fills up with water. Assuming appropriate secondary storage was in place, this process would only require your attention when the secondary holding tank filled up.

Safety Interlocks and Safety Devices on Baker Thermal Oxidizers

Air Proving Switch

Two U.L., FM and CSA approved air proving switches are provided to ascertain that the positive displacement vapor extraction blower and combustion blower are operational. In the event that either blower fails, the air proving switch will "open" the limits circuit thereby causing the unit to shut down the supplemental fuel line and to close the vapor line to the Oxidizer.

High/Low Gas Pressure Switch

A U.L., FM and CSA approved gas pressure switch is provided in the supplemental fuel train which will also "open" the limits circuit in the event an unusually high or low gas pressure condition exists.

High Temperature Limit Controller

A U.L. and FM approved high temperature limit controller has been engineered into the limits circuit to shut down the Oxidizer in the event a high temperature condition exists. The limit controller must be manually reset (per FM requirement) before the Oxidizer can be rendered operational. While in the high limit condition, the Oxidizer will not utilize supplemental fuel nor will vapors be allowed to enter the Oxidizer until the controller is manually reset.

FM Approved Flame Safety Device

Our Thermal Oxidizers utilize a FM approved and U.L. recognized flame safety device which lights the combustion burner on the Thermal Oxidizer after a 60 second purge (5 air changes) of the combustion chamber. The burner has a 15 second ignition trial which lights pilot only. In the event the pilot does not light, the flame safety device locks out the supplemental fuel train thereby reducing the potential for an explosion. The main gas valve in the supplemental fuel train cannot open unless the pilot has been established. Flame monitoring is accomplished via a 3/16" diameter inconel flame rod.

L.E.L. Combustibles Sensor and Controller

A catalytic bead L.E.L. sensor and controller have been integrated into the limits circuit. In the event that the alarm set point for L.E.L. has been exceeded, the L.E.L. controller "opens" the limits circuit which subsequently closes the vapor butterfly valve and temporarily shuts down the combustion burner until the L.E.L. returns to a safe level below the alarm setpoint.

Flame Arrester

A U.L. approved flame arrester has been piped into the vapor extraction discharge line in close proximity to the Thermal Oxidizer. The flame arrester prevents propagation of flame back to the source.

FM Approved Supplemental Fuel Train

A FM supplemental fuel train is provided with the Oxidizer and is fitted with an approved safety shut off valve for the main gas. The shut off valve will close in 0.3 seconds in the event of flame failure. The main gas valve is held shut with a 150 lb. force to assure a tight closure.

Oxygen Sensor and Proportional Dilution Valve

A O_2 sensor and P.I.D. controller is provided to monitor oxygen content in the vapor stream. We require 18% oxygen (minimum) in the stream for sufficient combustion of volatiles. In the event the oxygen content of the vapor stream drops off significantly the O_2 controller opens a proportionally modulated butterfly valve and lets in dilution air to bring the oxygen content up to a satisfactory level.

Alarm Card in Process Temperature Controller

We have integrated an alarm card into the process temperature controller to restrict the entry of volatiles into the Oxidizer until it reaches its correct operating temperature (1400° F.). This is accomplished by setting an alarm value equal to 1400 in the controller. When this value (in temperature) is reached, the process controller sends a signal to a butterfly valve drive motor which opens the valve and allows the vapor stream to enter the Oxidizer. Vapors cannot enter the Oxidizer at any temperature below which the alarm value has been set. This prevents the incomplete burning of hydrocarbons which occurs at lower operating temperatures.

Catalytic Oxidizer

BTU's/hr of Supplemental Fuel Required to Raise Air Temperature of Influent Vapor Stream from 100° F. to 700° F. at Various PPM VOC Concentrations

PPM VOC'S	% LEL	AIR FLOW SCFM				
		100	200	300	400	500
0	0	79,000	158,000	237,000	316,000	395,000
250	1.8	72,500	145,000	217,500	290,000	362,500
500	3.6	65,000	130,000	195,000	260,000	325,000
750	5.4	57,500	115,000	172,500	230,000	287,500
1000	7.3	52,500	105,000	157,500	210,000	262,500
1500	10.9	39,000	78,000	117,000	156,000	195,000
2000	14.5	25,000	50,000	75,000	100,000	125,000
2500	18.1	12,500	25,000	37,500	50,000	62,500
3000	21.7	0	0	0	0	0

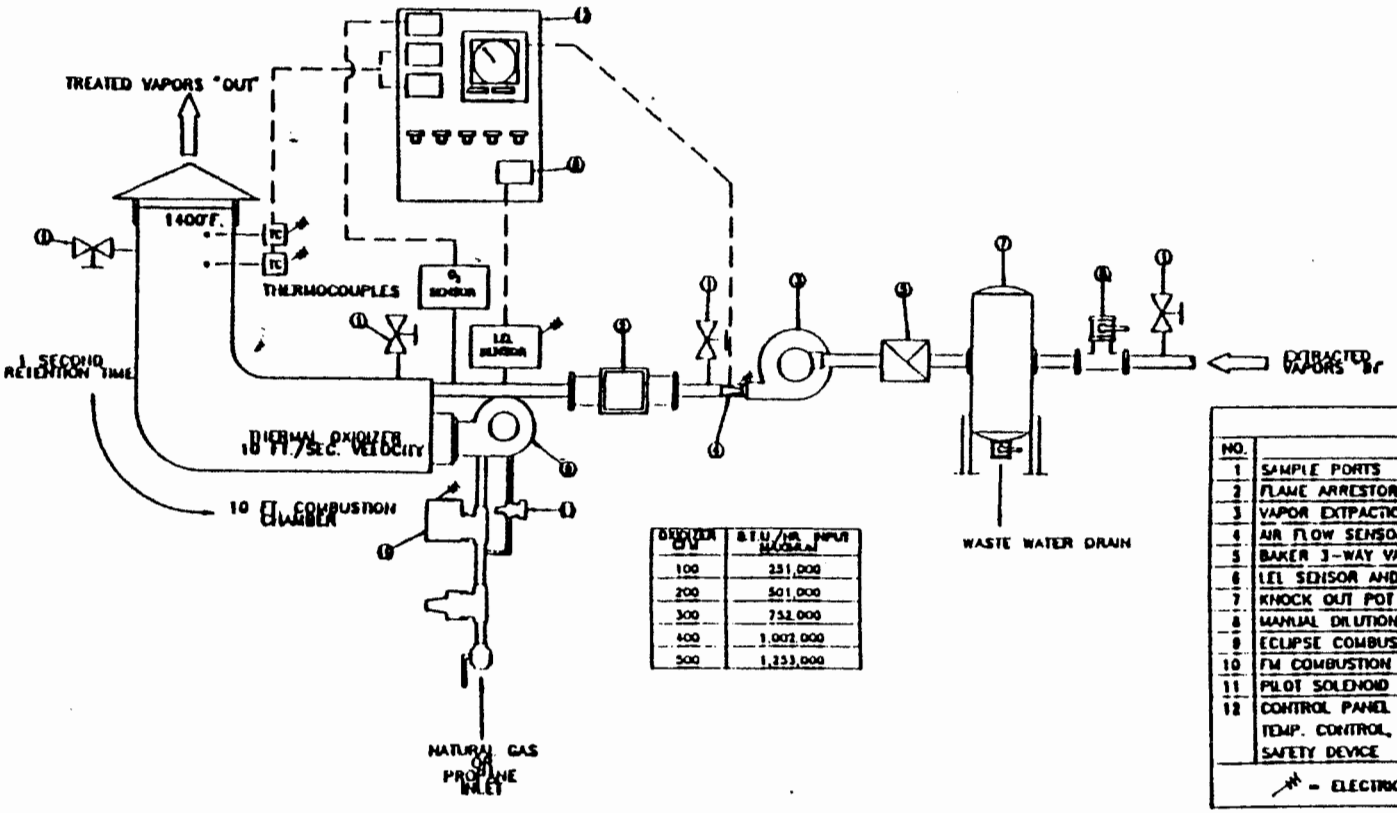
Direct Fired Oxidizer

BTU's/hr of Supplemental Fuel Required to Raise Air Temperature of Influent Vapor Stream from 100° F. to 1400° F. at Various PPM VOC Concentrations

250
370,000 410,000

PPM VOC'S	% LEL	300,000 AIR FLOW SCFM				
		100	200	300	400	500
500	3.6	134,000	268,000	402,000	536,000	670,000
1000	7.3	120,000	240,000	360,000	480,000	600,000
1500	10.9	108,000	216,000	324,000	432,000	540,000
2000	14.5	92,500	185,000	277,500	370,000	462,500
2500	18.1	80,000	160,000	240,000	320,000	400,000
3000	21.7	67,500	135,000	202,500	270,000	337,500
3500	25.4	57,500	115,000	172,500	230,000	287,500
4000	29.0	40,000	80,000	120,000	160,000	200,000
4500	32.6	26,000	52,000	78,000	104,000	130,000
5000	36.2	14,000	28,000	42,000	56,000	70,000
5500	39.9	- 0 -	- 0 -	- 0 -	- 0 -	- 0 -
6000	43.5	- 0 -	- 0 -	- 0 -	- 0 -	- 0 -

GENERAL ARRANGEMENT DRAWING



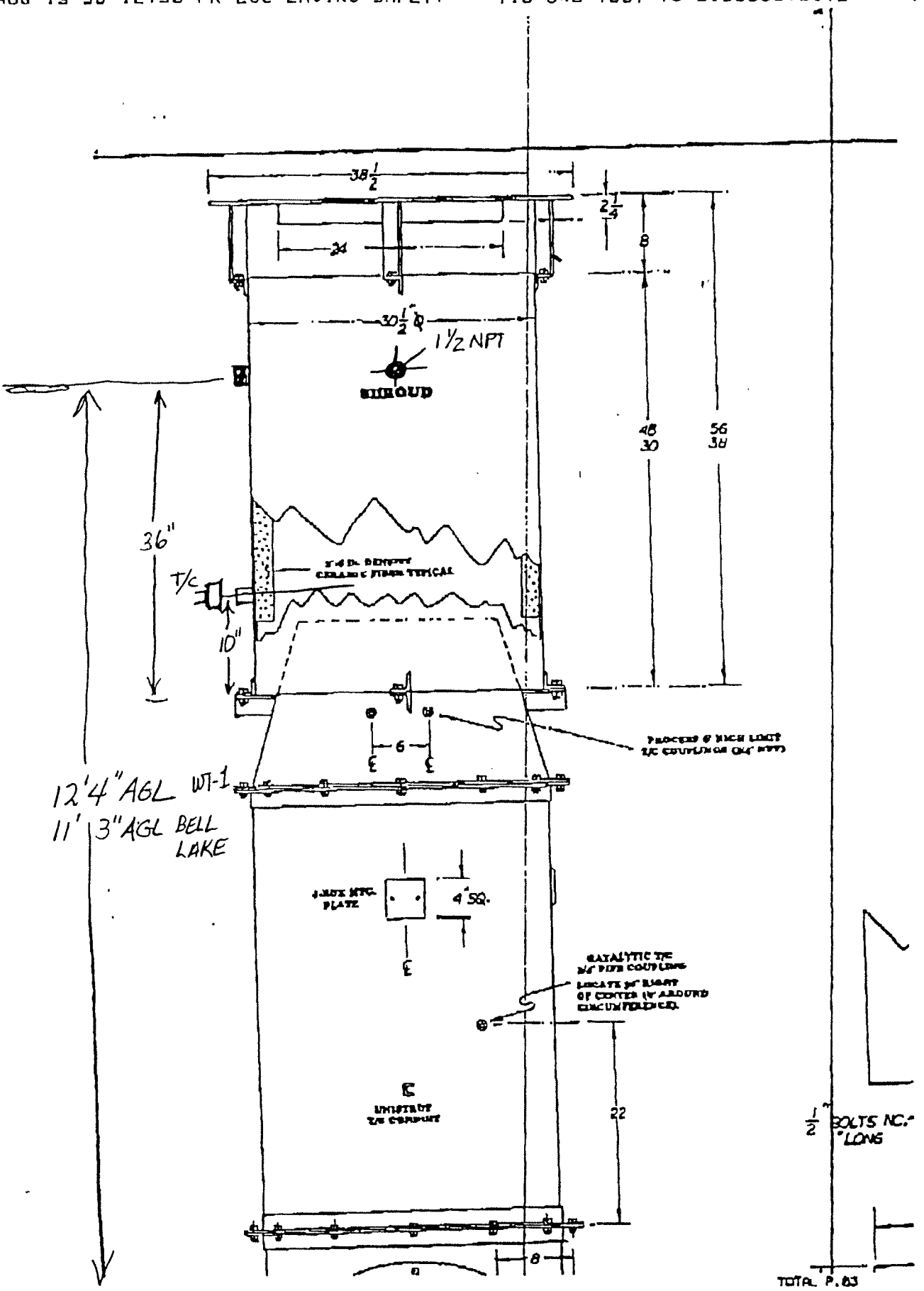
DESIGN CFM	BTU/HR INPUT MAXIMUM
100	251,000
200	501,000
300	752,000
400	1,002,000
500	1,253,000

NO.	DESCRIPTION
1	SAMPLE PORTS
2	FLAME ARRESTOR
3	VAPOR EXTRACTION BLOWER
4	AIR FLOW SENSOR - SIGNAL TO CHART RECORDER
5	BAKER 3-WAY VALVING W/ PROPORTIONAL AIR DILUTION
6	LEL SENSOR AND LEL CONTROLLER WITH ALARM SETPOINT
7	KNOCK OUT POT WITH INTEGRAL SENSOR & OPTIONAL AUTO. PUMP
8	MANUAL DILUTION VALVE
9	ECLIPSE COMBUSTION BURNER & SUPPLEMENTAL BLOWER
10	FM COMBUSTION FUEL TRAIN
11	PILOT SOLENOID VALVE
12	CONTROL PANEL WITH CHART RECORDER, TEMP. CONTROL, OVER TEMP. CONTROL, AIR MONITOR, LEL AND FM APPROVED FLAME SAFETY DEVICE

LEGEND

⚡ = ELECTRICAL SIGNAL ⧖ = SAMPLE PORTS

THERMAL OXIDIZER PROCESS AND INSTRUMENTATION DIAGRAM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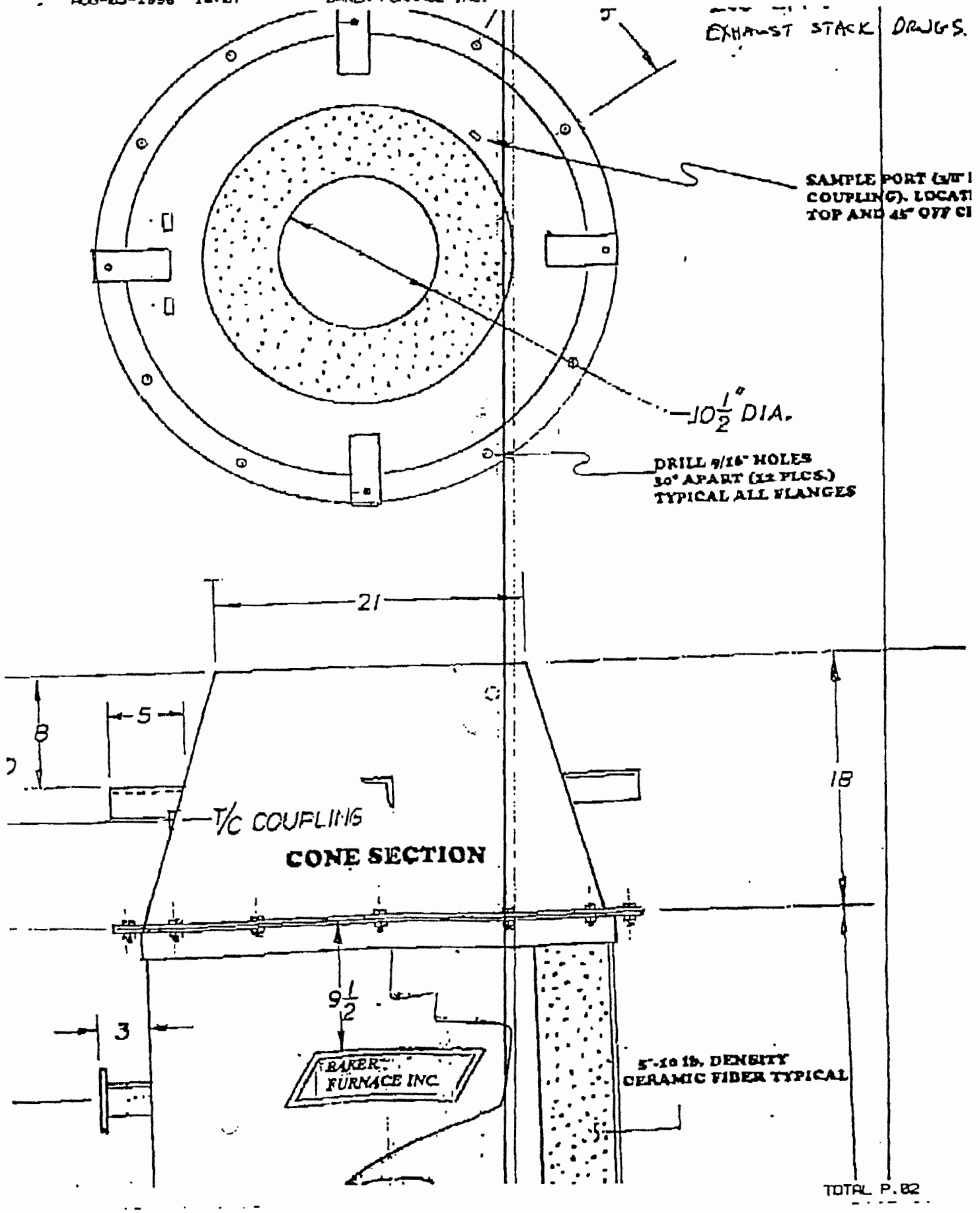
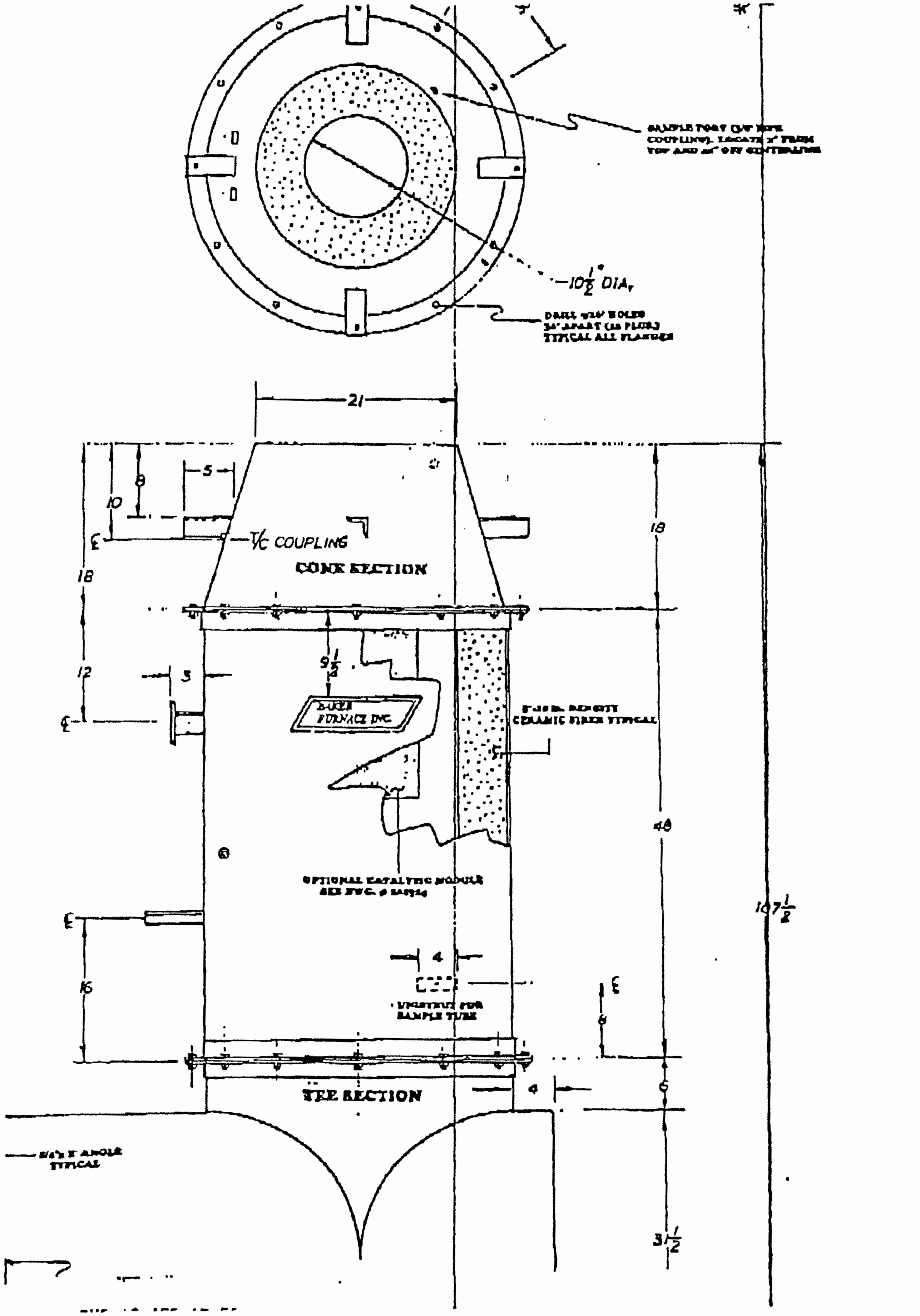
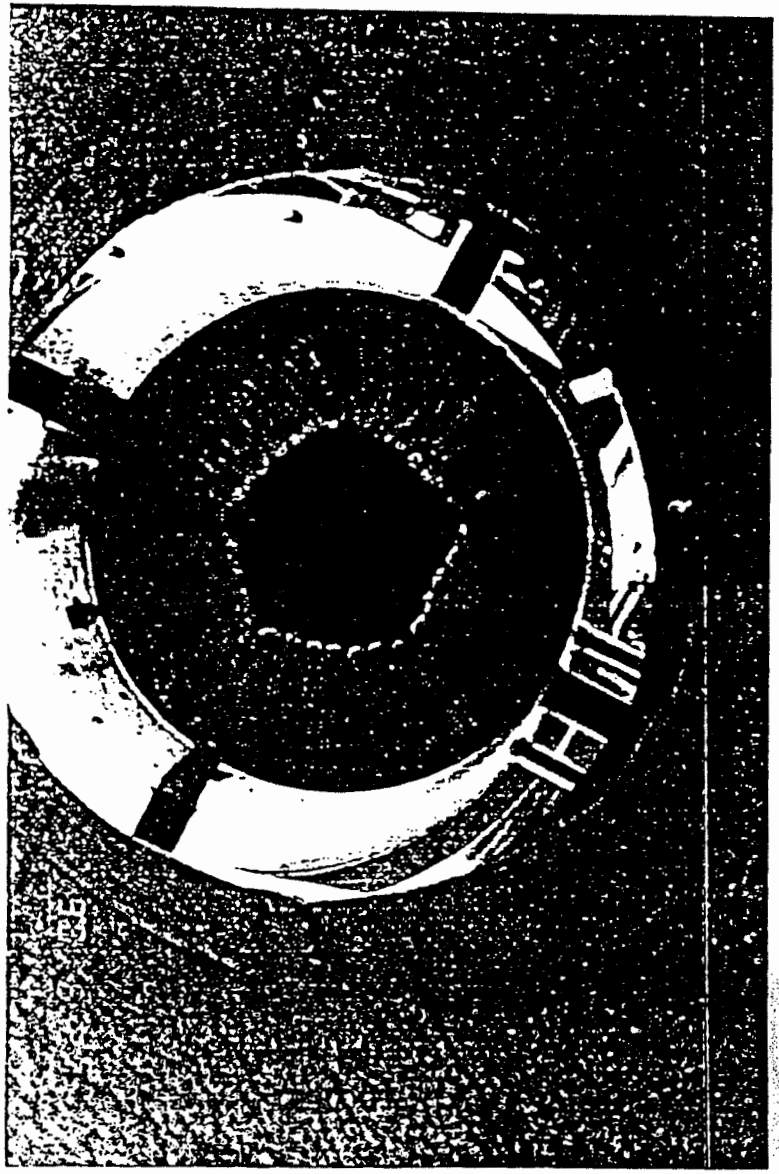
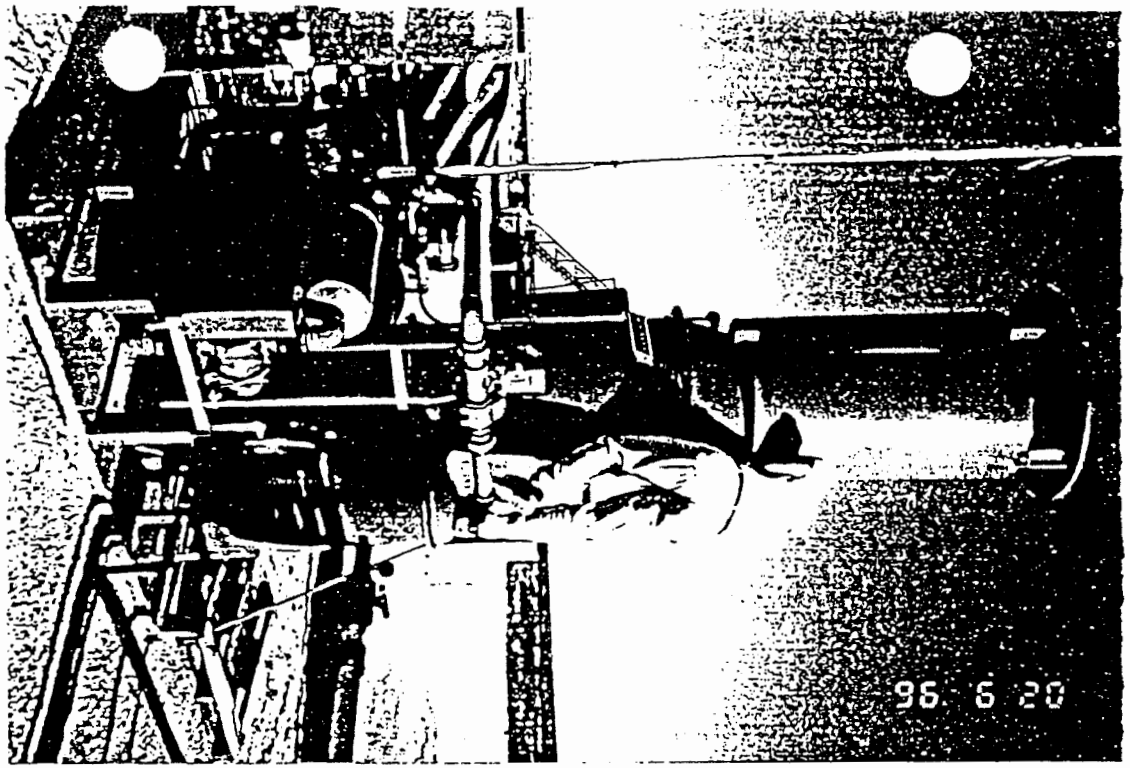
2 1/4
24
8
30 1/2
1 1/2 NPT
SHROUD
48
30
56
38
36"
T/C
10"
6
12'4" AGL WT-1
11' 3" AGL BELL LAKE
4" SQ.
22
8
1/2" BOLTS NC.
" LONG


EXHAUST STACK DRWG'S.
SAMPLE PORT (3/4" I
COUPLING). LOCATI
TOP AND 45° OFF CI
10 1/2" DIA.
DRILL 9/16" HOLES
30° APART (12 PLCS.)
TYPICAL ALL FLANGES
21
8
5
18
T/C COUPLING
CONE SECTION
9 1/2
3
BAKER FURNACE INC.
5"-10 lb. DENSITY
CERAMIC FIBER TYPICAL


10 1/2" DIA.
TYPICAL ALL FLANGES
21
5
8
10
18
T/C COUPLING
CONE SECTION
12
3
9 1/2
CERAMIC FIBER TYPICAL
48
107 1/2
OPTIONAL CATALYTIC MODULE
16
4
SAMPLE TUBE
6
TEE SECTION
TYPICAL
3 1/2

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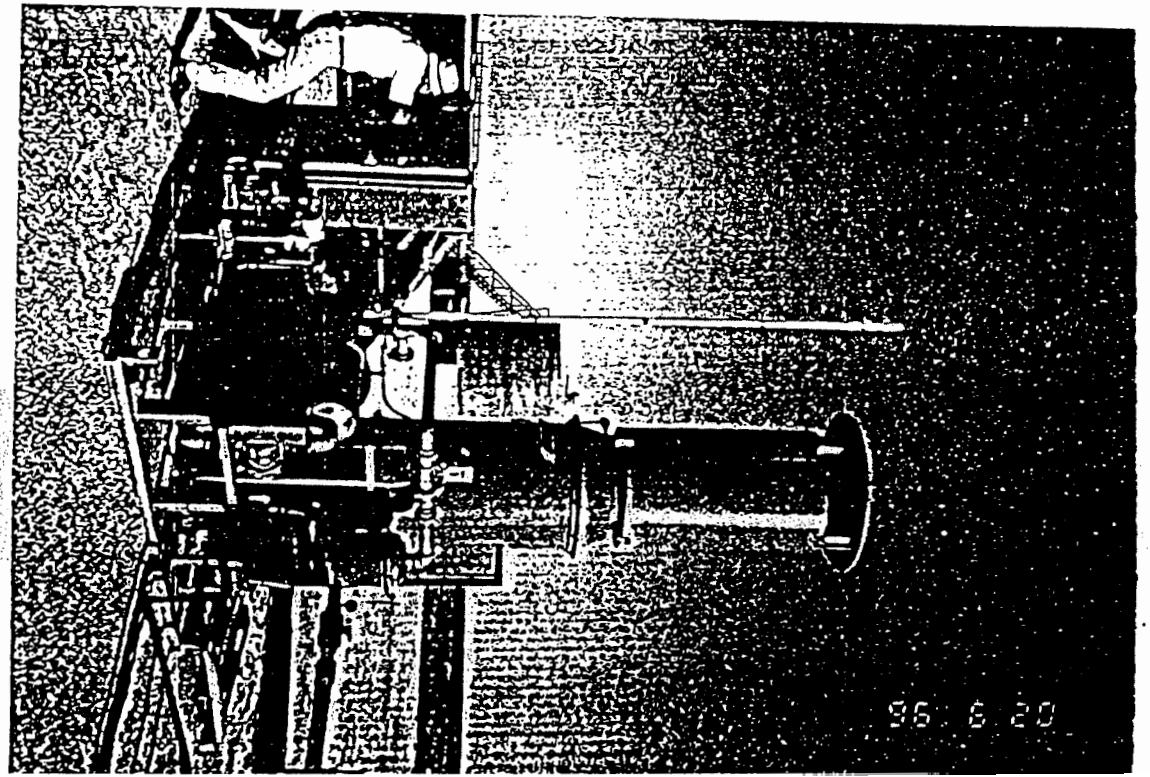
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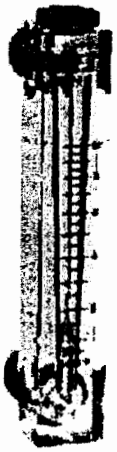
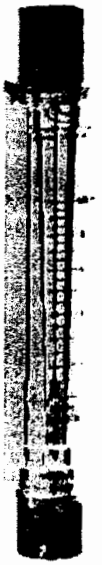
DWYER METERS

VFC Series Visi-Float® Flowmeter Installation and Operating Instructions



Back Connections



End Connections

SPECIFICATIONS

Meter Body:	Acrylic Plastic Metering tube machined into body
Wetted Metal Parts:	Stainless Steel
Floats:	Stainless Steel
Fittings:	PVC
Guide Rod Holder:	Mineral reinforced nylon bonded in fitting with epoxy (EC models only)
Pipe Connections	1" N.P.T. female, horizontal or vertical
"O" Rings:	Buna-N
Mounting Inserts	10-32 x ⅜" deep
Scale	Hot pressed into acrylic body
Pressure Rating	100 P.S.I. maximum
Temperature Rating	120°F maximum
Accuracy	± 2% of full scale

Dwyer Series VFC Visi-Float® flowmeters are available in two basic styles, either back or end connected with direct reading scales for air or water. Installation, operation, and maintenance are simple and require only a few common sense precautions to assure long, accurate, trouble-free service.

CALIBRATION

All Dwyer flowmeters are calibrated at the factory and normally will remain within their accuracy tolerance for the life of the device. If at any time you wish to re-check its calibration, do so only with instruments or equipment of certified accuracy. Do not attempt to check the Dwyer Visi-Float® flowmeter with a similar flowmeter as even minor variations in piping and back pressure can cause significant differences between the indicated and actual readings. If in doubt, your Dwyer flowmeter may be returned to the factory and checked for calibration at no charge.

LOCATION

Select a location where the flowmeter can be easily read and where the temperature will not exceed 120°F (49°C). The mounting surface and piping to the flowmeter should be free from vibration which could cause fatigue of fittings or mounting inserts. Piping must be carefully arranged and installed to avoid placing stress on fittings and/or flowmeter body. Avoid locations or applications with strong chlorine atmospheres or solvents such as benzene, acetone, carbon tetrachloride, etc. Damage due to contact with incompatible gases or liquids is not covered by warranty. Compatability should be carefully determined before placing in service.

PIPING

INLET PIPING:

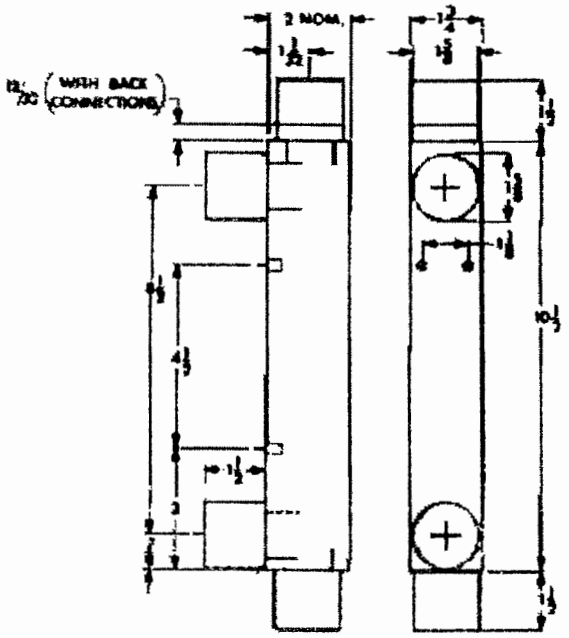
It is good practice to approach the flowmeter inlet with as few elbows, restrictions and size changes as possible. Inlet piping should be as close to the flowmeter connection size as practical to avoid turbulence which can occur with drastic size changes. The length of inlet piping has little effect on normal pressure fed flowmeters.

For vacuum service, the inlet piping should be as short and open as possible to allow operation at or near atmospheric pressure and maintain the accuracy of the device. Note that for vacuum service, any flow control valve used must be installed on the discharge side of the flowmeter.

DISCHARGE PIPING

Piping on the discharge side should be at least as large as the flowmeter connection. For pressure fed flowmeters on air or gas service, the piping should be as short and open as possible. This allows operation at or near atmospheric pressure and assures the accuracy of the device. This is less important on water or liquid flowmeters since the flowing medium is generally incompressible and back pressure will not affect the calibration of the instrument.

SERIES VFC
Visi-Float® Flowmeters



DIMENSIONS

POSITION AND MOUNTING

All Visi-Float® flowmeters must be installed in a vertical position with the inlet connection at the bottom and outlet at the top.

SURFACE MOUNTING:
Drill three holes in panel using dimensions shown in drawing. Holes should be large enough to accommodate #10-32 machine screws. If back connected model, drill two additional holes for clearance of fittings. Install mounting screws of appropriate length from rear. Attach piping using RTV silicone sealant or Teflon® tape on threads to prevent leakage.

CAUTION: Do not overtighten fittings or piping into fittings. Maximum recommended torque is 10 ft/lbs. Hand tighten only.

IN LINE MOUNTING.
Both end connected and back connected models may be installed in-line supported only by the piping. Be sure that flowmeter is in a vertical position and that piping does not create excess stress or loading on the flowmeter fittings.

OPERATION

Once all connections are complete, introduce flow as slowly as possible to avoid possible damage. With liquids, make sure all air has been purged before taking readings. Once the float has stabilized, read flow rate by sighting across the largest diameter of the float to the scale graduations on the face of the device.

MAINTENANCE

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

DISASSEMBLY:
The flowmeter can be completely disassembled by removing the connection fittings and top plug. When lifting out the float guide assembly, be careful not to lose the short pieces of plastic tubing on each end of the guide rod which serve as float stops.

CLEANING:
The flowmeter body and all other parts can be cleaned by washing in a mild soap and water solution. A soft bristle bottle brush will simplify cleaning of the flow tube. Avoid benzene, acetone, carbon tetrachloride, gasoline, alkaline detergents, caustic soda, liquid soaps, (which may contain chlorinated solvents), etc., and avoid prolonged immersion.

RE-ASSEMBLY:
Install the lower fitting and then the float and float guide. Finally install the upper fitting and plug being certain that both ends of the float guide are properly engaged and the float is correctly oriented. A light coating of silicone stop cock grease or petroleum jelly on the "O" rings will help maintain a good seal as well as ease assembly.

ADDITIONAL INFORMATION

For additional flowmeter application information, conversion curves, correction factors and other data covering the entire line of Dwyer flowmeters, write for bulletin F-41.

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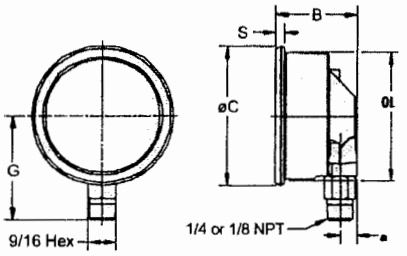
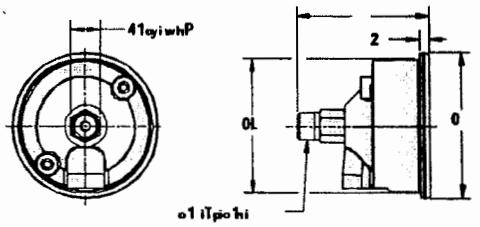
FR NO 51-440448-00

ASHCROFT

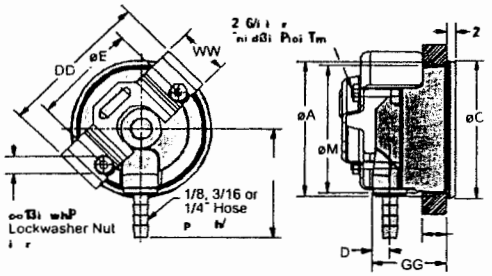
Diaphragm Gauges
Type 1490 Low Pressure
2½" and 3½"



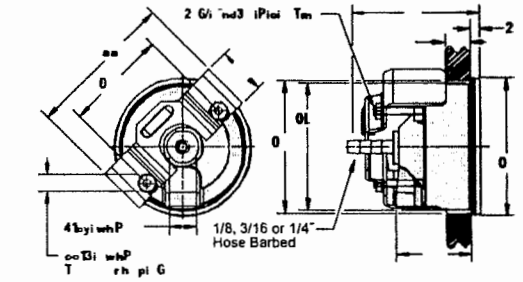
Size	øA	B	øC	D	G	S
2½"	2 19/32 (66)	1 23/32 (44)	2 1/8 (73)	3/8 (10)	2 1/16 (55)	11/64 (5)
3½"	3 5/32 (93)	1 11/16 (43)	3 31/32 (101)	1/4 (10)	2 23/32 (69)	11/64 (5)



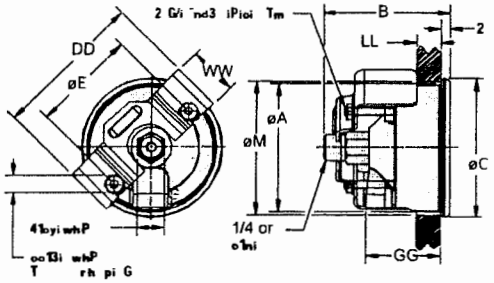
Size	øA	B	øC	S
2½"	2 19/32 (66)	2 19/32 (66)	2 1/8 (73)	13/64 (5)
3½"	3 21/32 (93)	2 9/16 (65)	3 31/32 (101)	13/64 (5)



Size	øA	øC	D	øE	G 1/8	G 3/16	G 1/4	øM	S	DD	GG	LL MAX	WW
2½"	2 19/32 (66)	2 1/8 (73)	3/8 (10)	2 1/8 (54)	1 3/4 (44)	2 1/4 (54)	2 29/32 (54)	2 21/32 (67)	13/64 (5)	3 1/16 (78)	1 19/32 (40)	1/2 (13)	1 (25)
3½"	3 21/32 (93)	3 31/32 (101)	3/8 (10)	3 3/16 (67)	2 5/16 (59)	2 21/32 (81)	2 13/16 (54)	3 3/4 (95)	13/64 (5)	4 1/8 (105)	1 17/32 (39)	1/2 (13)	1 (25)



Size	øA	B 1/8	B 3/16	B 1/4	øC	øE	øM	S	DD	GG	LL MAX	WW
2½"	2 19/32 (66)	2 5/16 (55)	2 17/32 (64)	2 11/16 (68)	2 1/8 (73)	2 1/8 (54)	2 21/32 (67)	13/64 (5)	3 1/16 (78)	1 19/32 (40)	1/2 (13)	1 (25)
3½"	3 21/32 (93)	2 1/8 (54)	2 1/2 (63)	2 21/32 (67)	3 31/32 (101)	3 3/16 (81)	3 3/4 (95)	13/64 (5)	4 1/8 (105)	1 17/32 (39)	1/2 (13)	1 (25)

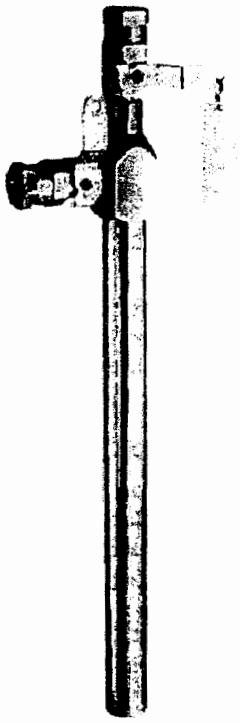


dui eTm

Size	øA	B	øC	øE	øM	S	DD	GG	LL MAX	WW
2½"	2 19/32 (66)	2 19/32 (66)	2 1/8 (73)	2 1/8 (54)	2 21/32 (67)	13/64 (5)	3 1/16 (78)	1 19/32 (40)	1/2 (13)	1 (25)
3½"	3 21/32 (93)	2 9/16 (65)	3 31/32 (101)	3 3/16 (81)	3 1/4 (95)	13/64 (5)	4 1/8 (105)	1 17/32 (39)	1/2 (13)	1 (25)

SERIES DS-400 FLOW SENSORS

Installation and Operating Instructions, Flow Calculations



INSPECTION

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

INSTALLATION

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

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

PRESSURE AND TEMPERATURE

Maximum 200 psig at 200°F.

UPSTREAM AND DOWNSTREAM DIMENSIONS IN TERMS OF INTERNAL DIAMETER OF PIPE

*SEE NOTE #1

UPSTREAM CONDITION	MINIMUM DIAMETER OF STRAIGHT PIPE		
	UPSTREAM		DOWNSTREAM
	IN-PLANE	OUT-OF-PLANE	
One Elbow or Tee	7	9	5
Two 90° Bends in Same Plane	8	12	5
Two 90° Bends in Different Plane	18	24	5
Reducers or Expanders	6	8	5
All Valves *See Note 2	24	24	5

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

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

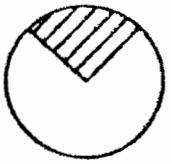
DWYER INSTRUMENTS INC
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46360 • U.S.A.
Telephone 219/879-8000
Fax 219/872-9057

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. Attach a ¾" NPT female fitting, such as a thred-o-let or saddle clamp, to the piping in which flow will be measured. Note the required upstream and downstream conditions on page one which should be observed.

2. Drill a hole through the center of the attached fitting into the pipe with a bit 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 inside the fitting body.

4. Insert the sensor until it contacts the opposite wall of the pipe and then withdraw it 1/16" for models -6 through -12 or ⅛" for models -14 through -24. This is to allow for thermal expansion.

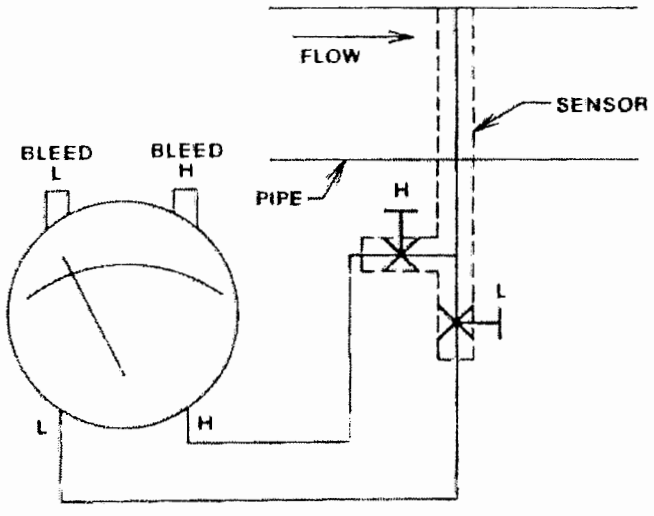
5. Tighten packing gland nut finger tight. Then tighten the nut with a wrench an additional 1¼ turns. Be sure to hold the sensor body with a second wrench to prevent the sensor from turning.

INSTRUMENT CONNECTION

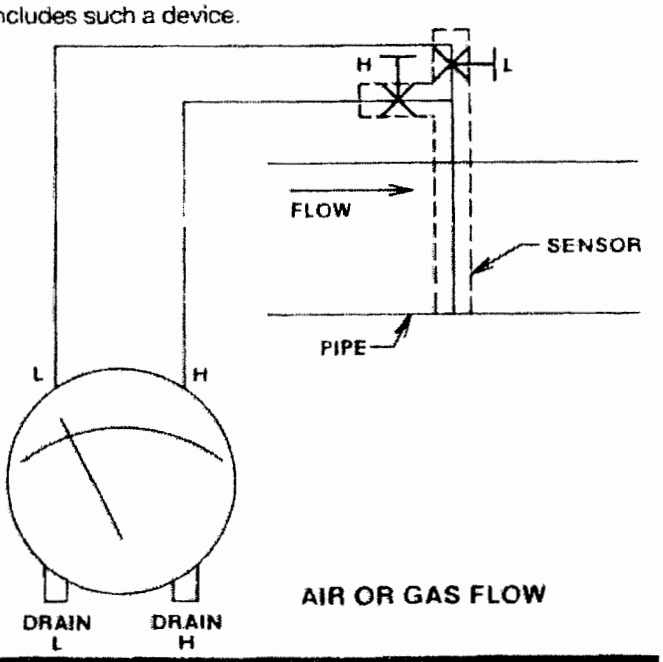
Connect the side pressure tap to the high pressure port of the Magnehelic (air only) or Capsuhelic gage or transmitting instrument and the top connection to the low pressure port. See the connection schematics below.

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

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

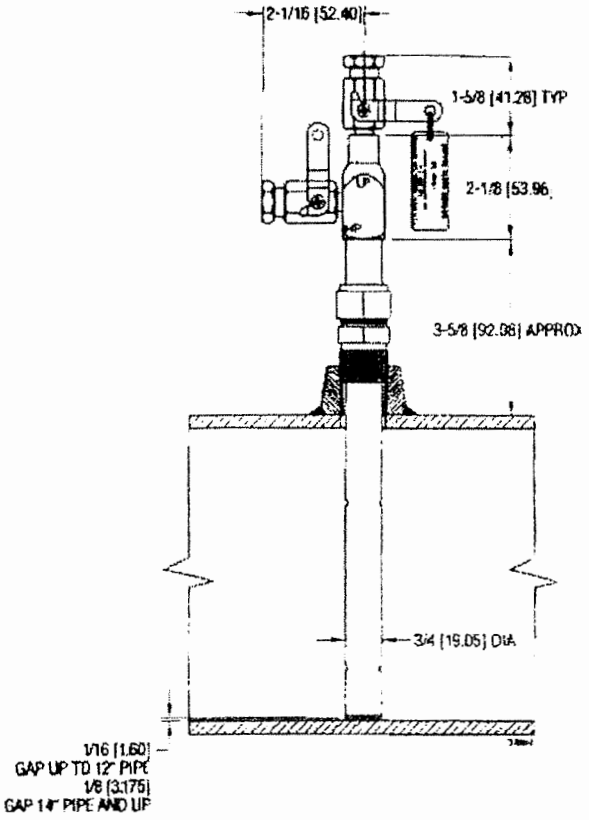


WATER FLOW



AIR OR GAS FLOW

SERIES DS-400 FLOW SENSORS



FLOW CALCULATIONS AND CHARTS

The following information contains tables and equations for determining the differential pressure developed by the DS-400 Flow Sensor for various flow rates of water, steam, air or other gases in different pipe sizes.

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

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

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

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

Pipe Size (Schedule 40 up to 20". Std. wt. for 24")	Flow Coefficient "K"	Operating Ranges Air @ 60°F & 14.7 psia (D/P Inches W.C.)	Operating Ranges Water @ 70°F (D/P Inches W.C.)	Velocity Ranges Not Recommended (Feet per Second)
6	.706	0.70 to 51	2.54 to 187	83 to 124
8	.675	0.64 to 28	2.31 to 102	53 to 79
10	.676	1.12 to 37	4.05 to 136	36 to 54
12	.683	0.19 to 20	0.70 to 72	26 to 40
14	.698	0.17 to 13	0.60 to 46	22 to 33
16	.688	3.78 to 56	13 to 203	17 to 26
18	.689	0.04 to 5.48	0.14 to 19	14 to 21
20	.686	0.39 to 4.93	1.40 to 17	11 to 17
24	.789	0.05 to 11	0.20 to 40	8 to 12

FLOW EQUATIONS

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

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

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

DIFFERENTIAL PRESSURE EQUATIONS

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

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

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

TECHNICAL NOTATIONS

The following notations apply:

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

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

SCFM TO ACFM EQUATION

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

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

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

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

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

*(520 = 460 + 60°) Std. Temp. Rankine

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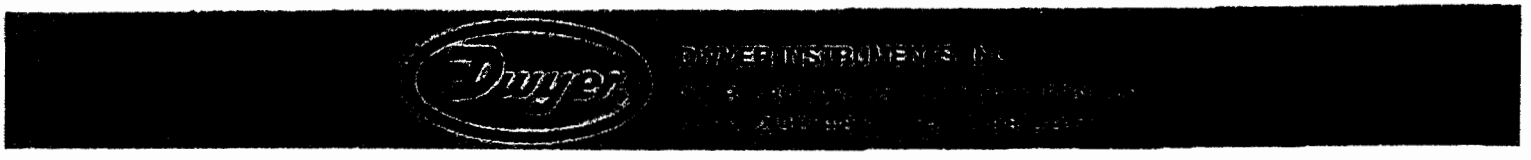
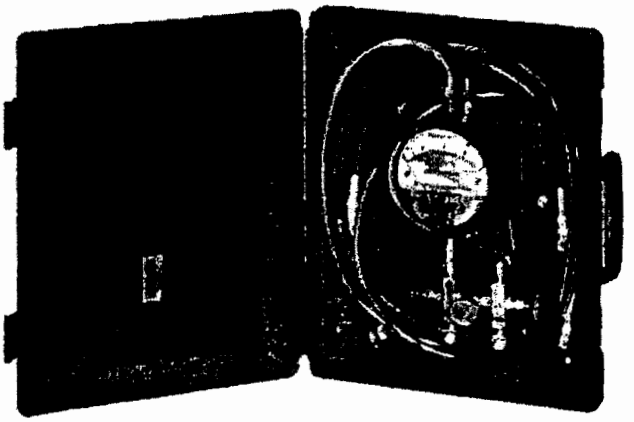


A-471 CAPSUHELIC PORTABLE KIT

This kit has been carefully engineered to include everything needed to adapt the 4000 series Capsuhelic gage for portable use. Once assembled, you can quickly, conveniently, and accurately measure positive, negative, or differential pressures of air and compatable gases and fluids. The Capsuhelic gage is not included in the kit. You should order it separately in the range best suited to your needs. It is available in many ranges from 0—0.50 in W.C. up to 0-300 PSI.



Operating Instructions

(See reverse side for kit assembly instructions)

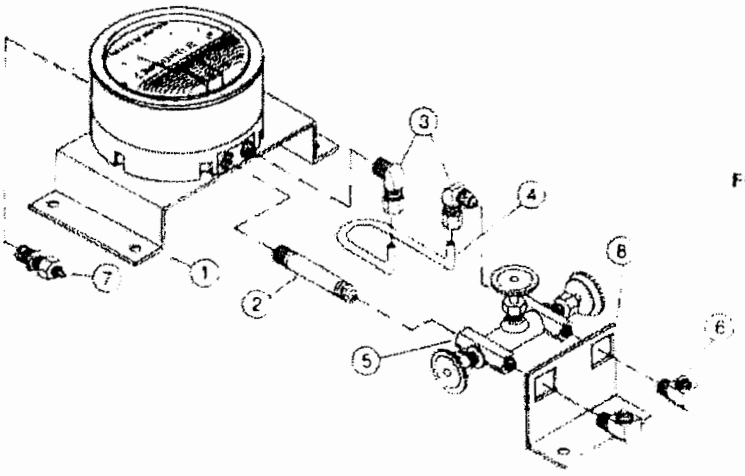
1. As noted in the assembly instructions, the equalizer and shutoff manifold must be installed in the upper pressure ports for air or gases and in the lower ports for fluids. This allows you to use the bleed fittings in the opposite ports to either drain condensate, (air or gas service) or purge air from the gage (fluid service).
2. Open case and place on a horizontal surface with the gage vertical as shown in photo above.
3. Close all three valves and attach the five foot high pressure hoses to the elbow connectors marked PROC. Connect the other ends to the pressure sources. When measuring differential pressures, the right high pressure line is run to the higher of two pressures and the left, low pressure line to the lower. You may also measure a single pressure, positive or negative, relative to atmosphere. Positive pressures are applied to the high pressure port and negative pressures to the low pressure port. Be sure the center equalizer valve is closed and the opposite port is vented
4. If measuring liquid pressure the following procedure is necessary. Open both bleed fittings using a 9/16" open end wrench. Attach the clear vinyl tubes to these fittings and position the other ends in a suitable container to collect the bled fluid. Slowly open all three valves until fluid leaves both bleed fittings thus indicating the gage is filled. Close both bleed fittings and drain remaining fluid.

   On air or gas service, slowly open all three equalizer valves. Next open both bottom bleed fittings to expel any condensate. Finally, close the bleed fittings before placing gage in service.
5. Close the left, low pressure valve. This will apply the higher pressure equally to both sides of the diaphragm. Turn the zero adjust screw at bottom of gage cover until the pointer is exactly on zero.
6. Close the center equalizer valve and open the left, low pressure valve. The gage will now be indicating differential pressure.
7. When all measurements are completed, disconnect pressure lines. If used on fluid, open bleed fittings and equalizer valve to drain entire assembly before storing.

Litho in U.S.A. 2/89

FR NO. 15-440360-00

A-471 PORTABLE KIT



NO.	PARTS LIST DESCRIPTION	QUANTITY REQ'D.
1.	Gage Mounting Bracket	1
2.	Nipple ¼" NPT x 3"	1
3.	Elbow, ¼" Compression x ¼" NPT Male	2
4.	Formed Copper Tube	1
5.	3 Way Manifold Valve	1
6.	Street El, ¼" NPT Male x ¼" NPT Female	2
7.	Bleed fitting ¼" NPT Male	2
8.	Manifold Mounting Bracket	1
	FOLLOWING ITEMS NOT SHOWN:	
9.	Carrying Case	1
10.	5 Ft. High Pressure Hose	2
11.	6-32 x 3/16" Machine Screw	4
12	10-32 x 1¼" Machine Screw	2
13.	10-32 Hex Nut	2
14.	3/16" x 3/8" Washer	2
15	¼"-20 x ½" Truss Head Machine Screw	6
16.	¼"-20 Hex Nuts	6
17.	Plastic Feet	2
18.	¾" Plastic Hole Plugs	6
19	3/8" Plastic Hole Plugs	2
20.	Vinyl Tube 3 Ft. Long	2
21	Adapter Elbow, 7/16"-20 x ¼" NPT Male	2
22.	Straight Adapter, 7/16"-20 x ¼" NPT Male	2

To Assemble Kit

NOTE: Before beginning assembly you must determine whether the gage will be measuring pressures of gases or fluids. Installation is reversed for the two types of media. Seal all pipe threads with Teflon tape or pipe joint compound.

1. Attach two plastic feet to case through holes provided. First insert #12 screw through #17 plastic foot and case. Secure to case from inside with #14 washer and #13 nut. Tighten nut only until foot is snug. Overtightening can collapse case wall. With case handle facing you, left hand pair of holes are used if for fluid service and right hand holes for air or gas service. Plug unused holes with #19 plastic hole plugs. Insert from outside, and press to lock.
2. Install one #3 elbow in the left "INST" port of the 3-way manifold valve. Install the second elbow in the bottom high pressure gage port for fluid service or the top low pressure gage port for air or gas service. Both fittings must face back when tight.
3. Install #2 nipple in remaining "INST" port of manifold and both #6 elbows in the two "PROC" ports. These elbows should face front when tight.
4. The manifold assembly is now attached to the gage by installing the other end of the nipple in the gage port next to the #3 elbow.
5. Installed #4 formed copper tube in #3 compression elbows.
6. Attach gage to #1 gage mounting bracket with #11 machine screws. Orient the bracket so the two 5/16" vent clearance holes are toward the top of the gage. Install both #7 bleed fittings in remaining gage ports.
7. The #8 manifold bracket is now fastened to the case with #15 machine screws and #16 hex nuts. Insert machine screws from back of case.
8. Lower completed gage/manifold assembly into case making sure that both "PROC" ports of manifold are positioned in the manifold bracket.
9. Align four holes in gage mounting bracket with matching holes in case and secure with #15 machine screws and #16 hex nuts. Screws must be inserted from back of case.
10. Make sure all fittings and fasteners are secure. Press #18 plastic plugs into holes in back of case.
11. Hoses are connected to completed assembly with #22 adapters installed in #6 elbows. If danger of dirt or other foreign matter entering gage exists, we recommend use of optional A-391 in line filter between these fittings. The two #21 adapters are for connecting opposite ends of hoses to pressure source. Loosely coil the hoses around the gage assembly for storage.

FOR REPLACEMENT PARTS OR REPAIR, WRITE:

DWYER INSTRUMENTS, INC.

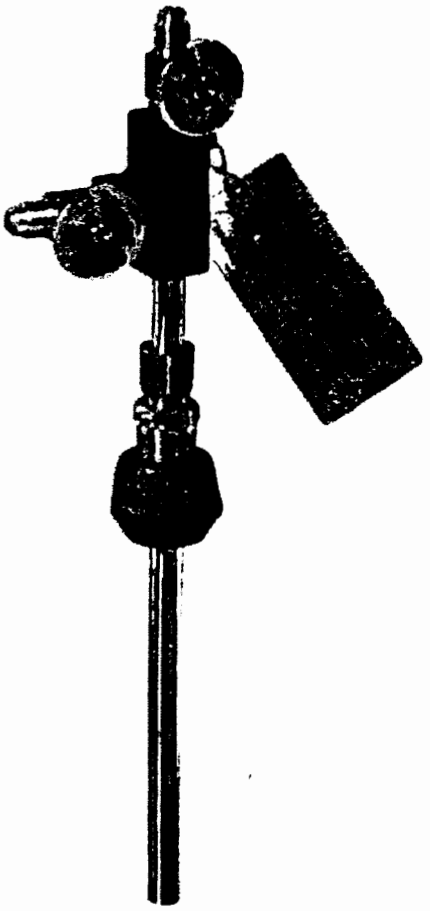
Series DS-200 Flow Sensor

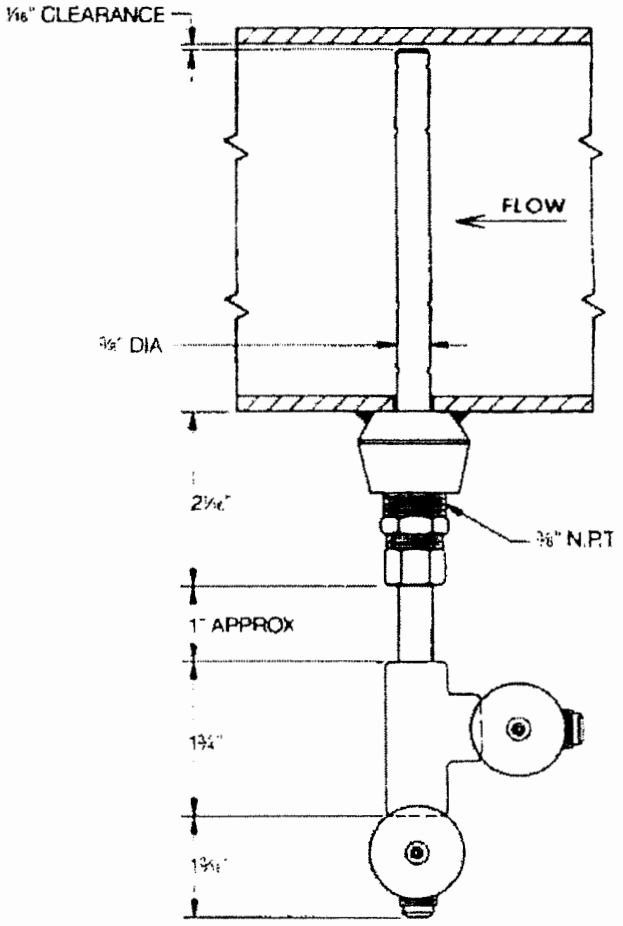
Flow Calculation and Data Bulletin

This bulletin contains equations, charts, and data for determining the differential pressure developed by the Dwyer Series DS 200 Flow Sensor for various flow rates of water, air, steam, or gases in various pipe sizes.

The contents of this bulletin can be utilized to prepare conversion charts to translate the differential pressure readings in a given flow sensor installation to the equivalent flow rate. Where direct readout of flow is required, use the bulletin to calculate the full flow differential pressure in order to specify the exact Dwyer Capsuhelic gage range needed. Special ranges and scale calibrations for the Capsuhelic gage are available at minimal extra cost. Consult Bulletin A-30 in the Dwyer catalog or contact the factory for additional information. Bulletin F-50 covers installation.

For additional useful information in working up flow calculations, the following reference is recommended: Crane Co. Technical Paper No. 400 "Flow of Fluids Through Valves, fittings and pipe" available from Crane Company, 300 Park Avenue, New York, New York 10022, Attn: Advertising Dept. Price $8.00.





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 page 3.
D = Inside diameter of line size expressed in inches. For square & rectangular ducts use $D = \sqrt{\frac{4 \times \text{Height} \times \text{Width}}{\pi}}$

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

SCFM TO ACFM EQUATION

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

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

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

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

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

*(520 = 460 + 60°) Std. Temp. Rankine

TABLE 1
FLOW COEFFICIENTS (K)

FPS = Average Velocity Ft./Sec. (Water)

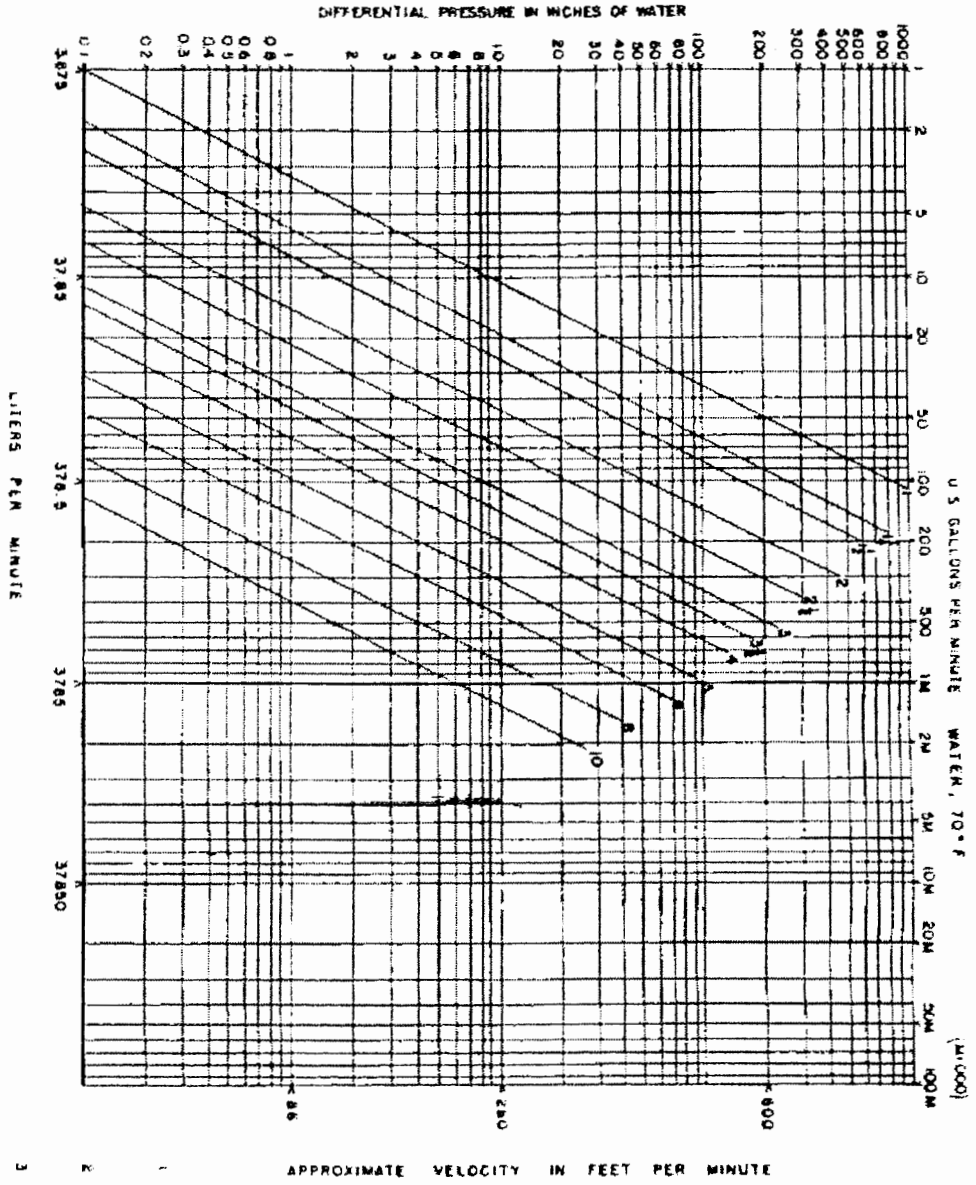
PIPE SIZE (SCH. 40)	VELOCITY* FPS	K	
1	13.0	.521	(use .558 above 7 FPS)
1-1/4	13.3	.536	(use .572 above 7 FPS)
1-1/2	13.0	.556	
2	15.0	.586	**NOTE:** If only one K factor is listed, it applies to all flow rates for the size of pipe and velocity limits listed.
2-1/2	15.1	.625	
3	15.2	.645	
4	15.6	.670	
5	16.0	.681	
6	16.6	.652	
8	16.0	.669	
10	17.1	.677	(use .726 above 6 FPS)

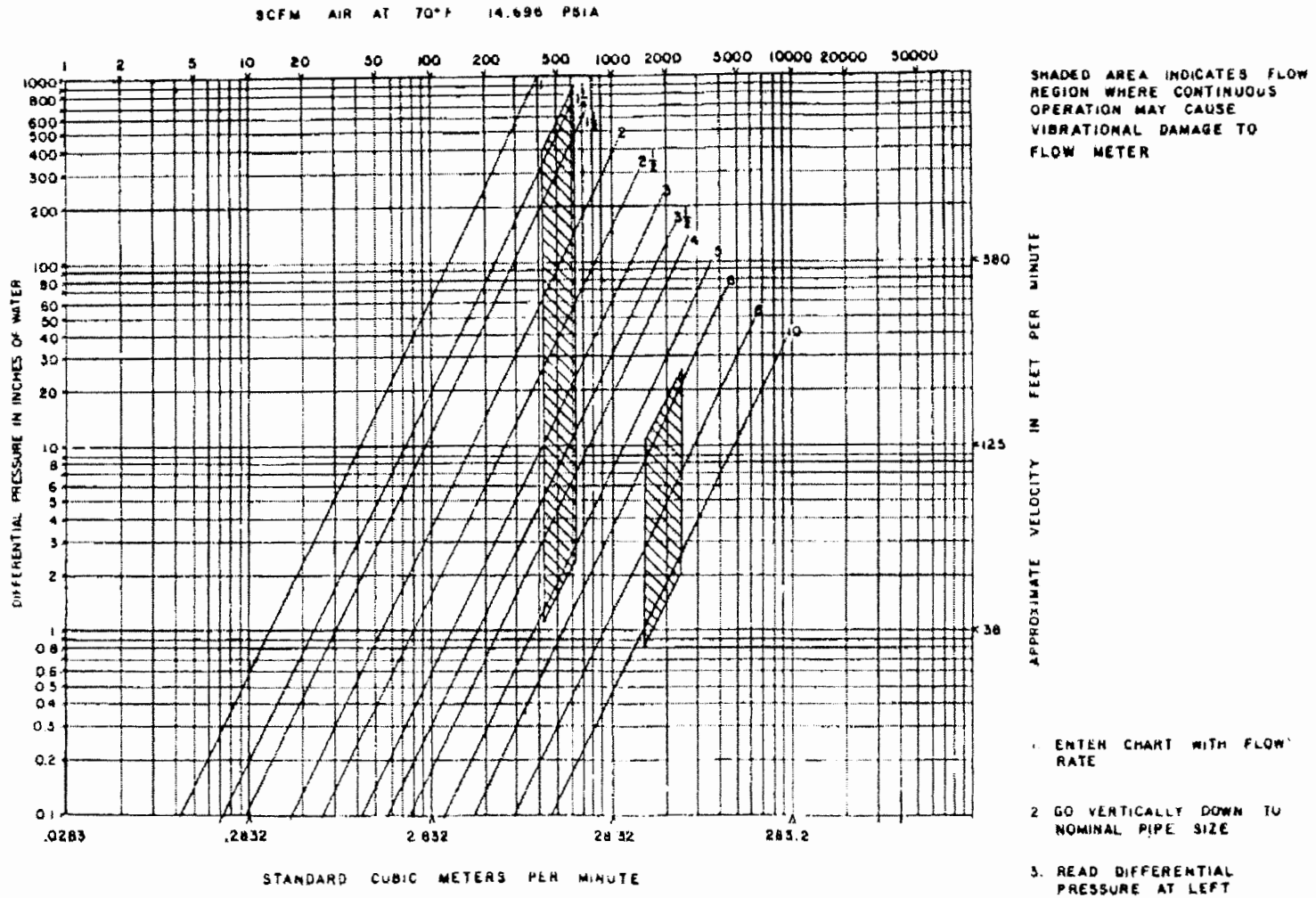
*Represents velocity at 100" H_20 differential pressure. Consult factory for velocities above those listed.

TABLE 2
ALTITUDE/PRESSURE TABLE

The following table gives the U.S. standard atmosphere (1962) for various altitudes above sea level.

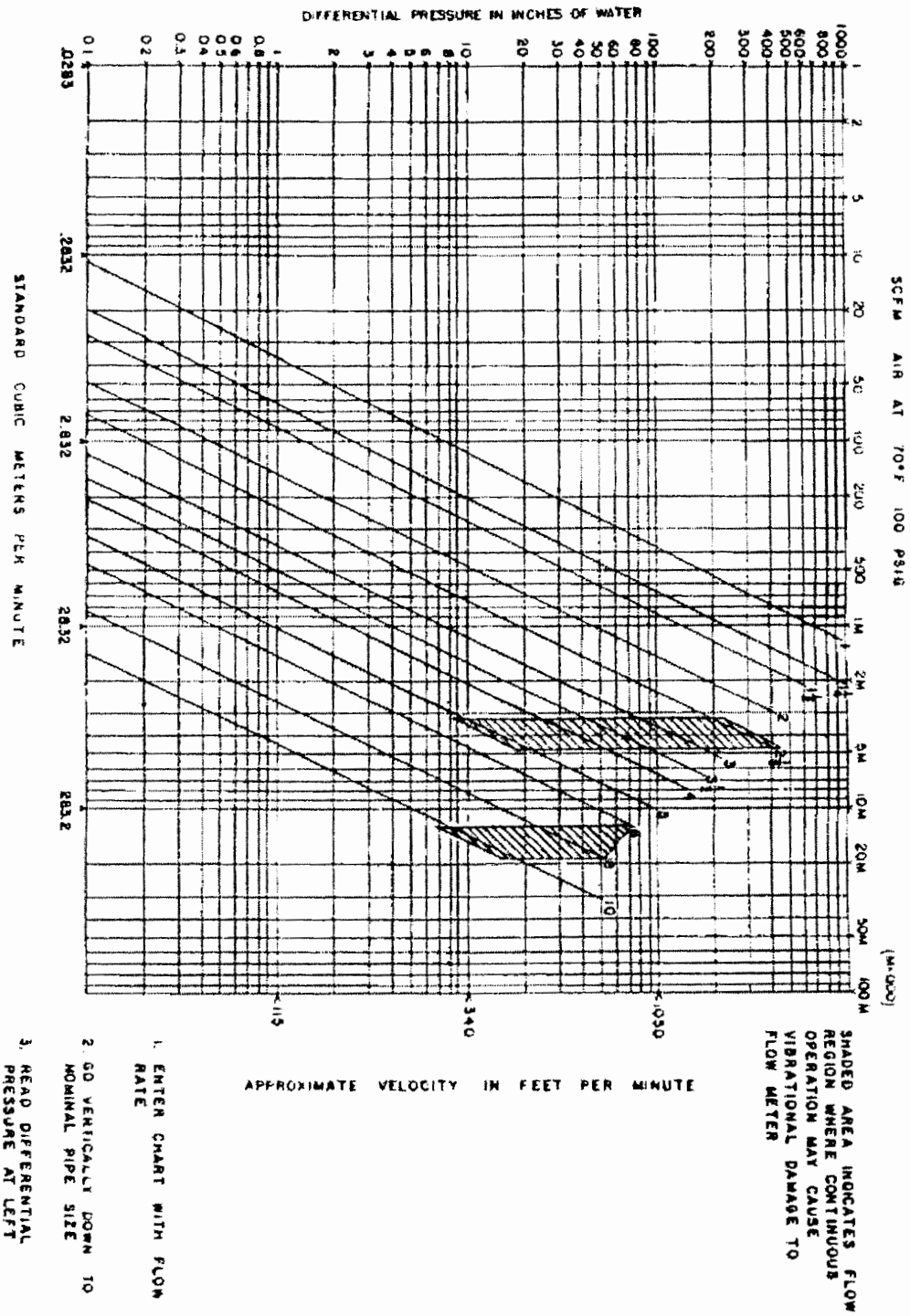
Altitude Feet	Atmospheric Pressure PSIA
0	14.696
500	14.433
1,000	14.173
1,500	13.917
2,000	13.664
2,500	13.416
3,000	13.171
3,500	12.930
4,000	12.692
4,500	12.458
5,000	12.227
6,000	11.777
7,000	11.340
8,000	10.916
9,000	10.505
10,000	10.106
15,000	8.293





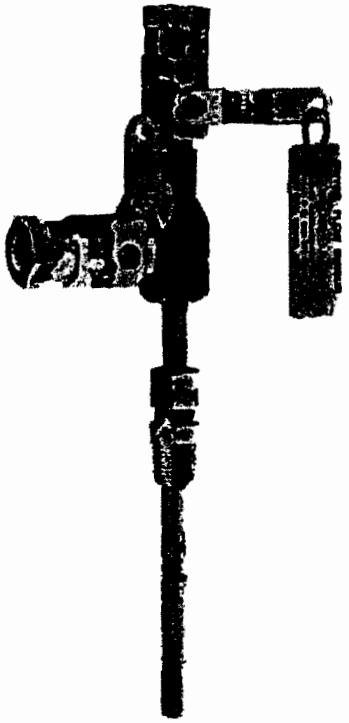
SHADED AREA INDICATES FLOW REGION WHERE CONTINUOUS OPERATION MAY CAUSE VIBRATIONAL DAMAGE TO FLOW METER

1. ENTER CHART WITH FLOW RATE
2. GO VERTICALLY DOWN TO NOMINAL PIPE SIZE
3. READ DIFFERENTIAL PRESSURE AT LEFT



SERIES DS-300 FLOW SENSORS

Installation and Operating Instructions, Flow Calculations



INSPECTION

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

INSTALLATION

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

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

PRESSURE AND TEMPERATURE

Maximum 200 psig at 200°F.

UPSTREAM AND DOWNSTREAM DIMENSIONS IN TERMS OF INTERNAL DIAMETER OF PIPE

*SEE NOTE #1

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

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

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

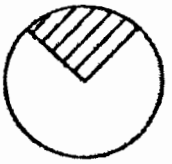
DWYER INSTRUMENTS, INC
P.O. BOX [illegible] MICHIGAN CITY, INDIANA [illegible] U.S.A.
Telephone [illegible]
FAX [illegible]

POSITION

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

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

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



Condensate drains back to pipe

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

Air bleeds back to pipe.

INSTALLATION

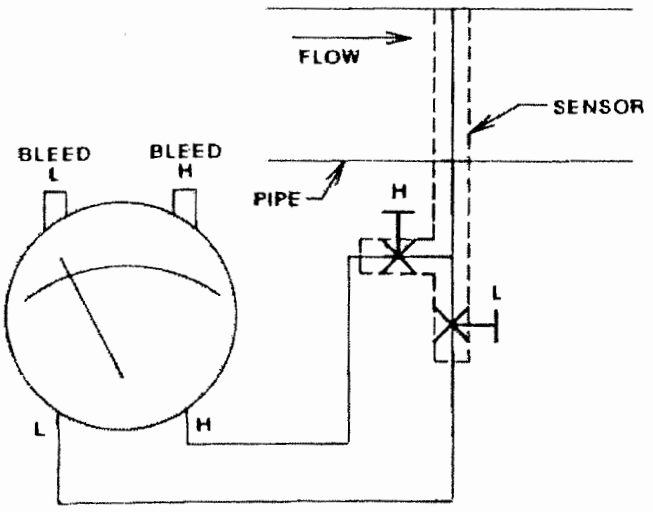
1. When using an A-160 thred-o-let, weld it to the pipe wall. If replacing a DS-200 unit, an A-161 bushing (1/4"×3/8") will be needed.
2. Drill through the center of the thred-o-let into the pipe, with a drill that is slightly larger than the flow sensor diameter.
3. Install the packing gland using proper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

INSTRUMENT CONNECTION

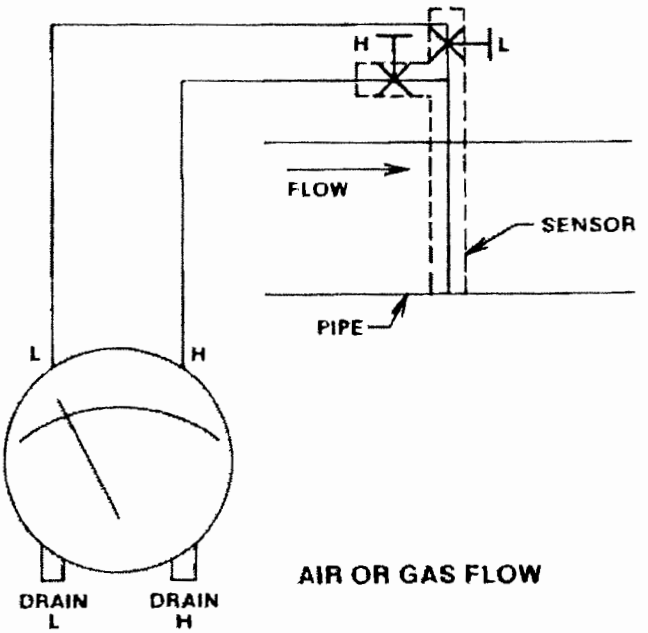
Connect the side pressure tap to the high pressure port of the Magnehelic (air only) or Capsuhelic gage or transmitting instrument and the top connection to the low pressure port. See the connection schematics below.

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

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

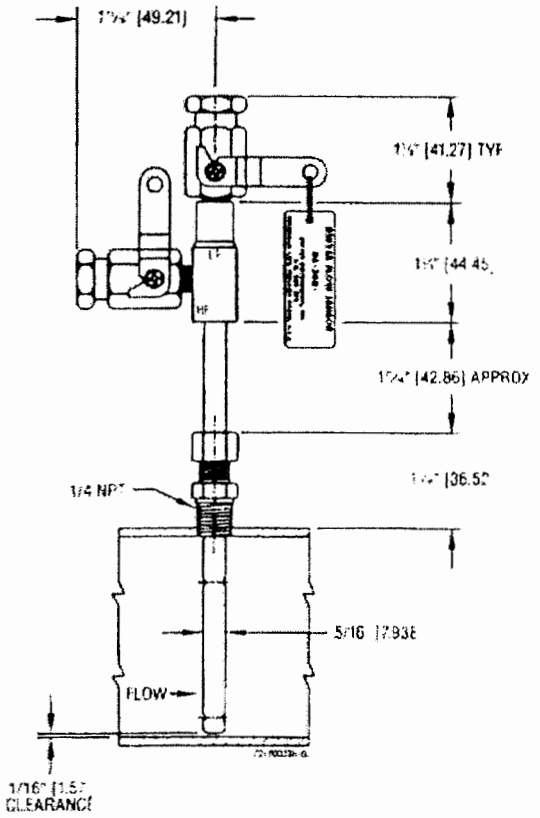


WATER FLOW



AIR OR GAS FLOW

SERIES DS-300 FLOW SENSORS



FLOW CALCULATIONS AND CHARTS

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

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

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

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

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

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

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2. Steam or Any Gas
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2. Steam or Any Gas
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3. Any Gas
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TECHNICAL NOTATIONS

The following notations apply:

ΔP = Differential pressure expressed in inches of water column.
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K = Flow coefficient — See Values Tabulated on page 3.
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S_f = Sp Gr at flowing conditions
S_s = Sp Gr at 60°F

SCFM TO ACFM EQUATION

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

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

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

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

*(520 = 460 + 60°) Std. Temp. Rankine

Printed in U.S.A. 6/96

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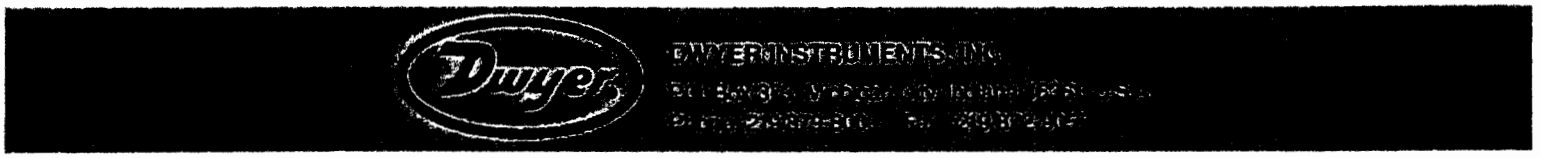
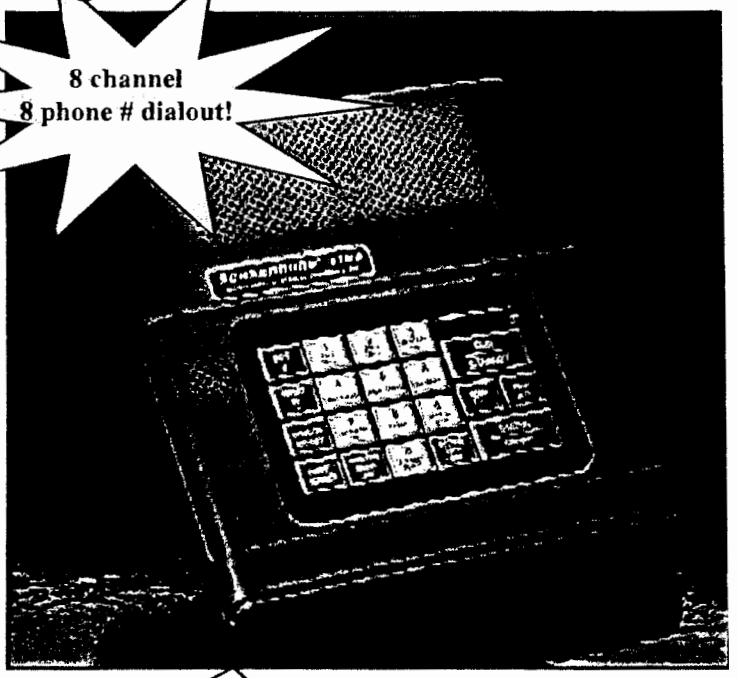


SENSAPHONE 1108

Sensaphone® 1108

Desktop Monitoring System

Environmental/Process monitoring over telephone lines with full programming capabilities



- ☐ The versatile Model 1108 is designed for programming flexibility
- ☐ Variable alarm recognition and "listen-in" time, with alarm disable, security code access, remote sensing, and other programming features
- ☐ Monitors power, temperature, and other important environmental conditions to protect computers, equipment, and processes
- ☐ Automatically contacts you at up to 8 locations if unsafe conditions occur
- ☐ Allows you to contact your system using any telephone, to receive status reports and listen-in to on-site sounds
- ☐ Helps you detect problems before they turn into disasters

Now you can protect your equipment and processes even when you can't be there - The Sensaphone 1108 monitors your computer rooms, equipment centers, offices, or any unattended facility to detect power failures, temperature extremes, intrusions, water incursion, sounds such as smoke and burglar alarms, and other conditions of your choice.

Alerts you immediately if problems arise - The Sensaphone 1108 automatically contacts you by phone at up to eight different phone numbers, to alert you of unsafe conditions. The system communicates in voice-synthesized English, and even lets you "listen-in" to actual on-site sounds.

CONDITIONS MONITORED:
Temperature
Humidity
Electricity
Water Incursion
Smoke
Sound
Windows & Doors
...and more!

ALERT

UP TO 8 DIAL-OUT NUMBERS:
If unsafe conditions occur, the Sensaphone will automatically dial up to eight numbers in sequence to advise you of the problem. Numbers may be up to 32 digits each, with your choice of pulse or tone dial-out.

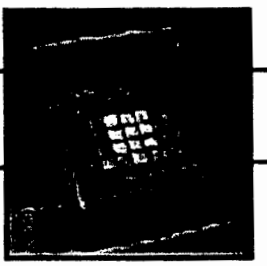
COMMUNICATES OVER STANDARD PHONE LINES:
Call-in for periodic status reports on all monitored conditions, using any telephone. The Sensaphone communicates in simple voice-synthesized English.

Phonetics, Inc.

901 Tryens Road, Aston, PA 19014 610-558-2700 FAX: 610-558-0222
http://www.sensaphone.com

See reverse side for a list of the Sensaphone's outstanding features and capabilities.

Sensaphone® 1108



Ideal for a variety of applications - The Sensaphone is useful wherever there is a need for monitoring of temperature, humidity, or other conditions. Sensors and input devices are available to suit a wide range of applications.

- ☐ HVAC Equipment
- ☐ Computer rooms
- ☐ Refrigeration and freezers
- ☐ Health care centers
- ☐ Offices
- ☐ Warehouses
- ☐ Livestock and egg/poultry
- ☐ Home & property
- ☐ Greenhouses

...and many others!

BUILT-IN FEATURES

- ☐ 8 User-selectable inputs, temperature or dry-contact
- ☐ Microphone monitors high sound alarms and enables remote listen-in
- ☐ AC Power failure sensing with variable recognition time
- ☐ Battery condition monitor
- ☐ Clock

ADVANCED CAPABILITIES

- ☐ User Programmable: Alarm recognition time, Call delay, Inter-call delay, Message repetitions
- ☐ Temperature sensing in Fahrenheit (-20°F to 150°F), or Celsius (-29°C to 65°C)
- ☐ Individual temperature input calibration
- ☐ Nonvolatile memory for all programmed parameters

VERSATILE DIAL-OUT CAPABILITIES

- ☐ Alert sensors trigger pulse or tone dialout automatically
- ☐ Dials up to 8 numbers, up to 32 digits each
- ☐ Continues dialing numbers in sequence, until acknowledged
- ☐ Call Progress: Intelligently detects ringing or busy signal
- ☐ Intelligent dial out to beepers and pagers

EASY CONTROL ACCESS:

- ☐ Keypad for local programming and status report
- ☐ Unit can be called from any phone to verify status of all monitored conditions
- ☐ Local or remote enabling/disabling of all dial-out conditions
- ☐ Can share a single phone line with an answering machine, allowing full operation of both units
- ☐ Programmable security code access

SPECIFICATIONS

Size: 7.5" W, 2" H, 8.5" D
Power Requirements: 120 VAC 60Hz 15W
Batteries: (6) 1.5 Volt "D" cell alkaline (not included)
Telephone Interface: FCC approved RJ-11 plug-in modular connector with 6' cord
Operating Range: Unit should be kept between 32° F and 120° F.
Temperature Sensing Range: -20° F to 150° F with remote temperature sensor.
Shipping Weight: 4 lbs.
NRTL listed for compliance with U.L. Standard 1459.
Technical data subject to change without notice.

We'd like to show you how the Sensaphone 1108 can help you monitor your equipment and facilities. Give us a call to find out more! Or listen to an actual Sensaphone report by calling 610-558-4591.

Phonetics, Inc.
901 Tryens Road, Aston, PA 19014 610-558-2700 FAX: 610-558-0222
http://www.sensaphone.com

Made in the U.S.A

ENGINEERING SPECIFICATIONS
SENSAPHONE® 1108 and 1118

I. General

The Automatic dialer shall be a self-contained microprocessor controlled system capable of monitoring up to 8 alarm channels, sound level and AC power. The system shall be configured for operation by the user by means of the built-in keypad. Characteristics of Input channels include Dry Contact and Temperature.

Upon detection of any alarm or status change, the system shall commence dialing telephone numbers and deliver a voice message identifying and describing the alarm condition(s). The alarm message shall be delivered in digitized human voice using messages from the unit's internal vocabulary. The system will continue to call telephone numbers in succession until a positive acknowledgment of the alarm message is received. Acknowledgment is accomplished by depressing tone keys from the called telephone, or by calling the system back within a programmed time period. The alarm may also be acknowledged using the local keypad. In addition, the system shall be able to receive incoming telephone calls. Upon answering, the system shall recite a status report and allow enabling and disabling of monitored conditions.

The system shall be FCC and DOC registered for direct connection to the telephone network. The system shall be NRTL listed in compliance with UL Standard 1459. The system shall have a one year warranty from the manufacturer. The system shall be a Sensaphone® 1108 by Phonetics, Inc.

II. I/O Channel Attributes and Features

A. Inputs

The system shall come standard with 8 input channels, configurable as NO or NC digital dry contact or temperature.

The system shall have the following built-in monitoring features:

1. AC power failure detection
2. Temperature with pre-wired 2.8K thermistor (-20°F to 150° F) on input #1.
3. High sound level detection.

All monitored channels, including built-in monitoring features, shall allow local keypad programming of pertinent operational data including, but not limited to:

1. Input type (NO/NC or temperature)
2. High and Low limits (temperature)
3. Calibration of temperature inputs (-10° to +10°)
4. Input recognition time (0 seconds to 272 minutes)
5. Enable/disable for each channel to dialout for alarm

III. Communications Features

A. Telephone Specifications

The system shall connect to a standard 2-wire telephone line using pulse or tone, with loop start only. The system shall recognize ringer frequencies from 16 to 60 Hz. No leased or dedicated lines shall be required. The system shall also be capable of being used on the same telephone line as other answering devices. Call progress detection shall ensure that the alarm dialout is not hindered by no answers or busy signals.

B. Telephone Numbers

The system shall be capable of dialing up to 8 telephone numbers, 32 digits each. The system shall allow local keypad programming of the following telephone dialing information:

1. Dialing method (Pulse or tone)
2. Message repetitions (0 to 10)
3. Maximum number of calls (0 to 255)
4. Call delay time (0 seconds to 60 minutes)
5. Intercall delay time (10 seconds to 60 minutes)

C. Beeper/Pager Dialout

The system shall be capable of intelligently dialing out to a numeric beeper or pager. The dialing sequence shall be programmable such that the pager number is dialed, the system waits for the telephone to be answered, and then additional identification DTMF digits are transmitted.

D. Line Seizure Feature (Model 1118 only)

The system automatically seizes control of the phone line to make an alarm phone call when the alarm occurs. All other calls, including current calls, will disconnect and all extensions will be disabled. Extensions will remain cut off until the alarm is acknowledged.

IV. Programming

A. Local Programming

The System shall contain an integral, sealed keypad for the purpose of locally programming all system data. Programming is assisted by digitized voice guidance.

B. Remote Programming

The system shall be remotely programmable using a standard touch-tone telephone. The following parameters may be remotely programmed:

1. Disable/enable inputs
2. Disable/enable AC power monitoring

G. Environmental

The system shall function over an operating range of 32° F - 120° F at up to 0 - 90% RH, non-condensing.

H. Maintenance

The system manufacturer shall have in-house service facilities and technical assistance available during normal business hours , Monday-Friday, 8am-5pm (EST).

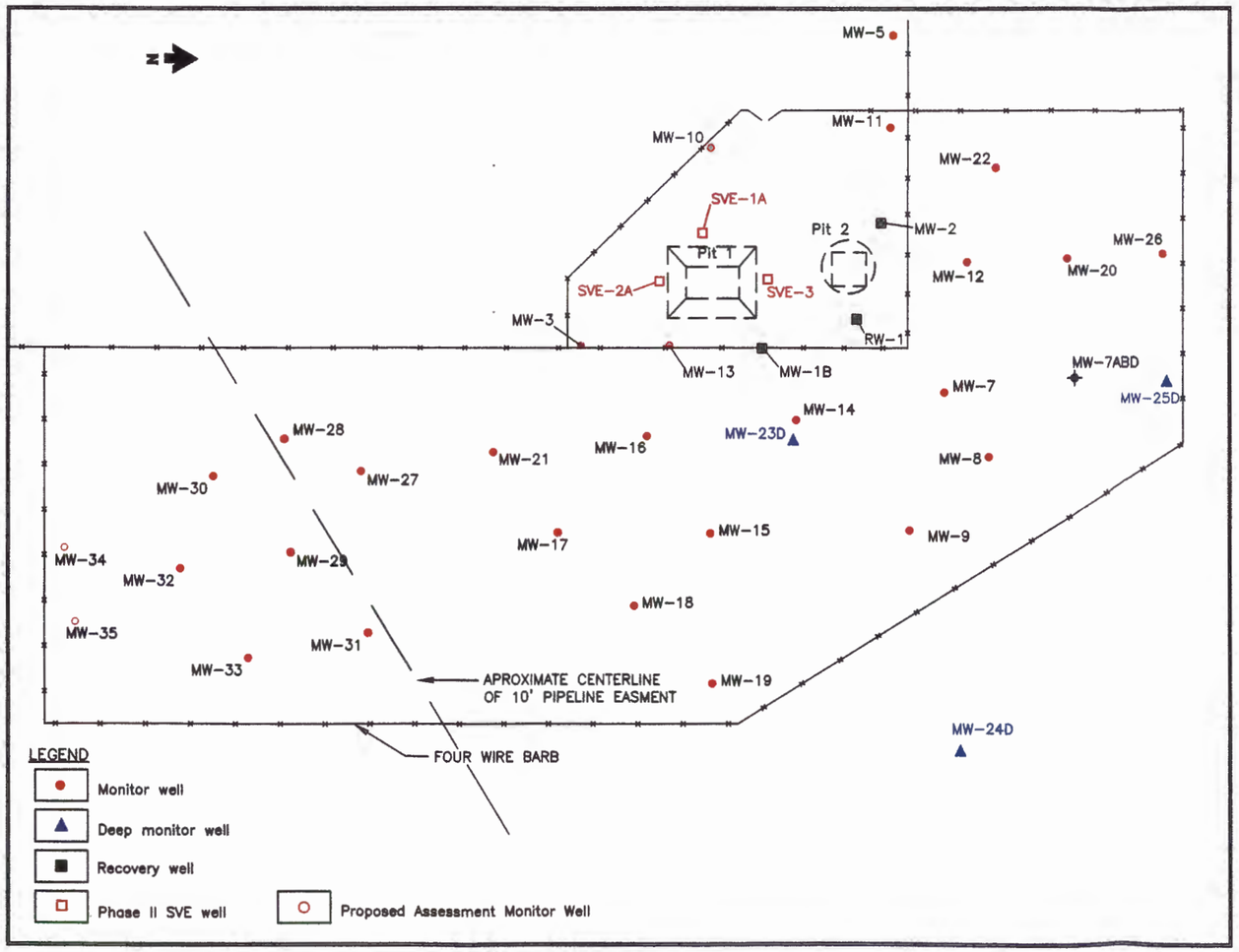
Specifications subject to change without notice.

Phonetics, Inc.
901 Tryens Road
Aston, PA 19014
Phone: (610)558-2700 FAX: (610)558-0222
www.sensaphone.com

APPENDIX C
DESIGN DRAWINGS

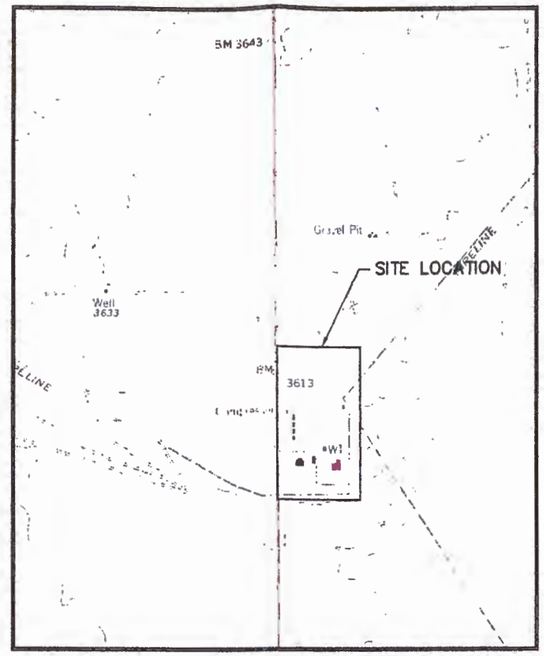
INDEX OF DRAWINGS

Dwg	Description
	Cover Sheet
G-1	Index of Drawings, Vicinity Map, Site Location Map, and Site Layout Map
G-2	Geologic Cross Section
G-3	Areal Extent of Impacted Groundwater
C-1	Multi-Phase Extraction Well Field Layout
C-2	Trenching/Conveyance Piping Plan
C-3	Equipment Compound Detail
C-4	Equipment Building Details
C-5	Equipment Building Details
C-6	Well Head Details
C-7	Trenching Details
C-8	Manifold Details
P-1	Process Flow Diagram
P-2	SVE System Process and Instrumentation Diagram
P-3	Total Fluids Process and Instrumentation Diagram
E-1	Electrical Details - One Line Diagram



SITE LAYOUT MAP

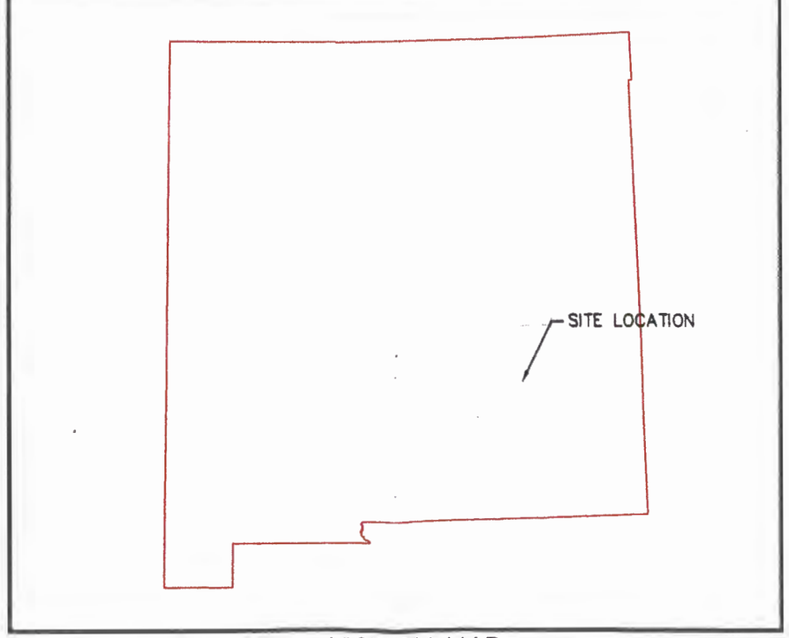
SCALE 1"=100'



SITE LOCATION MAP

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

SCALE 1"=2000'



VICINITY MAP

NOT TO SCALE

REVISIONS				
REMARKS	CHKD	DRWN	DATE	REV.

Tetra Tech EM Inc.

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CHECKED BY: BM

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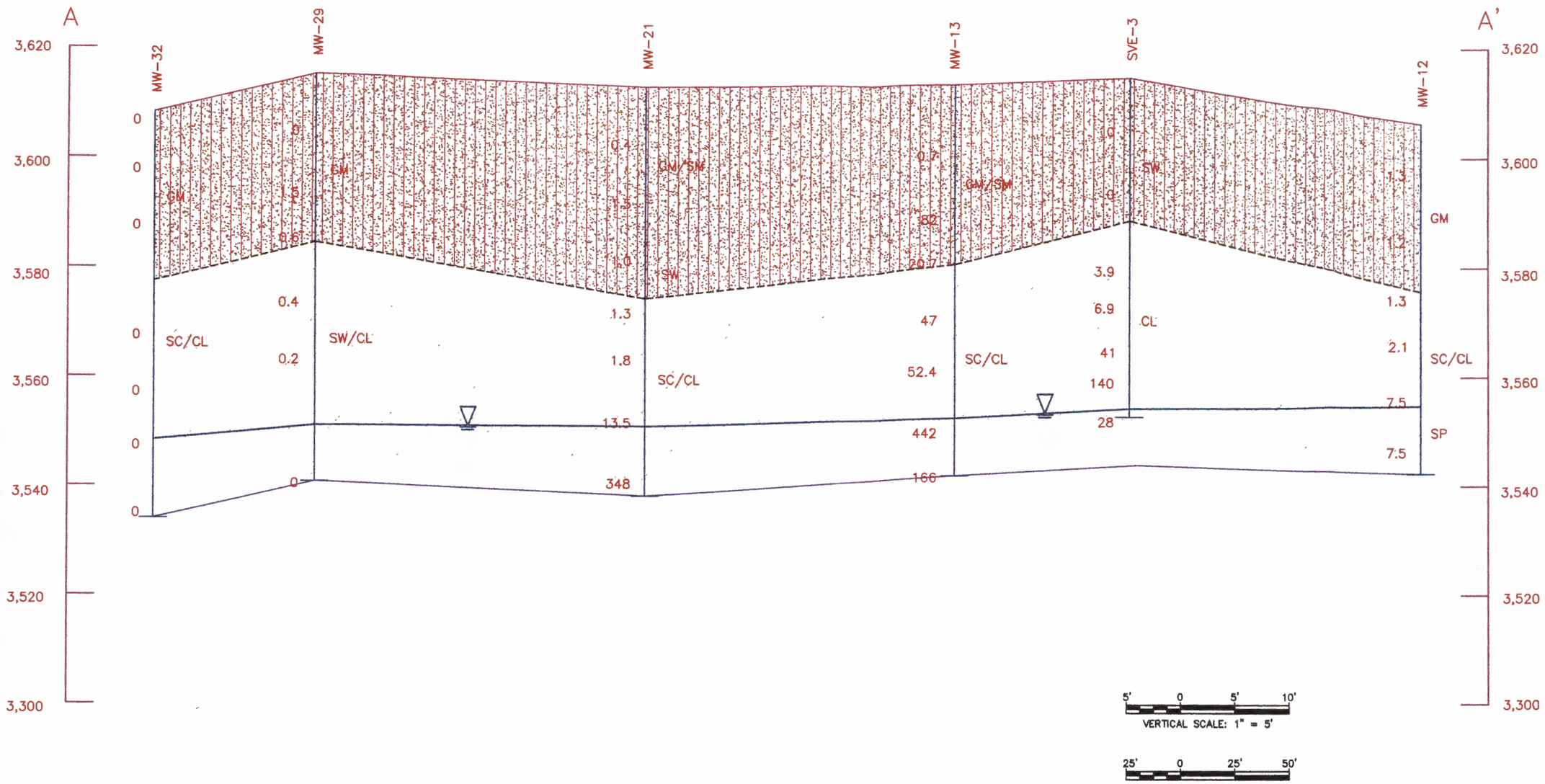
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

Index of Drawings, Vicinity Map, Site Location Map, and Site Layout Map

PROJECT NUMBER:
P-202203

DRAWING NO.:
G-1



5' 0 5' 10'
VERTICAL SCALE: 1" = 5'

25' 0 25' 50'
HORIZONTAL SCALE: 1" = 25'

LEGEND

GM	SILTY SAND
SW	WELL GRADED SAND
SM	SILTY SAND
SC	CLAYEY SAND
CL	CLAY
▽	POTENTIOMETRIC SURFACE ELEVATION
——	APPROXIMATE CONTACT BETWEEN SOIL TYPES

HEATED HEADSPACE READING (ppmv) — 47 — GM / CL — USCS SOIL CLASSIFICATION

REVISIONS

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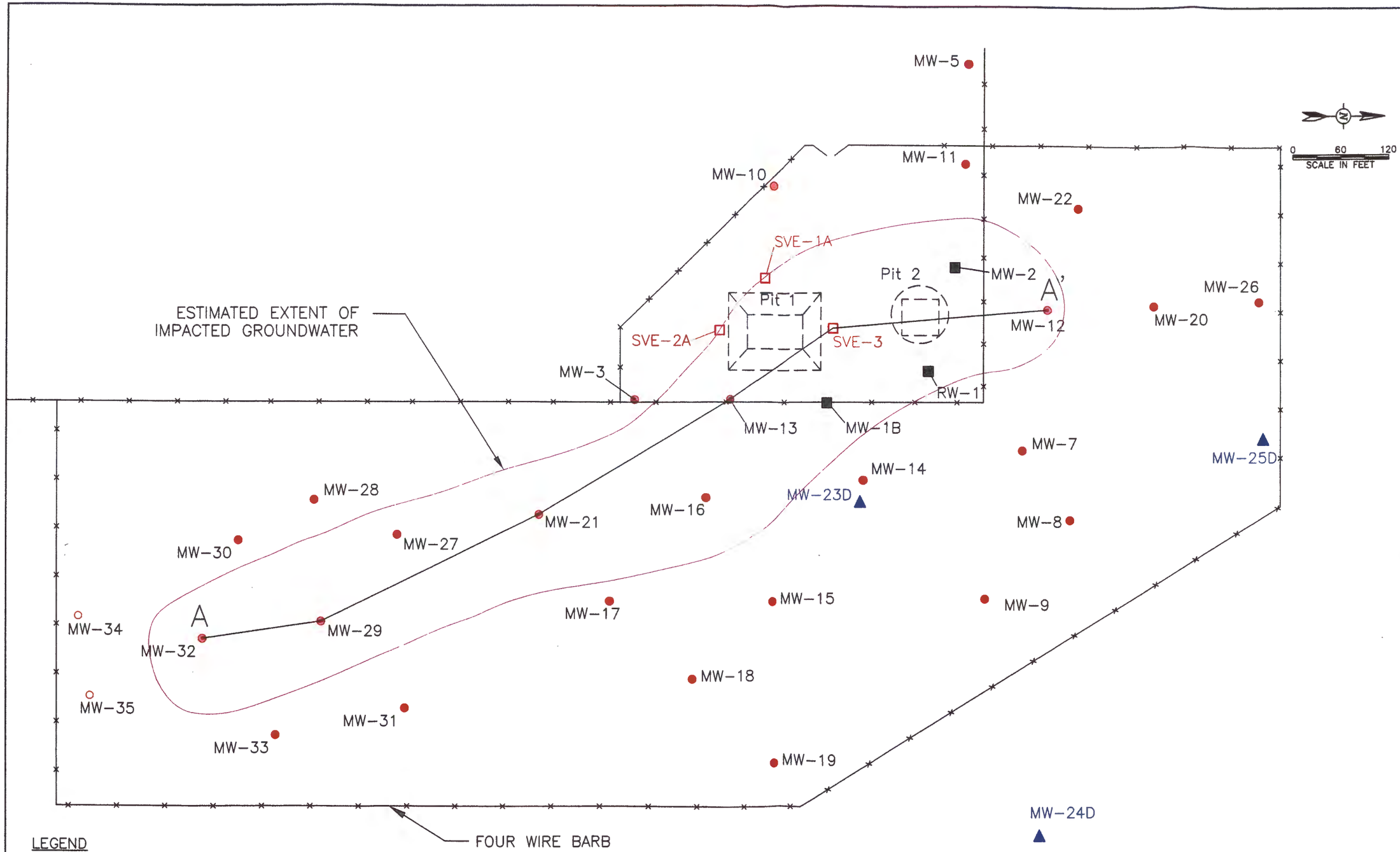
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

Geologic Cross Section

PROJECT NUMBER: P-202203

DRAWING NO.: G-2



REVISIONS

REV.	DATE	DRWN	CHKD	REMARKS

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ROSWELL COMPRESSOR STATION
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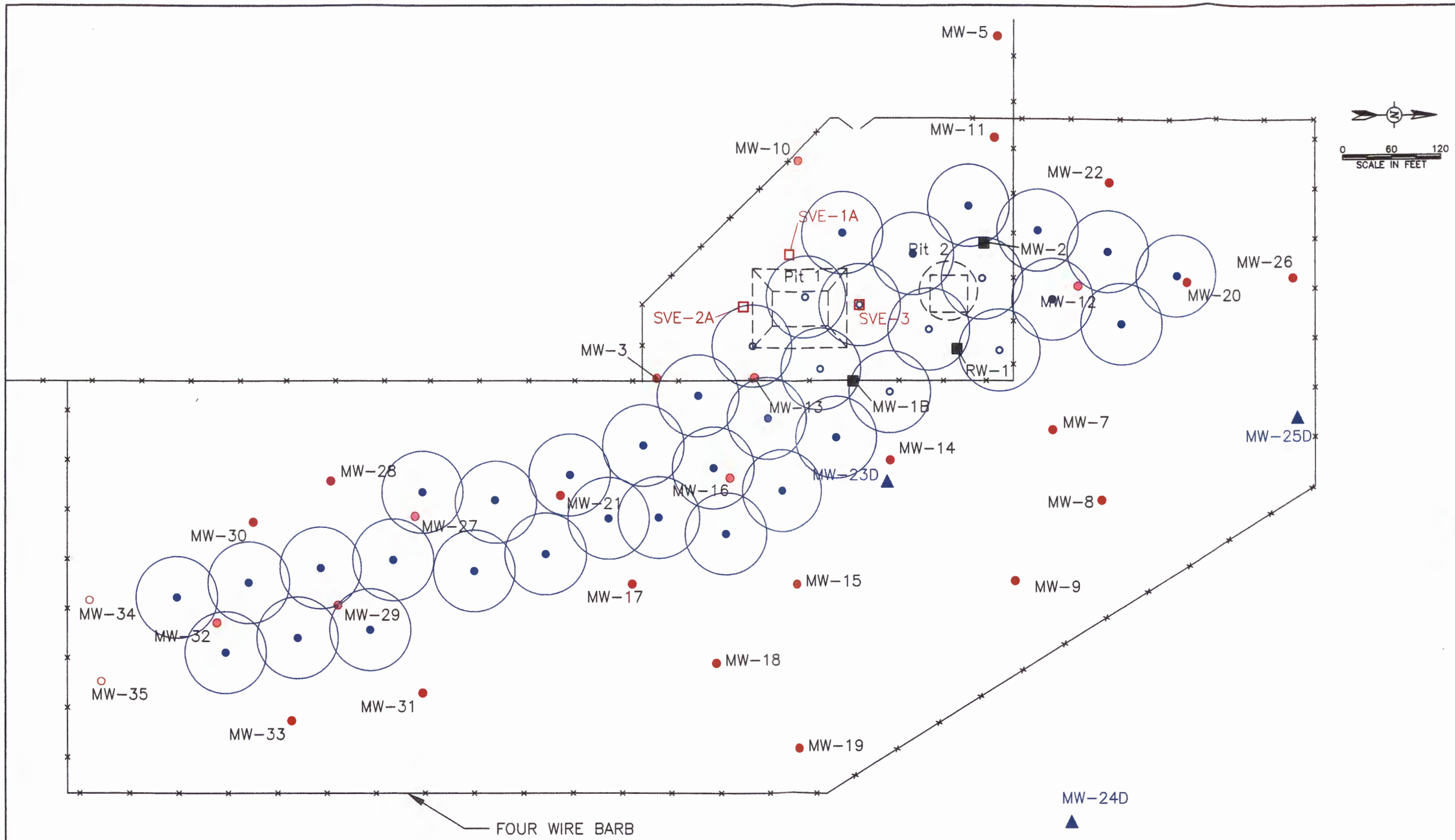
Areal Extent of Impacted Groundwater

PROJECT NUMBER: P-202203

DRAWING NO.: G-3



LEGEND

- Monitor Well
- Deep Monitor Well
- Recovery Well
- Phase II SVE Well
- Proposed Assessment Monitor Well
- 50 ft Radius of Influence
- Multi Phase Extraction Well
- Multi Phase Extraction and Shallow SVE Well

REVISIONS

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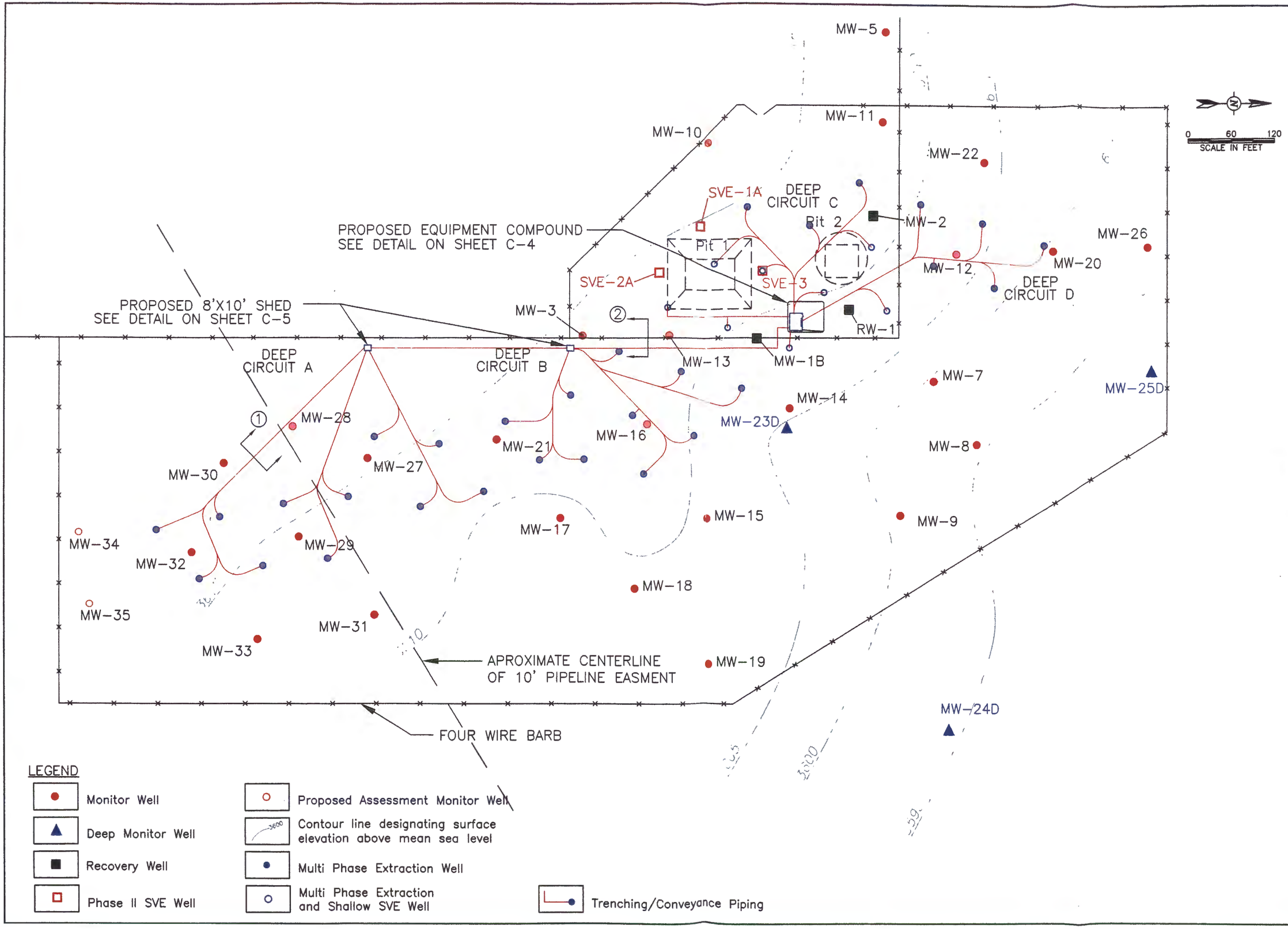
Multi Phase Extraction Well Field Layout

PROJECT NUMBER: P-202203

DRAWING NO.: C-1



REVISIONS

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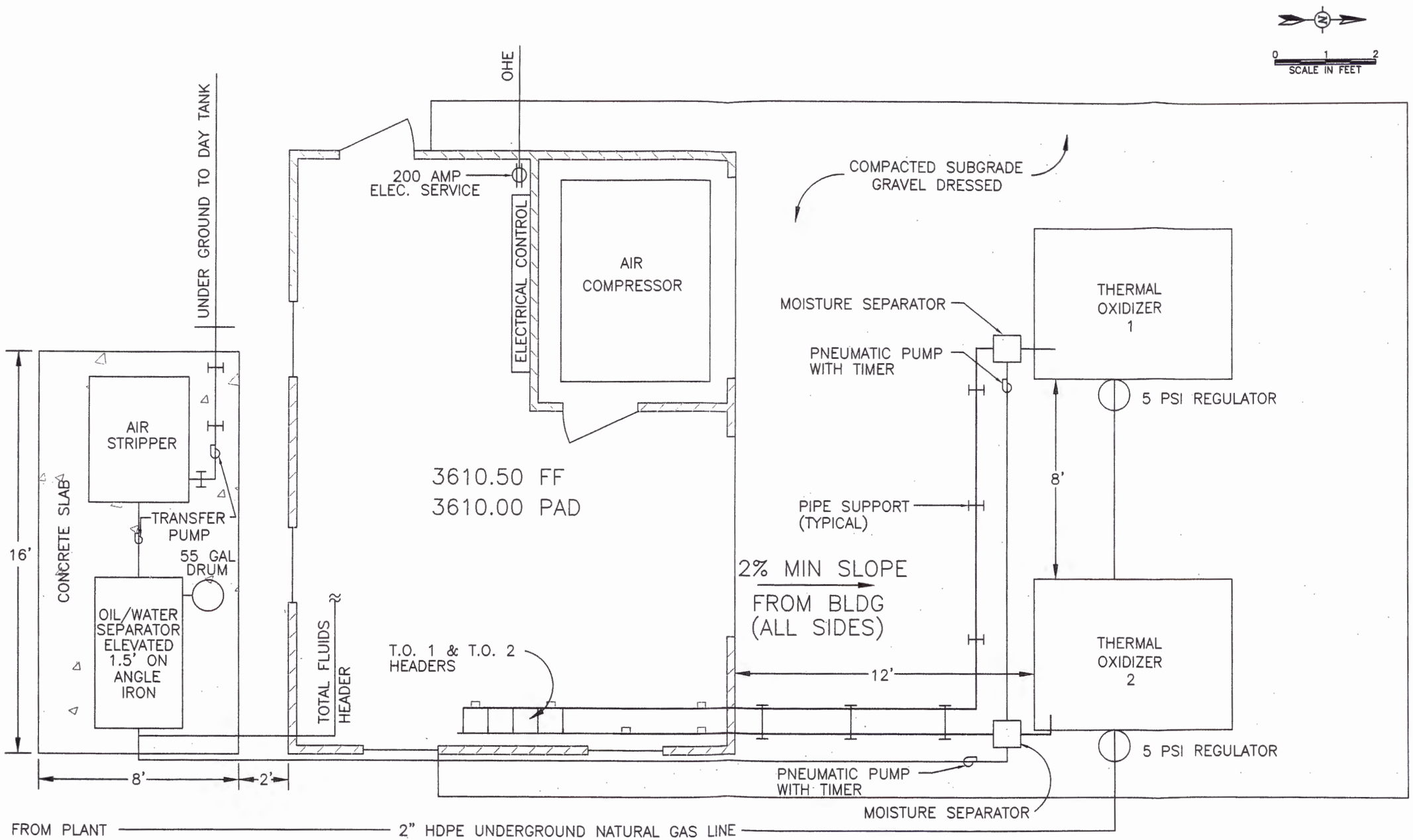
Trenching/Conveyance Piping Plan

PROJECT NUMBER:
P-202203

DRAWING NO.:
C-2



EQUIPMENT COMPOUND DETAIL (PLAN)

NTS

REVISIONS

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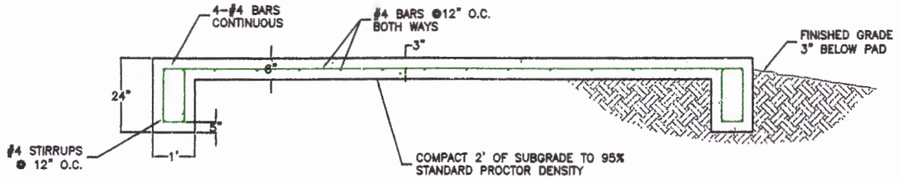
Equipment Compound Detail

PROJECT NUMBER:
P-202203

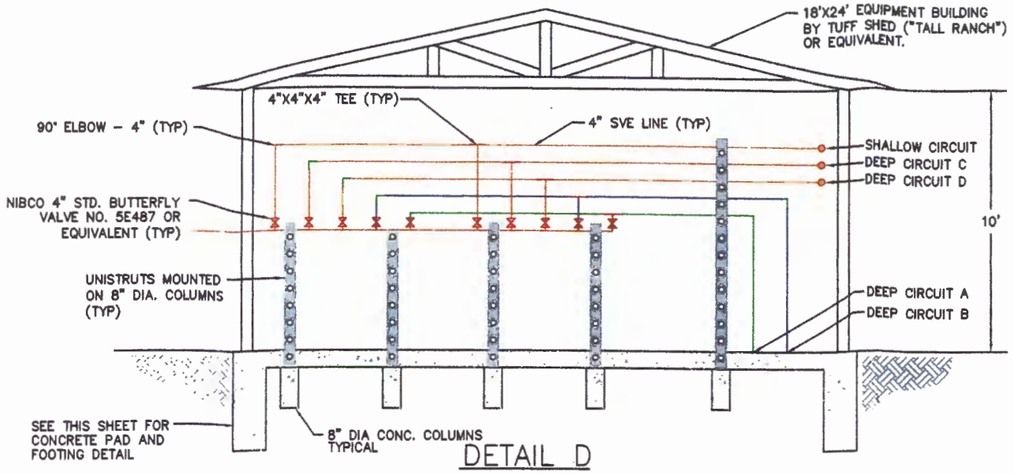
DRAWING NO.:
C-3



DETAIL B

CONCRETE PAD CROSS SECTION DETAIL

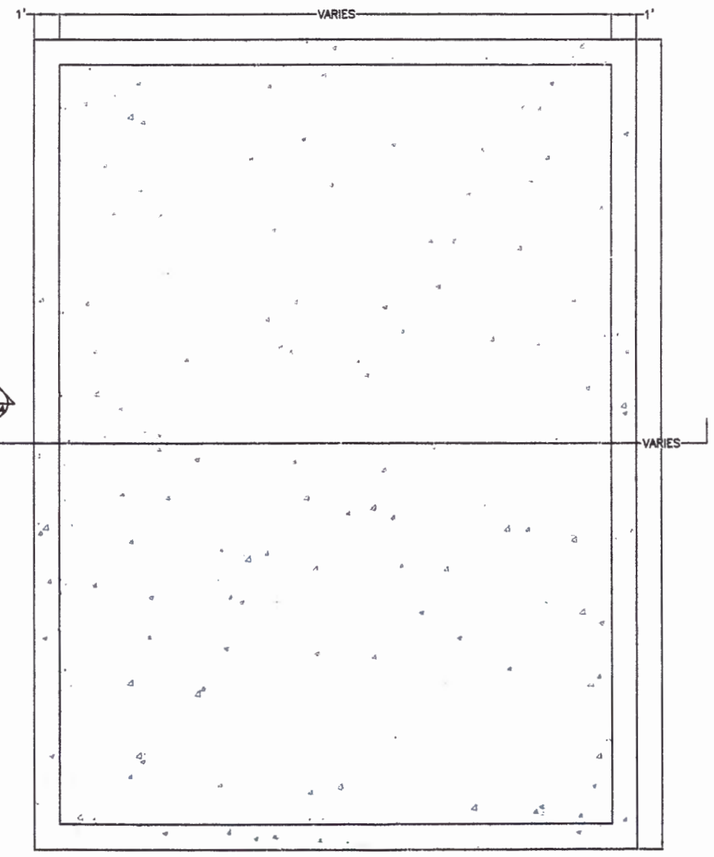
NTS



DETAIL D

EQUIPMENT BUILDING CROSS SECTION DETAIL (EAST WALL)

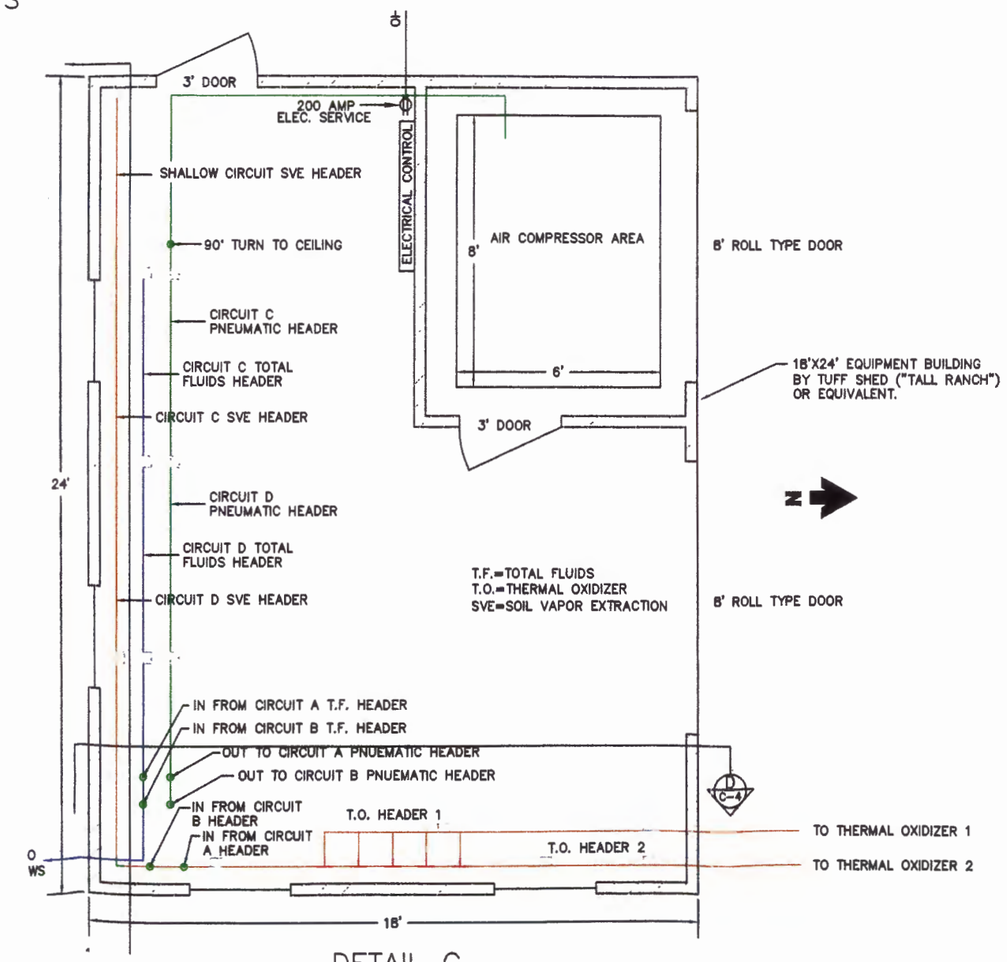
NTS



DETAIL A

CONCRETE PAD DETAIL

NTS



DETAIL C

EQUIPMENT BUILDING PLAN VIEW DETAIL

NTS

Tetra Tech EM Inc.

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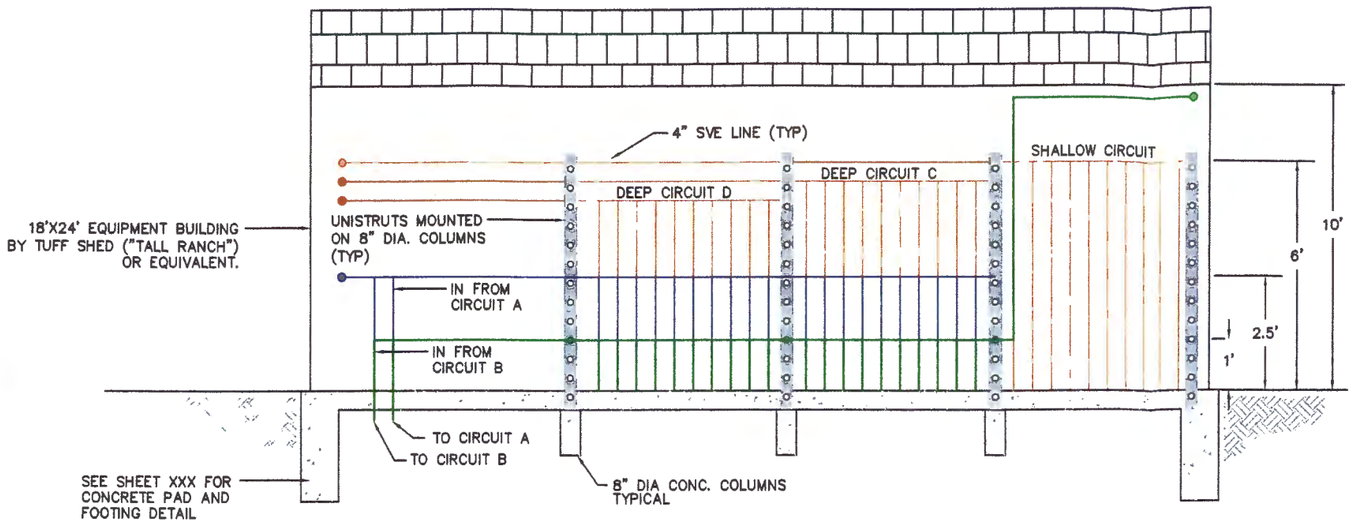
DATE:

ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

Equipment Compound Details

WORK ASSIGNMENT NO.: P-202203

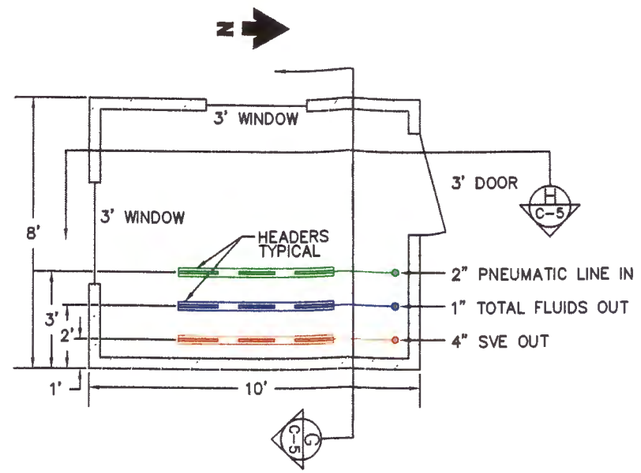
DRAWING NO.: C-4



DETAIL E

EQUIPMENT BUILDING CROSS SECTION DETAIL (SOUTH WALL)

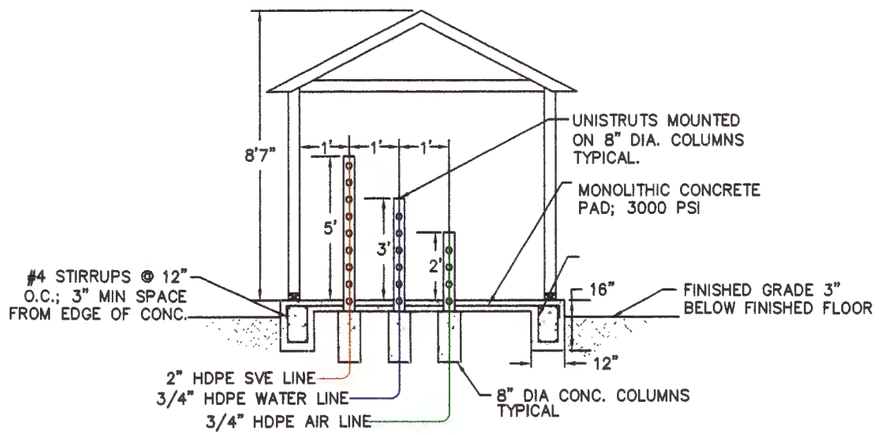
NTS



DETAIL F

EQUIPMENT SHED PLAN VIEW DETAIL

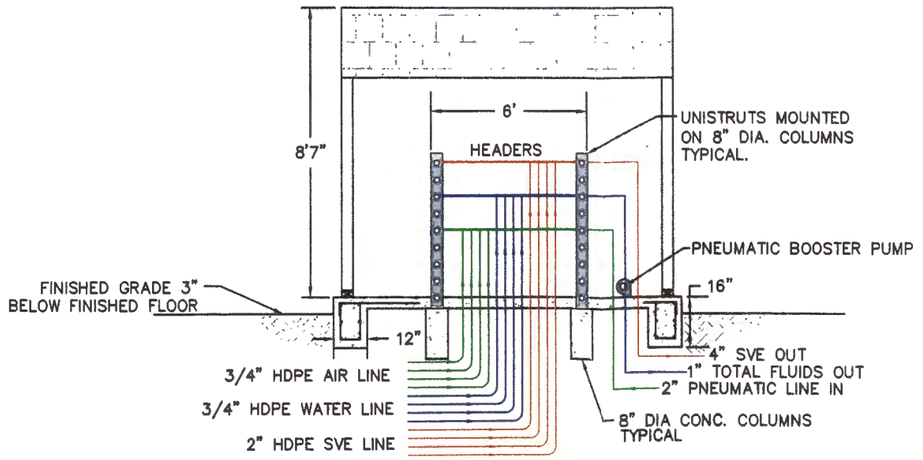
NTS



DETAIL G

EQUIPMENT SHED CROSS SECTION DETAIL (SOUTH WALL)

NTS



DETAIL H

EQUIPMENT SHED CROSS SECTION DETAIL (EAST WALL)

NTS

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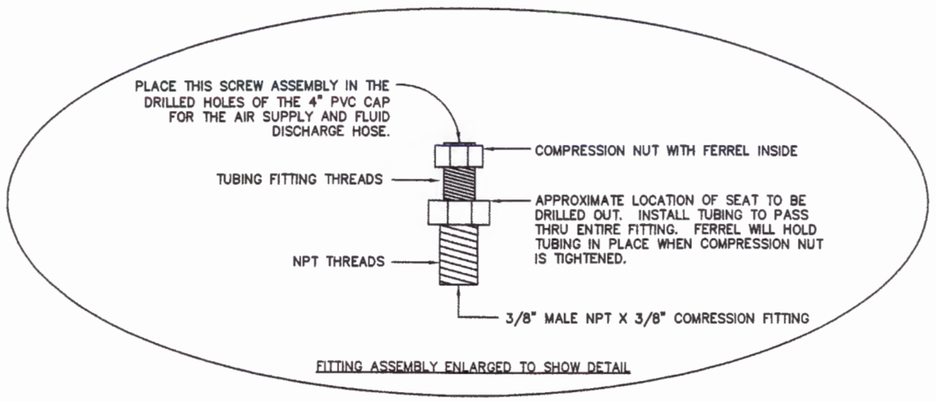
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

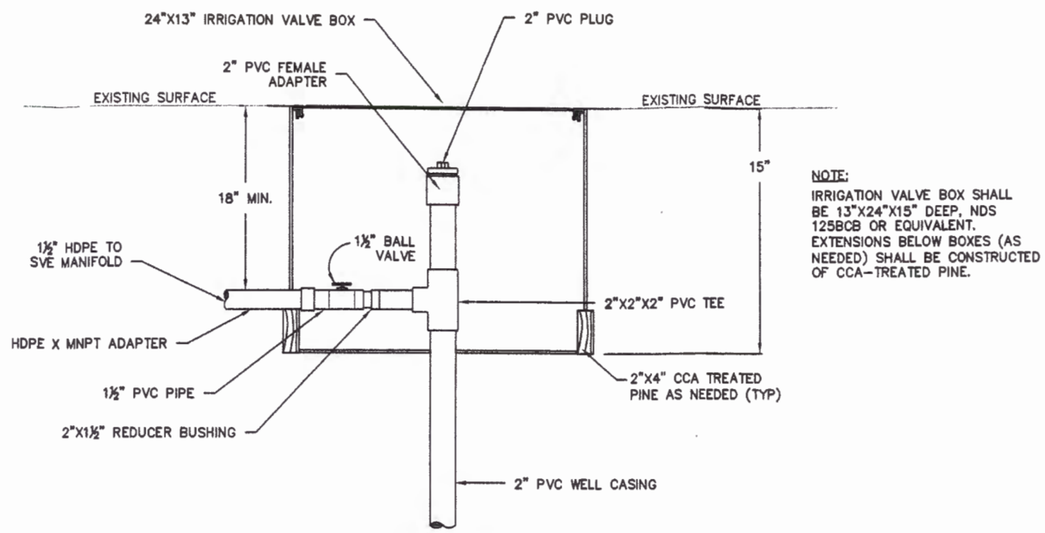
Equipment Building Details

WORK ASSIGNMENT NO.: P-202203

DRAWING NO.: C-5

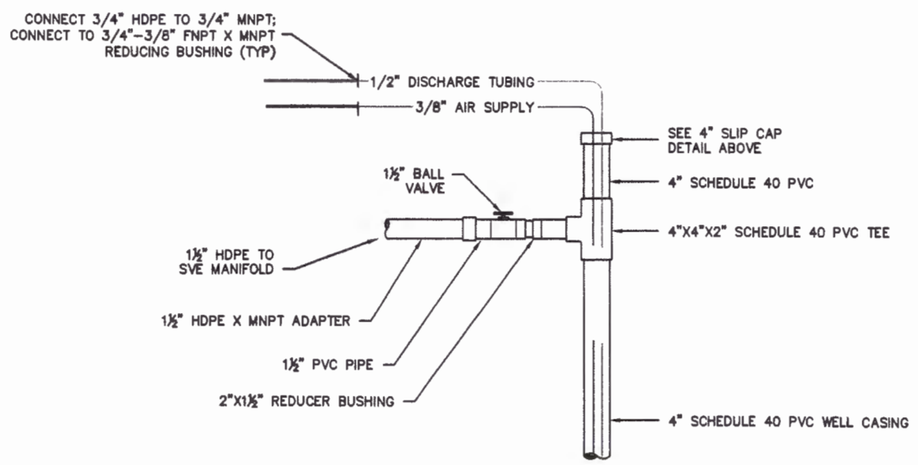


4" PVC SLIP CAP AND FITTING ASSEMBLY DETAIL
NTS



NOTE:
IRRIGATION VALVE BOX SHALL BE 13"X24"X15" DEEP, NDS 125BCB OR EQUIVALENT. EXTENSIONS BELOW BOXES (AS NEEDED) SHALL BE CONSTRUCTED OF CCA-TREATED PINE.

SHALLOW SVE WELLHEAD DETAIL
NTS



DEEP SVE WELLHEAD DETAIL
NTS

NOTE:
MPE WELL HEADS HOUSED IN 17"X30"X18" DEEP VALVE BOX, NDS 126BCB OR EQUIVALENT. EXTENSIONS BELOW BOXES (AS NEEDED) SHALL BE CONSTRUCTED OF CCA-TREATED PINE.

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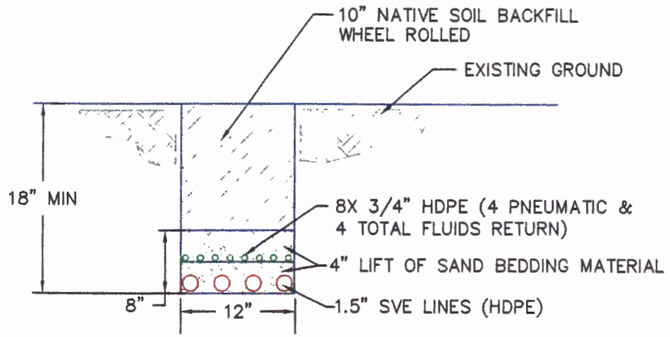
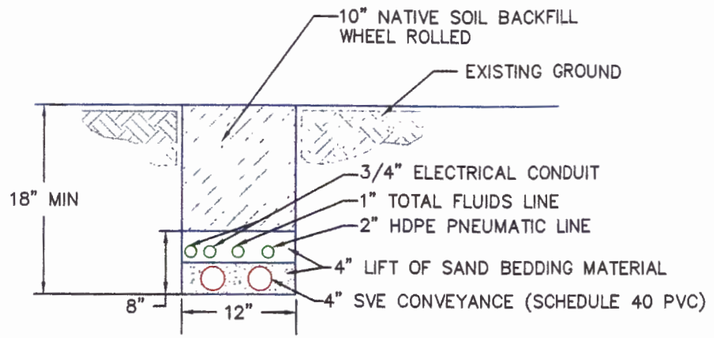
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO
Well Head Details
WORK ASSIGNMENT N
P-202203
DRAWING NO.:
C-6



DETAIL 1-TYPICAL
NTS



DETAIL 2-TYPICAL
NTS

Tetra Tech EM Inc.

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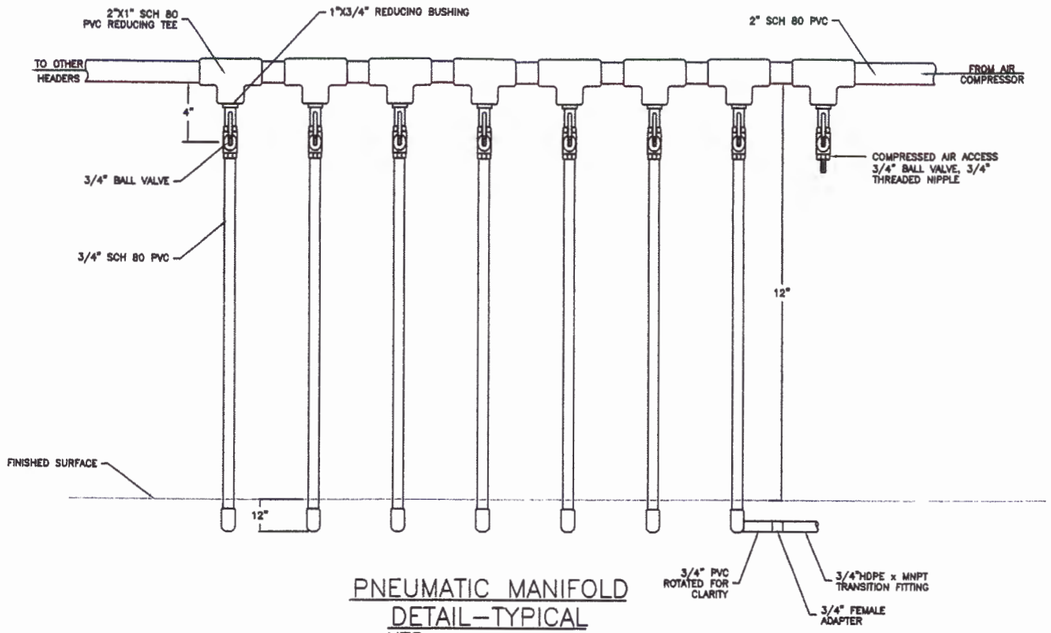
DATE:

ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

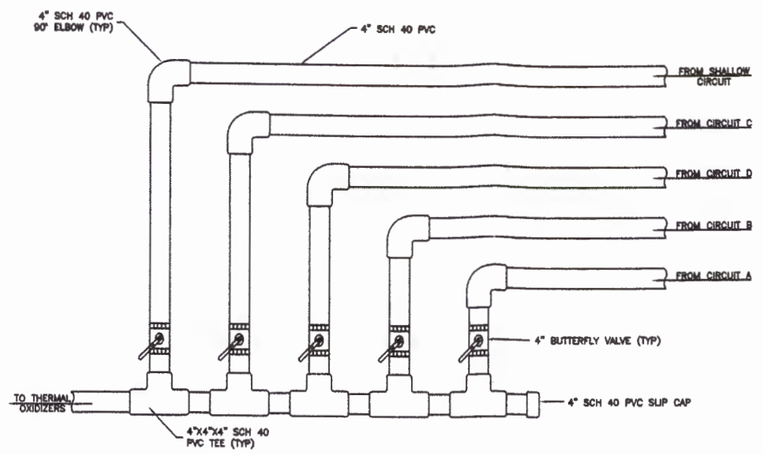
Trenching Details

WORK ASSIGNMENT NO.:
P-202203

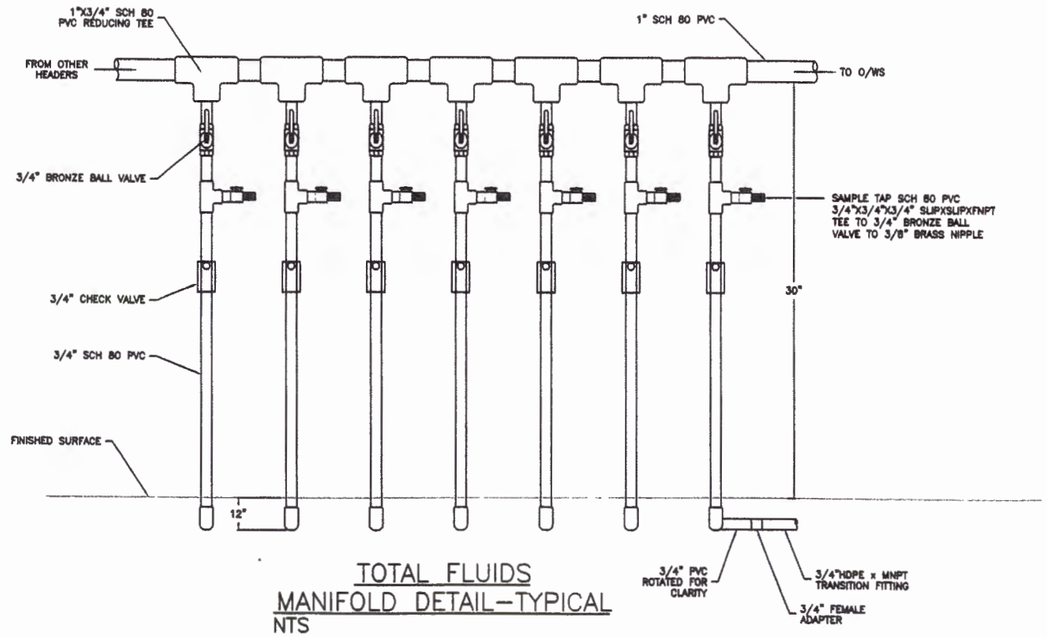
DRAWING NO.:
C-7



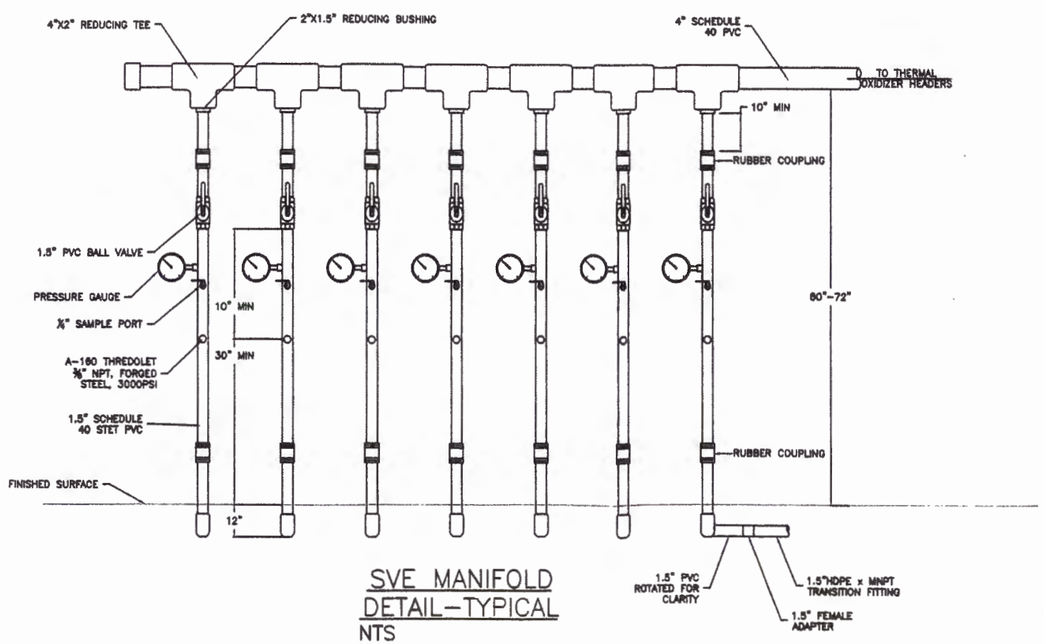
PNEUMATIC MANIFOLD DETAIL–TYPICAL
NTS



THERMAL OXIDIZER MANIFOLD DETAIL–TYPICAL
NTS



TOTAL FLUIDS MANIFOLD DETAIL–TYPICAL
NTS



SVE MANIFOLD DETAIL–TYPICAL
NTS

Tetra Tech EM Inc.

REV.	DATE	DRWN

DESIGNED BY: JS
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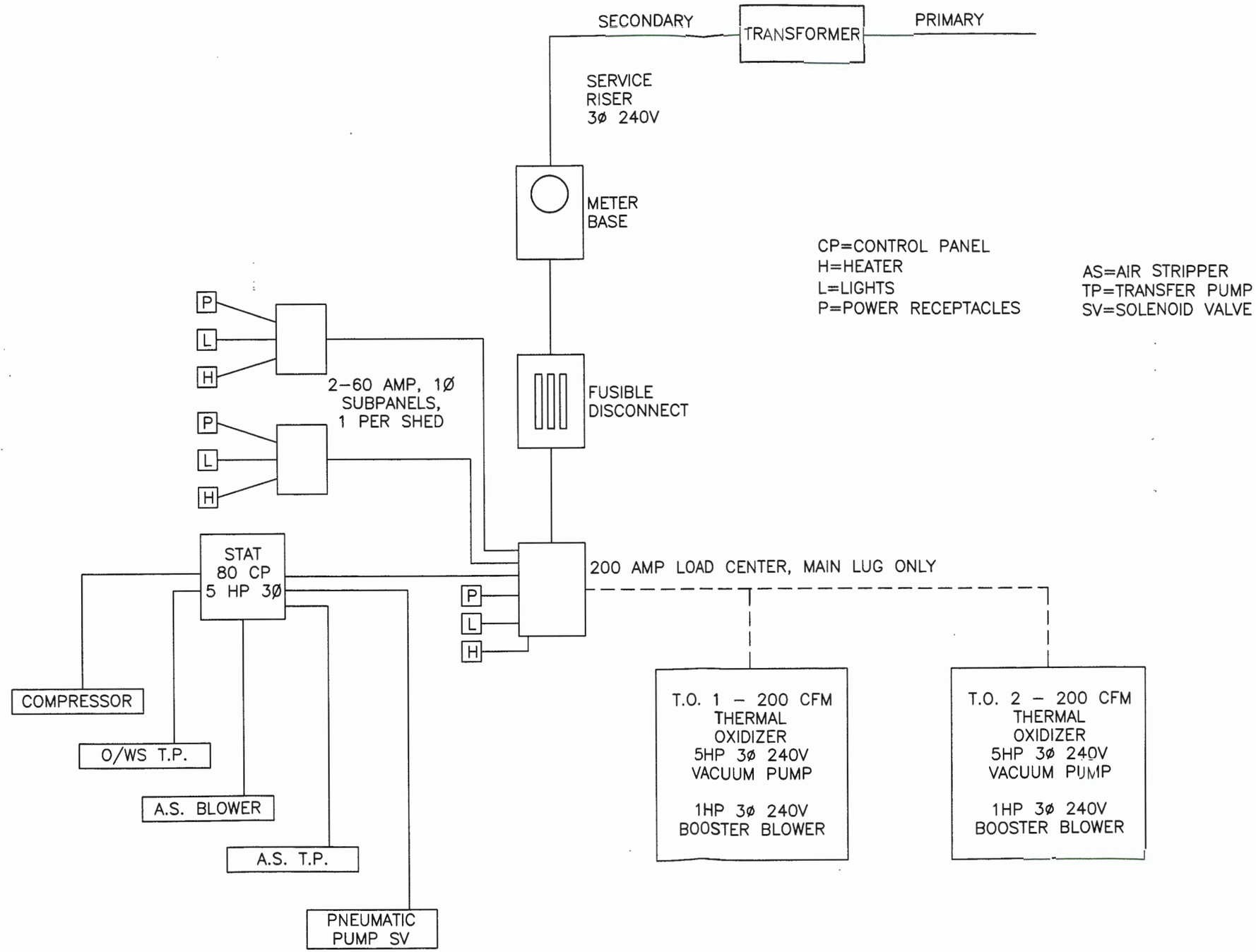
DATE:

ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

MANIFOLD DETAILS

WORK ASSIGNMENT NO.:
P202203

DRAWING NO.:
C–8



ELECTRICAL DETAILS

Tetra Tech EM Inc.

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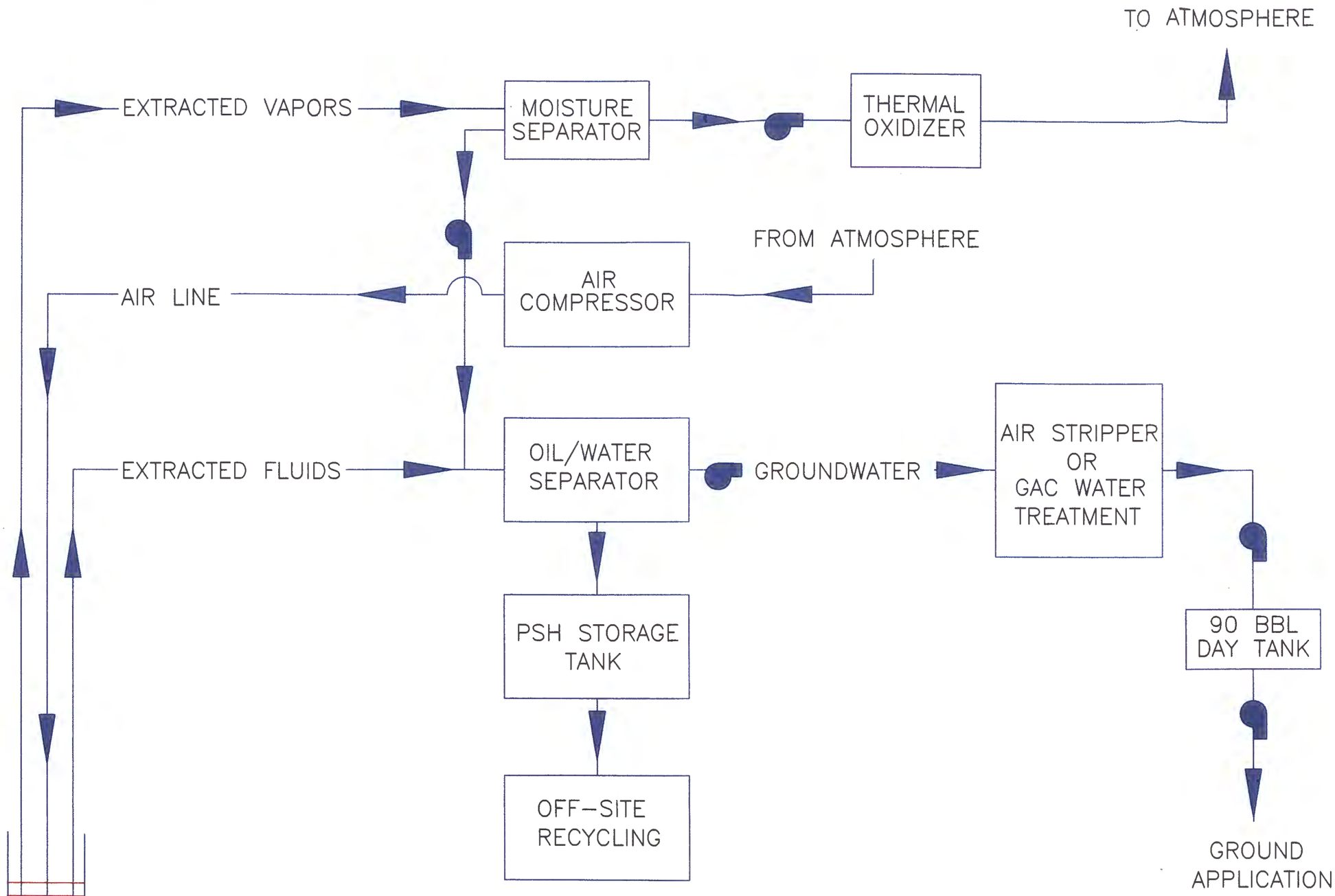
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

ELECTRICAL DETAILS
ONE-LINE DIAGRAM

WORK ASSIGNMENT NO.:
P202203

DRAWING NO.:
E-1



NOTES:

PSH=PHASE SEPARATED HYDROCARBONS
MPE=MULTI PHASE EXTRACTION
GAC=GRANULAR ACTIVATED CARBON
PUMP

REV.	DATE	DRWN	CHKD	REMARKS

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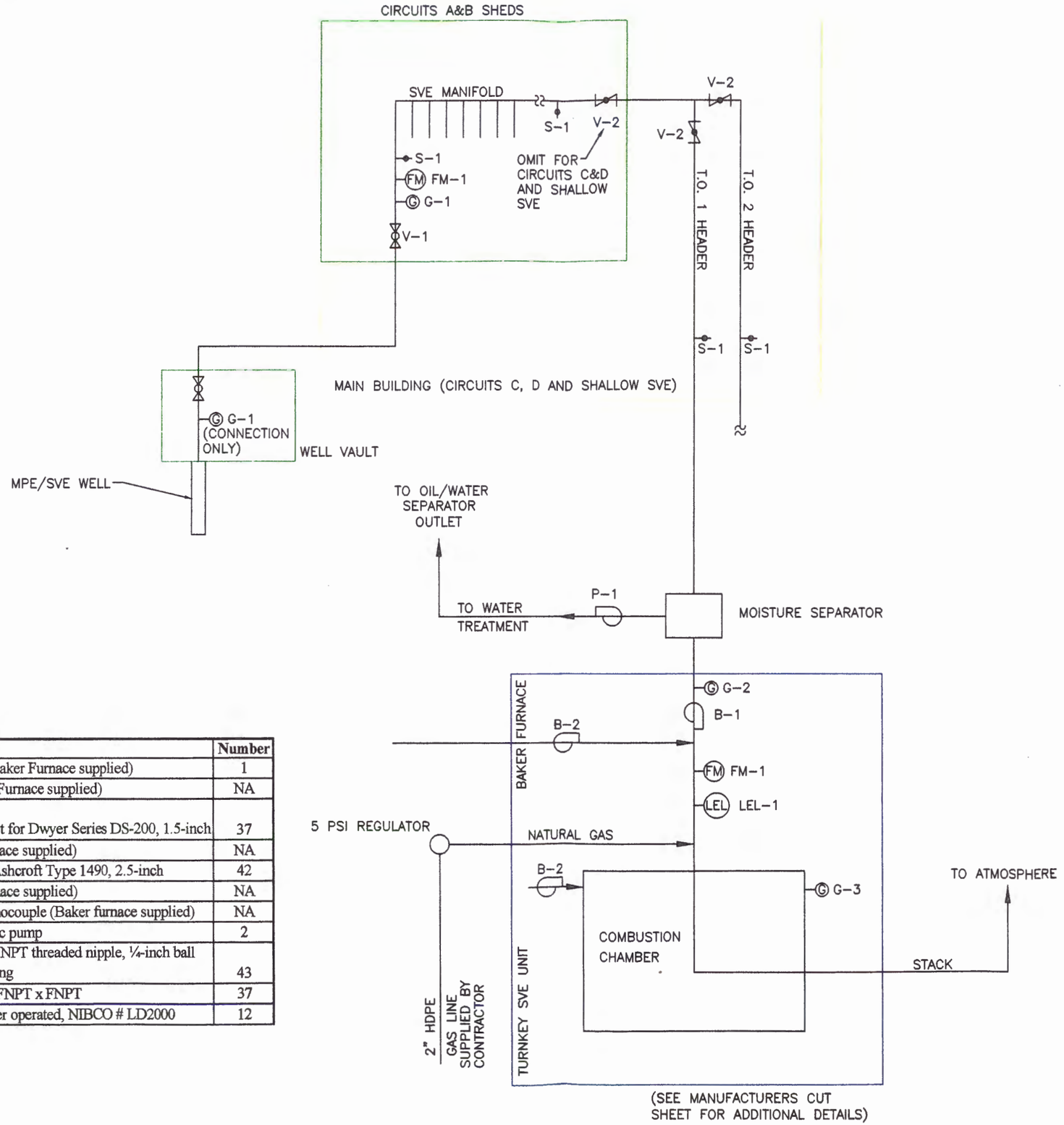
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

PROCESS FLOW DIAGRAM

PROJECT NUMBER
P-202203

DRAWING NO.:
P-1



Symbol	Description	Number
B-1	Blower, SVE extraction, (Baker Furnace supplied)	1
B-2	Dilution air blower (Baker Furnace supplied)	NA
FM-1	Pitot tube access, thred-o-let for Dwyer Series DS-200, 1.5-inch	37
FM-2	Air flow meter (Baker Furnace supplied)	NA
G-1	Diaphram vacuum gauge, Ashcroft Type 1490, 2.5-inch	42
G-2	Vacuum gauge (Baker Furnace supplied)	NA
G-3	Combustion chamber thermocouple (Baker furnace supplied)	NA
P-1	WILDEN oil-less pneumatic pump	2
S-1	Vapor sample tap, brass, ¼ NPT threaded nipple, ¼-inch ball valve, and ¼-hose barb fitting	43
V-1	Ball valve, 1.5-inch, PVC, FNPT x FNPT	37
V-2	Butterfly valve, 4-inch, lever operated, NIBCO # LD2000	12

Tetra Tech EM Inc.

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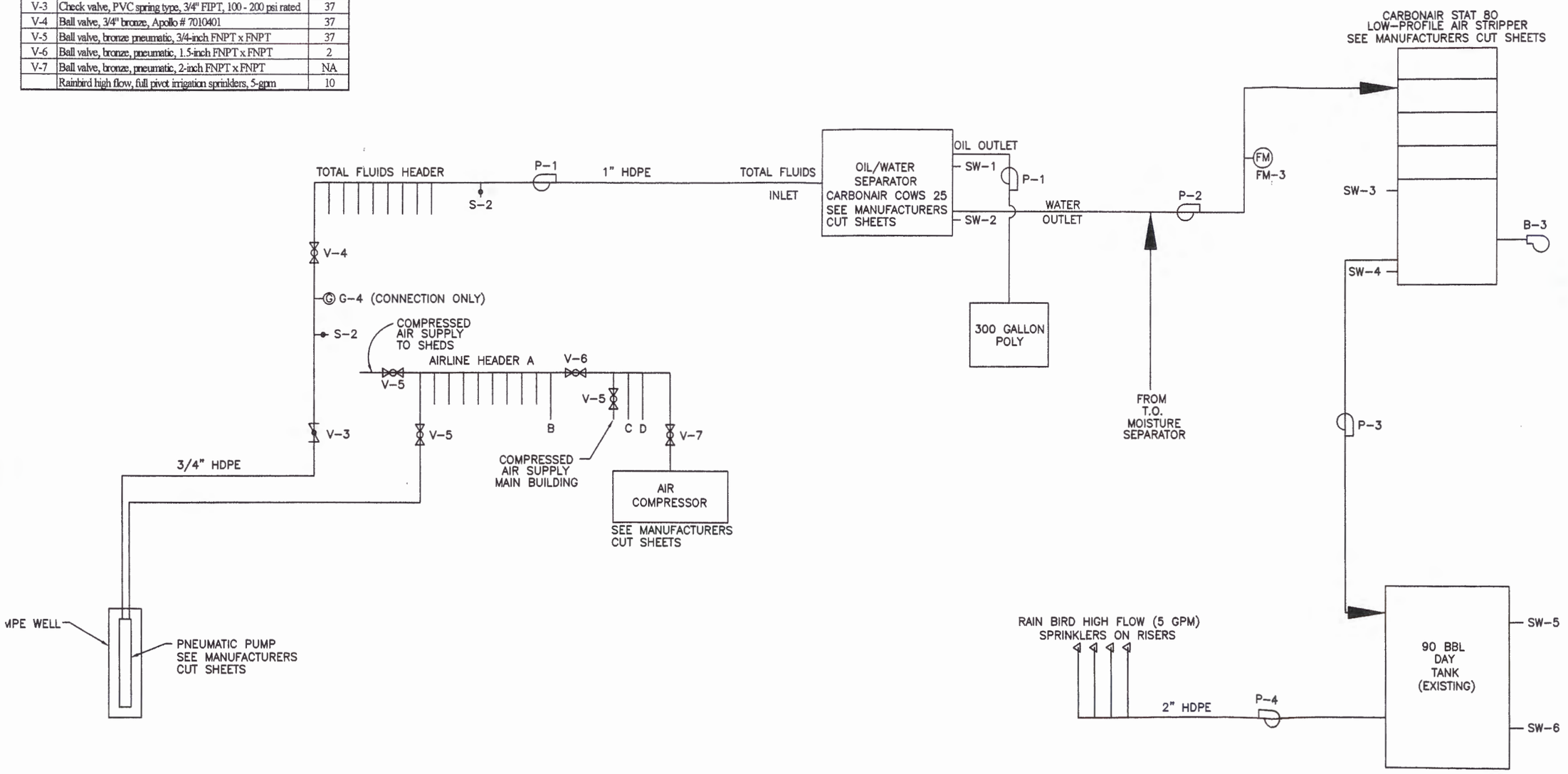
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

SVE SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

WORK ASSIGNMENT NO.: P-202203

DRAWING NO.: P-2

Symbol	Description	Number
B-3	5-HP, 300 cfm 30 TEFC blower (Carbonair supplied)	NA
FM-3	Totalizing flow meter, water , Hayes 1-inch	1
P-1	Wilden oil-less pneumatic pump	1
P-2	Transfer pump, Meyers CT (Carbonair supplied)	NA
P-3	Transfer pump, 1-HP, 230V, 3-0, 20 gpm (Carbonair supplied)	NA
P-4	Irrigation pump, Sta-Rite DHG, 2HP, high head	1
S-2	Sample tap, total fluids line, stainless steel petcock	38
SW-1	High level switch, O/W S, (Carbonair supplied)	NA
SW-2	Low level switch, O/W S, (Carbonair supplied)	NA
SW-3	High level switch, A/S, (Carbonair supplied)	NA
SW-4	Low level switch, A/S, (Carbonair supplied)	NA
SW-5	High level switch, day tank, contractor supplied	1
SW-6	Low level switch, day tank, contractor supplied	1
V-3	Check valve, PVC spring type, 3/4" FIPT, 100 - 200 psi rated	37
V-4	Ball valve, 3/4" bronze, Apollo # 7010401	37
V-5	Ball valve, bronze pneumatic, 3/4-inch FNPT x FNPT	37
V-6	Ball valve, bronze, pneumatic, 1.5-inch FNPT x FNPT	2
V-7	Ball valve, bronze, pneumatic, 2-inch FNPT x FNPT	NA
	Rainbird high flow, full pivot irrigation sprinklers, 5-gpm	10



Tetra Tech EM Inc.

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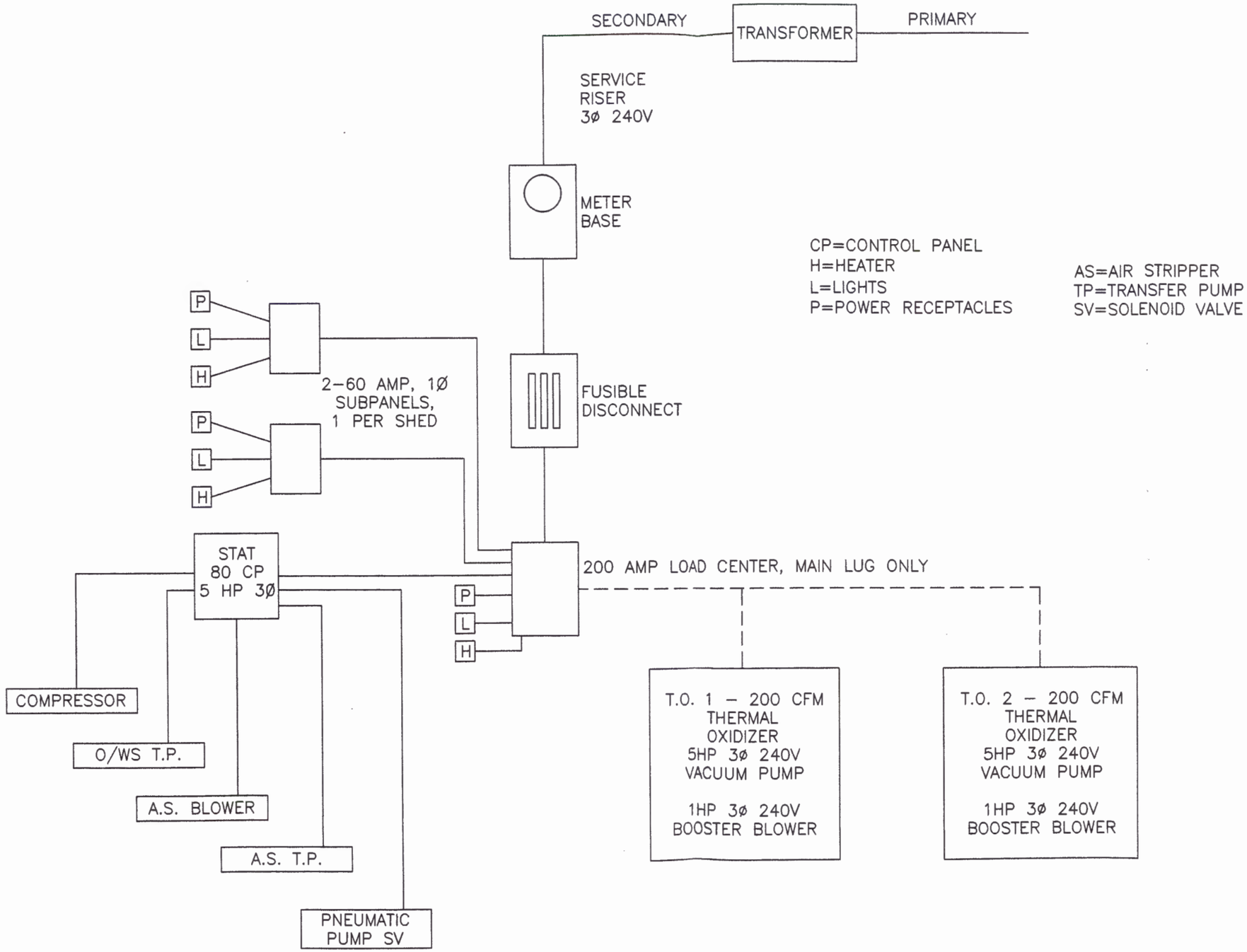
APPROVED BY:
DATE:

ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

TOTAL FLUIDS SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

WORK ASSIGNMENT NO.:
P-202203

DRAWING NO.:
P-3



ELECTRICAL DETAILS

Tetra Tech EM Inc.

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ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

ELECTRICAL DETAILS
ONE-LINE DIAGRAM

WORK ASSIGNMENT NO.:
P202203

DRAWING NO.:
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