ADDENDUM NO. 4
TO THE
BIDDING REQUIREMENTS AND CONTRACT DOCUMENTS
FOR THE
DIV IV DRY WEATHER PUMP STATION AND FORCE MAIN REHABILITAITON

OWNER: **City of Anderson**

ISSUED BY/ENGINEER: Egis Group
8320 Craig Street
Indianapolis, Indiana 46250

ISSUED TO: All Plan and Specifications Holders of Record

ISSUE DATE: July 17, 2025

BID DATE: July 22, 2025

This Addendum No. 4 shall clarify, correct, or change the Bidding Requirements or the proposed Contract Documents. This Addendum is a part of the Bidding Requirements and the proposed Contract Documents and shall govern in the performance of the Work.

PART 1 - PROJECT MANUAL

1.1 ITEM NO. 1 – 00410 EXHIBIT A - BID FORM – REVISED

A. The bid form has been revised to separate the mandatory alternate into two parts: MA1.1 – Cleaning and Televising 30" RCPP Force Main and MA1.2 – Testing 30" RCPP Force Main. The updated bid form is reissued with this addendum.

1.2 ITEM NO. 2 – SECTION 01110 – REVISED

A. The following items must be added to 1.9.A.

4. Any valves to be removed and not repurposed to be protected and returned to Owner.

5. All pumps and motors to be returned to Owner.

B. The following must be revised in item 1.9.A.

2. All electrical and instrumentation cable and **devices** to be removed and not reused or repurposed must be provided to Owner.

1.3 ITEM NO. 3 – SECTION 02821 – ISSUED

A. Section 02821 – Chainlink Fences and Gates has been issued with this addendum.

1.4 ITEM NO. 4 – SECTION 02535 – REVISED

There are five locations where references are being corrected to direct bidders to the correct area within the specification. The corrections are noted below. The specification will be reissued in the conformed set prior to construction.

A. Section 2.2.C is revised as follows:

*When combined with the CIPP tube, the resin system shall provide a CIPP that meets the applicable sub-sections of ASTM F2019, Section 7., the minimum physical properties specified in Section **2.3**.E., and those properties which are to be utilized in the design of the lining system for this project.*

B. Section 2.3.F is revised as follows:

*The required CIPP wall thickness shall be based at a minimum on the physical properties in Section **2.3**.E. above (or greater values if substantiated by third-party testing) and in accordance with ASTM F2019 and the design guidelines in the Appendix X1 of ASTM F2019, with the following design parameter considerations:*

There are no modifications to the table to follows the paragraph.

C. Section 3.8.D. is revised as follows:

For every two thousand five hundred (2,500) lineal feet of liner installed, two samples shall be processed and tested. The CIPP physical properties shall be tested in accordance with ASTM F2019, Section 7 and Appendix X1.2. The flexural properties must meet or exceed the values listed in Section **2.3.**E. of this specification and the values submitted to the Owner by the Installation Contractor for this project's CIPP wall design, while noting the allowances in ASTM F2019, Section 7.3.1.

D. Section 3.8.F. is revised as follows:

Wall thickness of samples shall be determined in a manner consistent with 7.1.3 of ASTM F2019. The minimum wall thickness at any point shall not be less than 80.0% of the specified design thickness calculated in **2.3**.F of this document, or 3.0mm, whichever is greater. The mean wall thickness shall not be less than the specified thickness calculated in **2.3**.F. of this document.

PART 2 – DRAWINGS

2.1 ITEM NO. 1 – NEW AND REISSUED SHEETS - NONE

2.2 ITEM NO. 2 – CLARIFICATIONS

All drawing clarifications that result in a drawing change will be documented on the drawing as part of the conformed drawing set prior to construction.

A. Sheets C100, C101 and C102

The overland bypass piping must be 36" HDPE IPS or greater in diameter or a combination to deliver 22 MGD to the PTF while the overland bypass is in operation.

B. Sheets C103 and C104 – Note Update

There is a leader and note to the 30" RCP forcemain indicating that an alternate bid will be required for lining the 30" forcemain. The lining portion of this note will be stricken in the conformed set. As per the updated bid form, no lining alternate is requested for the 30" forcemain.

C. Sheet E102 – Note 19

There is a typo in the part number as listed. The part number should read "IMLLEDS34NJ5BU". The listed light was used as basis of design. Other manufacturers are listed. Other equals would be consider so long as basis of design is met.

PART 3 – ADDITIONAL TECHNICAL INFORMATION

The following technical information is not part of the Contract Documents, but Bidder is entitled to rely upon this "technical data" as provided in Paragraph 5.02 of the General Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any "technical data" or any other data, interpretations, opinions or information contained in such information.

3.1 ITEM NO. 1 – PUMP BASIS OF BID

A. All bids should be developed utilizing Flygt pumps as the basis of bid. Once awarded, the Engineer and Owner can choose to review any alternates the successful Bidder may wish to propose under the full terms of the contract documents.

3.2 ITEM NO. 2 – PRE-BID MEETING MINUTES AND ATTENDEE LIST

A. The pre-bid meeting minutes and attend list are attached for all bidders use. Questions noted during the meeting are captured and answered as part of this addendum.

3.3 ITEM NO. 3 – QUESTIONS

A. Can water/steam cured reinforced liners be utilized as an alternate for bidding?

Response: Bids should be produced based on the basis of design of the UV cured reinforced liner. After bidding, the Engineer and Owner will review alternates that may result in a deduction to the project cost per the contract documents.

B. What is the test procedure for the 36" forcemain after CIPP: hold time; allowable leakage or PSI drop; etc?

Response: The 36" forcemain should be tested per 02545 Section 3.9 following lining.

C. Are there as-built drawings available of the 36" forcemain? Are the existing 90s actually 90s or two 45s?

Response: The Owner has made available the only drawings they have for the 36" forcemain. The plans indicate 5 horizontal elbows (4-90s and 1-45). There appears to be 2 vertical deflections shown in the profile view. Please see attached and make note the sections of the General Conditions concerning use/accuracy of historic drawings.

D. Spec 02533 Part 3.1D and Part 3.3I require GPS data capture in conjunction with sewer televising. What is the intent of this requirement and is it acceptable to capture GPS readings above ground versus a nozzle-mounted GPS unit?

Response: The specification requires the use of survey grade GPS units to capture field data of critical infrastructure that the Owner may not possess. The specification also requires the data to be delivered to the Owner in a manner to import or utilize the data in the GIS system if the Owner has one. The specification is written under the basis the readings with be captured above ground or while fittings or pipe is exposed in an open access pit.

E. Does Anderson have a preferred dump/dewatering pad location at their plant for sewer cleaning debris, or should Bidders include the cost for offsite transport and disposal?

Response: There are locations available. Specific location will be determined during construction. At this time offsite transport and disposal does not need to be calculated into bids.

F. The Owner is providing water for sewer cleaning and CIPP operations. Is that water complimentary or metered for purchase, and if the latter, what usage fees apply?

Response: Water will be made available metered at the same rate that wastewater pays. For the purpose of the bid assume $4 per 1,000 gallons.

G. Please verify part / catalog number Appleton Mercmaster LED IMLLEDS34NJSBLI. that the engineer has requested. It is on page E102 on the prints.

Response:. There is a typo in the part number as listed. The part number should read "IMLLEDS34NJ5BU". Please see 2.1 above.

H. Can the owner/ client confirm how many access pits are anticipated for the CIPP work on the force main?

Response: Ultimately, the number of access pits should be determined by the CIPP installer, we assumed up to 8 may be required.

I. Can the owner/ client provide the sign-in sheet for the mandatory pre-bid conducted on 7/15/25?

Response: See attached.

J. With the pre-bid being pushed a week, would the owner/client be open to pushing the bid date 7 days to allow contractors time to coordinate with potential subs based on who attended the pre-bid meeting?

Response: This unfortunately cannot be accommodated.

K. Section 02410 calls out specifications for HDD work. Can the owner/client identify where this work is needed on the this contract?

Response: This specification was included in the technical manual in case the successful bidder would like to use trenchless installation for the limited watermain included on the project.

L. For bidding purposes can the owner/client define if the CIPP liner needs to be designed as fully or partially deteriorated?

Response: For the purpose of developing the bid, bidders should assume a fully deteriorated condition. However, per specification 02535, the Owner will make the final determination after the pre-lining cleaning and televising has been completed. Please also see attached a copy of a previously completed SmartBall inspection report on the 36" forcemain.

M. Can potential prime contractors use subcontractors that did not attend the mandatory pre-bid meeting?

Response: Subcontractors did not need to attend the pre-bid meeting. Only prime contractors were required to attend the pre-bid meeting.

N. Do the pumps and valves need to comply with BABA requirements?

Response: Based on funding, this project does not need to meet BABA requirements.

O. Is it the intent to leave the bypass tap(s) as a permanent fixture or can we do this a temporary bypass taps?

Response: The intent is to leave a permanent bypass connection point per to the 30" forcemain as shown on sheet C103.

P. Does the Owner need SCADA CAD design/development as a part of the Bid?

Response: No.

Q. Is clean water required for the pump test, or can influent wastewater be used by opening the gate at the existing screen structure?

Response: Influent wastewater is acceptable.

R. During the pre-bid, other piping was noticed that could require heat trace. Will we only be providing heat trace for what's specified in the drawings?

Response: Once the dry weather pumps are replaced, the only exposed water piping should be the newly installed seal water piping to the existing wet weather pumps. Only the newly installed seal water piping will receive freeze protection.

S. Who will be providing the I&C?

Response: The Owner will supply all I&C components. The Owner will build all panels, excluding the MAS panel supplied by the pump manufacturer. The Owner will provide all integration to their system. The Contractor will need to hardwire all panels.

T. Since the wet weather pumps were designed to pump to a building on site, will they have enough head pressure to pump to a building 4000' away. We anticipate an additional 80' of TDH due to friction loss. We will ask the design flow and specs for the existing pumps we are to use for bypassing. Since the owner is providing bypass pumps, who will be responsible in the event of a spill or backup?

Response: The existing wet weather pumps were originally designed for a future scenario to pump up to 20 MGD to the top of the existing biotowers at the Gene Gustin facility. They are currently performing a long-term temporary use pumping to the primary tanks at the Dewey Street facility. Pump curve and design specifications have been made available with this addendum. In the event of a spill or backup, it is ultimately the Contractor's responsibility to work with the Owner to ensure that daily operations remain unimpeded.

U. Are sizes and duty points for the existing wet weather pumps clarified in the specs?

Response: Sizes and duty points of the existing wet weather pumps may not be in the cur-

rent project manual. Information for the pumps from construction has been made available with this addendum.

V. Does this project need any back-up equipment, such as pumps?

Response: At this time, no backup equipment is anticipated.

W. Has the existing 30" main been pressure tested? If so, when?

Response: The existing 30" main was tested several years ago but not recently. There is a bid alternative for cleaning and televising the existing 30" main if necessary.

X. Clarify that the new connection is from an abandoned line and is to be reused.

Response: Please see the Constrained Activity No. 1 in Section 00140. The new connection will stub up above ground and allow the 30" wet weather force main to connect to either the existing 36" dry weather force main or the existing 30" concrete force main.

Y. How much flexibility is there for the lining's installation time?

Response: If communicated in advance, Anderson is willing to extend working hours if doing so will help facilitate the CIPP lining process.

Z. How much shift time / install time is allowed?

Response: This is part of the same question as Y above. See the response above.

AA. How long can work extend beyond normal hours.

Response: This is part of the same question as Y above. See the response above.

BB. What is the lead time for the pumps?

Response: 3 to 4 weeks for submittals and 20 to 25 weeks for delivery.

CC. Is there an engineers' estimate for this project?

Response: For bonding purposes, please use an approximate estimate of $5.5 to $6.2M.

DD. Are there any winter restrictions with running the bypass during cold weather?

Response: No, ambient temperatures of raw wastewater should allow for bypass pumping during cold weather.

EE. Clarify that there are no structural issues; the CIPP is just to increase the coefficient of the pipe.

Response: Correct, the CIPP system is to improve roughness of pipe and pumping system capacity. The main was inspected by Smart Ball several years ago, and no major structural defects were detected at that time.

FF. Are there any spare parts?

Response: One spare parts kit for the pumps should be included in the deliverables to the Owner. This should include, at a minimum, seals, bearings, and o-rings.

GG. Are there any worries about shutdowns?

Response: The scenario of using the wet weather pumps through the existing 30" concrete pipe was hydraulicly modeled and this system was found to be adequate for use while the 36" force main is and/or the dry weather pumps are offline.

HH. Is this project part of the LTCP?

Response: Yes, federal funds are not used, but the EPA is monitoring the implementation schedule of this project as part of Anderson's LTCP.

II. Are the proposed pipe connections between the wet weather force main and the existing 36" main and existing 30" main buried?

Response: No, these stubs will be above grade and allow for temporary overland bypass piping.

JJ. Can any soils be left on site?

Response: Yes, soil can be left on site if coordinated with Anderson. Concrete needs to be hauled offsite and disposed.

KK. Is dewatering included?

The contractor should include dewatering incidental to other pay items. Anderson will allow dewatering and sewer debris to be disposed of on site.

LL. Is the last section of the 30" temporary piping over land?

Yes, a connection will need to be installed at the intersection of 6th Street and Gene Gustin Way. From that point, a temporary 30" pipe will be routed overland west to the nose of the Preliminary Treatment Facility. Anderson expressed interest in routing the overland pipe around the west side of this building rather than around the east side as currently shown on the plans.

MM. At the top of Preliminary Treatment Facility

a. Is the contractor responsible for doing anything to the roof? thin membrane/coating new?

   Response: No improvements or modifications are anticipated or required at this time to the roof of the PTF.

b. What is the overland pipe size?

   Response: During design, engineer modeled 30" and 36" HDPE for the above ground section. Contractor and/or their sub should propose what they feel is required to deliver 22 MGD utilizing the existing wet weather pumps and proposed connection plan.

c. What is the DR of the overland pipe? Is there a specific pressure rating?

   Response: DR 21 100 PSI was modeled

d. Can the pipe be anchored to the existing concrete structure?

   Response: Yes, but all penetrations must be repaired with non-shrink grout.

NN. What is the access to the central office, will it need to be cut off if needed?

Response: Access to Anderson Municipal Lights and Power Field Services and Anderson Water (also identified as Central Services) is off 8th Street with an entrance between Dale Keith Jones Road and Gene Gustin Way. See below.

There are existing chain link fences that will need to cut and repaired or sections removed and replaced to allow for the temporary bypass piping enter the site. Bypass piping cannot rest directly on the fence. The Owner would also like the overland bypass to route on the northwest side of the PTF between the PTF and the anoxic/anerobic tanks. Sheet C100 will be updated accordingly as noted above as part of the conformed set. Please see enlarged view on page 10 for reference.

OO. Does Anderson have concerns about running equipment across the overland route of the temporary bypass?

Response: No, as long as daily activities are communicated.

PP. Is there on-site storage?

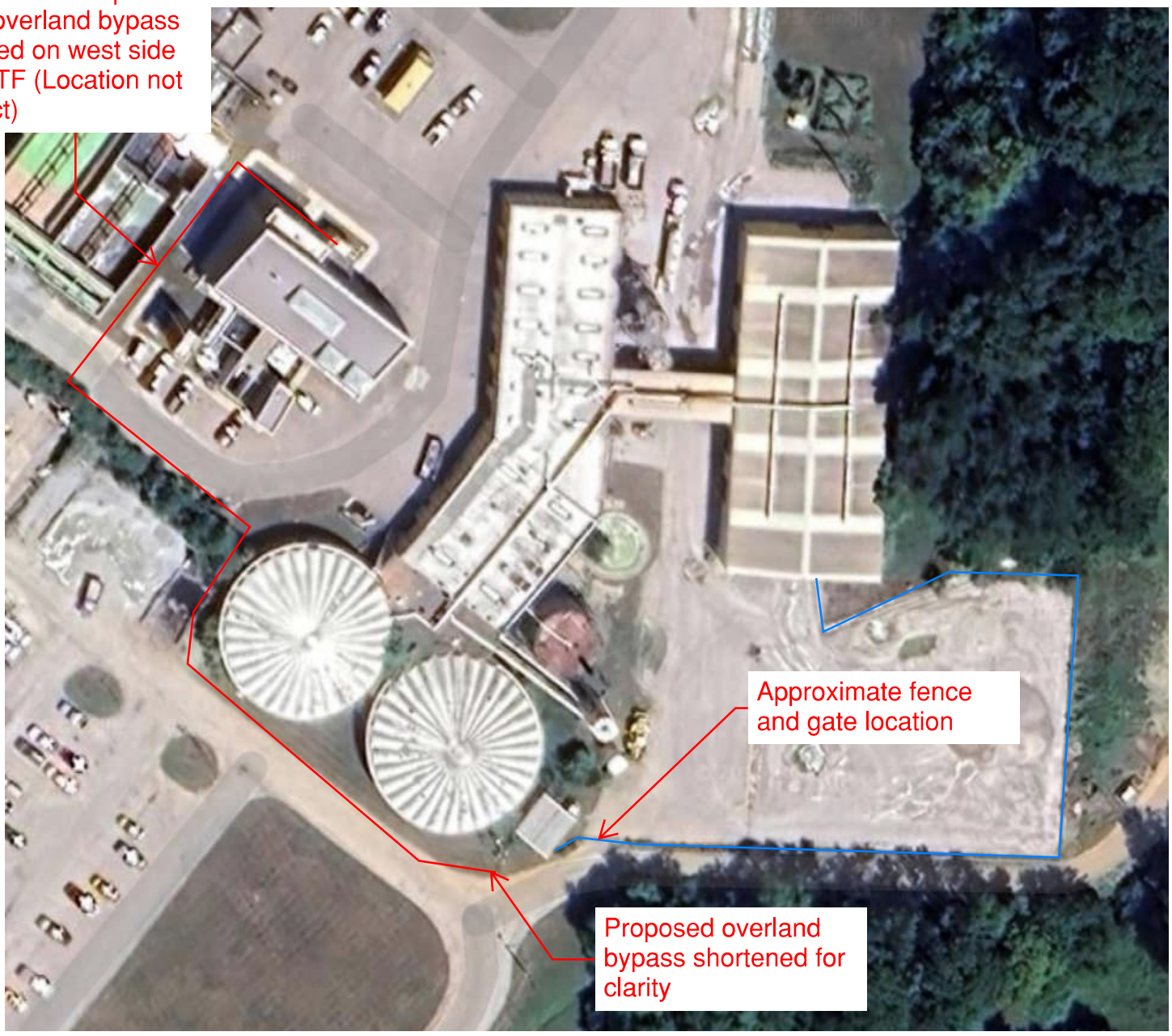
Response: Anderson is willing to accommodate reasonable equipment and material staging if doing so helps expedite the project.

QQ. Is the monorail crane structure galvanized or painted steel?

Response: Galvanized.

Encls.: 00410A – Revised Bid Form Exhibit A
02821 – Chainlink Fences and Gates
Pre-bid Meeting Minutes and Sign in Sheet
1974 and 2012 36" Forcemain Plans
36" Forcemain Smartball Report
Wet Weather Pump Curve and O&M Manual

Owner has requested the overland bypass placed on west side of PTF (Location not exact)



BID FORM ATTACHMENT A - BID PRICES
OWNER: City of Anderson
PROJECT: Div IV Dry Weather Pump Station and Force Main Rehab

	Estimated Quantity	Unit Type	Unit Price	Estimated Price
Bidder will complete the Work for the following Unit price(s):				
Administrative				
1 Mobilization/Demobilization *(not to exceed 5% of base bid)*	1	LS		
2 Field Offices	21	Mo		
3 Dry Weather Pump Station and 36" Force Main Bypass	1	LS		
4 Wet Weather Bypass Pumping	1	LS		
5 Erosion Control	1	LS		
6 Structure Backfill				
6.01 Over Sewer Force Mains and Laterals	600	LF		
7 Flowable Backfill				
7.01 Flowable Backfill	200	LF		
Water Systems				
8 Water Main Connections				
8.01 2" Hot Tap Service Connection	1	EA		
9 Water Services				
9.01 2-inch Water Service	100	LF		
Sewer Rehabilitation				
10 CIPP Lining				
10.01 36-inch Forcemain	3,125	LF		
Lift Stations and Force Mains				
11 Lift Stations				
11.01 Lift Station Structural: Slab Replacement and Hatches	1	LS		
11.02 Lift Station Piping	1	LS		
11.03 Lift Station Submersible Pumps, Slide Rails, Startup	1	LS		
11.04 Lift Station Electrical	1	LS		
11.05 Lift Station Instrumentation and Control	1	LS		
11.06 Wet Weather Pump Station Heat Trace/Insulation (No Building)	1	LS		
11.07 Demo of Existing Dry Weather Pump Station	1	LS		
11.08 Dry Weather Pump Station Wet Well/Valve Vault Penetration	4	EA		
11.09 Monorail Crane	1	LS		
11.10 Relocate Light Pole	1	LS		
12 Sewer Force Main Connections				
12.01 30" "Dry" Tap Force Main Connection	2	EA		
12.02 36" "Dry" Tap Force Main Connection	2	EA		
13 Force Main Plug Valves				
13.01 30" Plug Valve	2	EA		
13.02 36" Plug Valve	2	EA		
Bases and Pavements				
14 Pavements				
14.01 Asphalt Pavement Repair	200	SY		
15 Sidewalks				
15.01 Concrete Sidewalk and Ramp Repairs	60	SY		
Lawns and Grasses				
16 Lawns and Grasses				
16.01 Seeding	1,250	SY		

Total Unit Price Base Bid Amount, inclusive of all Pay Items:

_____ $ _____
(words) *(numerals)*

Mandatory Alternate #1.1: Clean and Televise 30" RCP Force Main	1,350	LF		
Mandatory Alternate #1.2: Test 30" RCP Force Main	1,350	LF		

Bidder: _____ Date:

By: _____
(Signature of Bid Form Signatory)

Name (typed or printed): _____

SECTION 02821
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Chain-Link Fences: Industrial.

2. Gates:

   a. Swing.
   b. Motor-operated horizontal sliding.

3. Fence-mounted panel signs.

B. Related Sections include the following:

1. Section 02300 - Earthwork for site excavation, fill, and backfill where chain-link fences and gates are located.

2. Section 03300 - Cast-in-Place Concrete for post concrete fill and equipment bases/pads for gate operators and controls.

3. Section 13720 – Intrusion Detection Systems for proximity reader requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide chain-link fences and gates capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Minimum Post Size and Maximum Spacing for Wind Velocity Pressure: Determine based on mesh size and pattern specified, and on the following minimum design wind pressures and according to CLFMI WLG 2445:

   a. Wind Speed: 100 mph.
   b. Fence Height: as indicated on Drawings.
   c. Line Post Group: ASTM F1043 or Schedule 40 steel pipe.
   d. Wind Exposure Category: B.

2. Determine minimum post size, group, and section according to ASTM F1043 for framework up to 12 feet high and post spacing not to exceed 10 feet.

B. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.3 SUBMITTALS

A. Action Submittals

1. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
    a. Fence and gate posts, rails, and fittings.
    b. Chain-link fabric, reinforcements, and attachments.
    c. Structural analysis data.
    d. Gates and hardware.
    e. Accessories: Barbed wire
    f. Gate operators, including operating instructions.
    g. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
    h. Manufacturer's color charts or 6-inch lengths of actual units showing the full range of colors available for components with factory-applied color finishes.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
    a. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
    b. Wiring Diagrams: For power, signal, and control wiring.

B. Informational Submittals

1. Product Certificates.
2. Strength test results for framing according to ASTM F1043.
3. Qualification Data.
    a. Fence installer.
    b. Fence testing agency.
4. Material Certificates.
5. Schedule of Tests and Inspections.
    a. Fence grounding test.
6. Field Test Reports.
    a. Fence grounding test.

7. Design Data.

8. Manufacturers Installation and Maintenance Data.

C. Project Record Documents

1. Product Data.

2. Field Test Reports.

3. Operation and Maintenance Data.

4. Record Drawings.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.6 SPECIAL WARRANTY

A. Special Warranty: Manufacturer's standard form in which [manufacturer] [Installer] agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Faulty operation of gate operators and controls.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. All fence post and fence fabric sizes are intended to be nominal.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Height indicated on Drawings. Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with ASTM A392, CLFMI CLF 2445, and requirements indicated below:

1. Steel Wire Fabric: 9 Gauge Metallic coated wire.
    a. Mesh Size: 2 inches.
    b. Weight of Metallic (Zinc) Coating: ASTM A392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied after weaving.
    c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

B. Selvage: Knuckled top and bottom.

2.3 FENCE FRAMING

A. General: Comply with ASTM F1043, Heavy Industrial Fence for framing and the following:

1. Group IA round steel pipe, Schedule 40.
2. Type A external and internal coatings.

B. Height: As indicated on the Drawings.

C. Fence Frame Size

1. Top Rail: 1-5/8 inches.
2. Line Post: 2-3/8 inches.
3. End, Corner, or Pull Post: 2-7/8 inches.

D. Gate Post Sizes

1. Swing Gate Post: In accordance with ASTM F900.
2. Horizontal-Slide Gate Post: In accordance with ASTM F1184.

2.4 TENSION WIRE

A. General: Provide horizontal tension wire at the following locations:

1. Bottom of fence fabric.

B. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire complying with ASTM A817, ASTM A824, and the following:

1. Metallic Coating: Type II, zinc coated (galvanized) by hot-dip process matching chain-link fabric coating weight.

2.5 SWING GATES

A. General: Comply with ASTM F900.

1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.

B. Frames and Bracing: Fabricate members from galvanized steel tubing with outside dimension and weight according to ASTM F900.

1. Gate Fabric Height: 2 inches less than adjacent fence height.

2. Leaf Width: As indicated.

3. Frame Members:

a. Tubular Steel: 1.90 inches round.

C. Frame Corner Construction:

1. Welded

2. Adjustable truss rods 3/8-inch-diameter for panels 5 feet wide or wider.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame as required to attach barbed wire assemblies.

E. Hardware: Locking devices, hangers, and stops fabricated from galvanized steel. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

1. Furnish mated locks and five sets of keys for Owner.

2.6 HORIZONTAL SLIDE GATES

A. General: Comply with ASTM F1184 for gate posts and single sliding gate types. Provide automated vehicular gates that comply with ASTM F 2200.

1. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.
    a. Gate Frame Width and Height: As indicated.

B. Pipe and Tubing:
    1. Zinc-Coated Steel: Protective coating and finish to match fence framing.
    2. Gate Posts: Comply with ASTM F 1184. Provide round tubular steel posts.
    3. Gate Frames and Bracing: Round tubular steel.

C. Frame Construction: Welded.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches as required to attach barbed wire assemblies.

E. Hardware
    1. Hangers, roller assemblies, and stops fabricated from galvanized steel. Provide safety guards on all roller assemblies.

2.7 FITTINGS

A. General: Comply with ASTM F626.

B. Post and Line Caps: Provide for each post.
    1. Line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: Attach rails securely to each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:
    1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
    2. Rail Clamps: Line and corner boulevard clamps for connecting rails in the fence line-to-line posts.

E. Tension and Brace Bands: Pressed steel or Aluminum Alloy 6063.

F. Tension Bars: Steel or aluminum, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: Hot-Dip Galvanized pressed steel, with clips, slots, or other means for attaching strands of barbed wire, integral with post cap for each post, unless otherwise indicated.

I. Tie Wires, Clips, and Fasteners: According to ASTM F626.

J. Finish:

1. Metallic Coating for Pressed Steel: Not less than 1.2 oz. /sq. ft. zinc.

2. Aluminum: Mill finish.

2.8 BARBED WIRE

A. Zinc-Coated Steel Barbed Wire: Comply with ASTM A121, Chain-Link Fence grade for the following three-stranded barbed wire:

1. Standard Size and Construction: 0.099-inch-diameter line wire with 0.080-inch- diameter, 4-point round barbs spaced not more than 4 inches o.c.

2.9 GATE OPERATORS

A. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.

2. Provide operator with UL approval.

3. Provide electronic components with built-in troubleshooting diagnostic feature.

4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.

B. Comply with NFPA 70.

C. UL Standard: Fabricate and label gate operators to comply with UL 325, Class III.

D. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

1. Voltage: 120 V.

2. Horsepower: 1/2 minimum.

3. Enclosure: Open dripproof.

4. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

5. Service Factor: 1.15 for open dripproof motors motors.

6. Phase: One.

E. Gate Operators: Concrete equipment base/pad mounted and as follows:

1. Mechanical Slide Gate Operators:

   a. Duty: Heavy duty, commercial/industrial.
   b. Gate Speed: Minimum 60 feet per minute.
   c. Frequency of Use: 10 cycles per hour.
   d. Operating Type: Roller chain, with manual release.
   e. Drive Type: Enclosed worm gear and chain-and-sprocket reducers, roller-chain drive.

F. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 enclosure for pedestal mounting and with space for additional optional equipment. Provide the following remote-control device(s):

1. Proximity Card Reader: Functions only when authorized card is presented. Programmable, magnetic multiple-code system; face-lighted unit fully visible at night.

   a. Reader Type: Proximity.
   b. Features: Capable of monitoring and auditing gate activity.
   c. Match card requirements with intrusion detection system so that the same card operates gate and intrusion detection system.

2. Telephone Entry System: Hands-free voice-communication system for connection to building telephone system with digital-entry code activation of gate operator and auxiliary keypad entry.

   a. Residential System: Designed to be wired to same line with telephone.
   b. Auxiliary Keypad: Multiple programmable code capability of not less than five possible individual codes, consisting of one- to seven-digit codes.

1) Features: Capable of monitoring and auditing gate activity.
2) Face-lighted unit with keyless-membrane keypad fully visible at night.

3. Vehicle Loop Detector: System including automatic closing timer with adjustable time delay before closing and loop detector designed to open gate upon the approach of a vehicle from inside the Site. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement as recommended in writing by detection system manufacturer for function indicated.

   a. Loop: Wire, factory pre-formed or indicated for field assembly , for pave-over installation.

G. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.

2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.

3. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

H. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

1. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge.

I. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.

2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.

3. Automatic Closing Timer: With adjustable time delay before closing.

4. Open Override Circuit: Designed to override closing commands.

5. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.

6. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.

J. Accessories:

1. Warning Module: Audio sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

2. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.

a. Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.

3. Postal box.

4. Instructional, Safety, and Warning Labels and Signs: Manufacturer's standard for components and features specified.

K. Equipment Bases/Pads: Cast-in-place or precast concrete, depth not less than sixty-inches (60”), dimensioned and reinforced according to gate-operator component manufacturer's written instructions.

L. Control Pedestal: Architectural, in-ground style pedestal with 4” X 4” post and large 11” X 13” faceplate to accommodate telephone systems. Black wrinkle powder coat finish. Insert the bottom 22” or more into the ground/cement to end up with a 42” or higher mount.

2.10 CAST-IN-PLACE CONCRETE

A. Class “B” concrete.

2.11 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure

without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

2.12 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Aluminum.

2. Material on or below Finished Grade: Copper.

3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.

2. Grounding Rods: Copper-clad steel.

a. Size: 5/8 by 96 inches.

2.13 PANEL SIGNS

A. Exterior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:

1. Material

a. Aluminum Sheet: 0.050 inch thick.
b. Acrylic Sheet: 0.060 inch thick.

2. Edge Condition: Square cut.

3. Corner Condition: Rounded.

4. Frames: Unframed.

5. Fence-fabric mounted.

6. Manufacturer's standard non-corroding, non-removable mechanical aluminum fasteners for fence fabric.

B. Panel Sign Schedule.

1. Fiberglass Hazard, Warning, and Notice Signs

a. Stop
1) Size: 18” x 18” octagon

2) Material: Aluminum.
3) Color: Red with White Text and White Border

b. Warning - Authorized Personnel Only
1) Size: 10” H x 14” W
2) Material: Aluminum.
3) Color: Orange with Black Text or combination of Red with White Text and White with Black Text

c. No Trespassing – Violators Will Be Prosecuted
1) Size: 10” H x 14” W
2) Material: Aluminum.
3) Color: Red with White Text (“No Trespassing”) and White with Black Text (“Violators Will Be Prosecuted”)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by Engineer.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

2. Maintain temporary fence to secure site to Engineer’s satisfaction during fence installation.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment.

D. Line Posts: Space line posts uniformly at 10 feet o.c. maximum.

E. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fencing. Install braces at end posts, gate posts, and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 6 feet or higher, on fences with top rail and at 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.

1. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

G. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Chain-Link Fabric: Apply fabric to outside of enclosing framework unless otherwise indicated. Leave 1 inch between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and

tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at 1 end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach both ends to chain-link fabric per ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to top rails and line posts at 12 inches o.c. and to braces at 24 inches o.c.

K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

L. Barbed Wire: Install barbed wire uniformly spaced as indicated on Drawings. Pull wire taut and install securely to extension arms and secure to end post or terminal arms.

3.5 PANEL SIGN INSTALLATION

A. Mechanical fasteners shall be placed through predrilled holes.

B. Flush-mount signs. Generally, mount signs with top at 5’ above finished grade.

C. Panel Sign Location Schedule.

1. Stop
    a. Location: Mounted flush on fence fabric in the middle of horizontal sliding entrance gate, either side. Mount in manner to prevent binding as gate opens and closes.
2. Warning - Authorized Personnel Only
    a. Location: Mounted facing outward on fence fabric adjacent to all swing and sliding entrance gates.
3. No Trespassing – Violators Will Be Prosecuted
    a. Location: Mounted facing outward on fence fabric. Every 200’ on straight runs, minimum one each straight run. Space evenly.

3.6 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing.

Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.7 GATE OPERATOR INSTALLATION

A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation for Support Posts, Pedestals, and Equipment Bases/Pads: Hand-excavate holes for bases/pads, in firm, undisturbed soil to dimensions and depths and at locations as required by gate-operator component manufacturer's written instructions and as indicated.

C. Vehicle Loop Detector System: Bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

D. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.8 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:

1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
    a. Gates and Other Fence Openings: Ground fence on each side of opening.
        1) Bond metal gates to gate posts.
        2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2, unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:

1. Each Barbed Wire Strand. Make grounding connections to barbed wire with wire-to-wire connectors designed for this purpose.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.9 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: Engage a qualified independent testing and inspecting agency to perform field quality-control testing.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.

2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Engineer promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.

3.10 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, and limit switches.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Test and adjust controls, alarms, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lubricate hardware, gate, and other moving parts.

END OF SECTION 02821

IMAGINE. CREATE. ACHIEVE.
a sustainable future

Pre-Bid Meeting Minutes
City Of Anderson Water Pollution Control
Dry Weather Pump Station and Forcemain Rehabilitation Project
July 15, 2025

Meeting Location: **Dewey Street Wastewater Treatment Plant, 2104 W 8th Street, Anderson, IN 46016**
Time: **9:00 AM, LOCAL TIME**

1. SIGN ATTENDANCE SHEET (SEE ATTACHED)

2. INTRODUCTION OF RESPONSIBLE PERSONNEL

2.1 City of Anderson Water Pollution Control

A. Ryan Paschal, Superintendent
   i. Phone:
   ii. Email: rpaschal@cityofanderson.com

B. Chip Broderick, Head of Maintenance

2.2 Egis BLN USA, Inc.

A. Renee Goff, P.E. and Pete Wamsley, P.E.
   i. Phone: 317-806-4341 and 317-806-6021
   ii. Email: renee.goff@egis-group.com and pete.wamsley@egis-group.com

3. PROJECT SCOPE

3.1 Dry Weather Pump Station and Force Main Rehabilitation

A. CIPP lining approximately 3,600 linear feet of 36" ductile iron force main.
B. Installation of 3 new submersible dry weather pumps at Dewey Street Pump Station.
C. Existing building demolition, wet well top slab reconstruction, electrical and controls upgrades, and monorail crane installation.

4. PROJECT OVERVIEW

4.1 Funding and Agency Requirements

A. Project is locally funded through bonds. *Egis mentioned that, although locally funded, this project is being monitored by US EPA and IDEM, and contractual milestone dates are firm.*

4.2 Project Schedule and Time for Completion

A. Project is anticipated to be awarded in August with an NTP to follow.

B. Substantial Completion is 512 days, Fully Operational Completion is 547 days, and Final Completion is 618 days.

4.3 Preceding Work

A. There is no preceding work.

4.4 Owner-Provided Products

A. There is no owner provided products.

4.5 Concurrent Work

A. There is no other concurrent work known at this time.

4.6 Work Restrictions

A. 7:00 a.m. to 6:00 p.m. Monday through Friday
B. Saturday: 8:00 a.m. to 4:00 p.m.
C. Sunday: no work
D. No early morning Work without Owner's prior written authorization.
E. Limit utility shutdowns to 8:00 a.m. to 4:00 p.m. Monday through Thursday.
F. Limit noisy activities to weekdays from 8:00 a.m. to 5:00 p.m.
G. No nighttime Work without Owner's prior written authorization.
H. Communicate any work outside of these hours.

4.7 Utilities

A. This is a congested site for buried utilities. The utilities and other buried features shown on the drawings are from previous plan sets and have not been potholed. Contractors should anticipate some potholing or other non-destructive exploration methods may need to be utilized to facilitate exact location of existing utilities and buried features.

4.8 Permits – Owner-Obtained

A. IDEM Construction Stormwater General Permit
    i. Provided by Owner but may have to be modified with the assistance of the Contractor. Contractor shall install, maintain, and repair all required erosion control measures for implementation. Quality Deficiencies for not maintaining BMPs, causing illicit discharges, and other inactions as described in 01571 Temporary Sediment and Erosion Control Section 1.3.B-D.
B. IDEM Wastewater Construction Permit

4.9 Geotechnical

A. All available geotechnical information available to the design team is available in the bid documents.

4.10 Status of Land Acquisition

A. Contractor is responsible for coordinating with the property owner for right of entry to easement on the Newsom property.
B. Almost all the open-cut work is acquired, and the land is owned by the Wastewater Department or the City of Anderson.

4.11 Traffic Control

A. There is no traffic control on this project.

4.12 Constrained Activities

A. Constrained Activity No. 1: 30" Wet Weather Force Main Connection
   i. A permanent bypass connection point is to be installed on the 30" Wet Weather force main. The 30" Wet Weather force main conveys flows from the Wet Weather Pump Station to the Primary Clarifiers/Settling Tanks. The proposed bypass point will allow Wet Weather Pump Station flows to be diverted to either the existing 30" concrete force main or the existing 36" dry weather force main for future bypass needs.
   ii. Activity Start and End
      i. Start: Isolation of Wet Weather Pump Station to remove from service by Owner.
      ii. End: Restoration of Wet Weather Pump Station to normal service.
   iii. Preceding Work
      i. Coordinate with and obtain approval from the Owner at least 48-hours prior to start of activity.
      ii. Install new conduit and electrical cable to relocated pull box location for wet weather pumps. Have all terminations completed such that switch over can be completed quickly when wet weather pumps are able to come offline.
      iii. Wet Weather bypass plan must be approved and installed to allow wet weather to be offline. Bypass shall use the existing on-site bypass piping and begin at the Screening Structure.
      iv. During Wet Weather bypass, complete switch over of electrical connections for all wet weather panel relocations.
      v. Install new seal water supply piping to wet weather pumps.
      vi. Install bypass connection to the 30" wet weather force main.

B. Constrained Activity No. 2: 36" Dry Weather Force Main Connection
   i. A permanent bypass connection point is to be installed on the 36" Dry Weather force main. The 36" Dry Weather force main conveys flows from the Dewey Street Plant to the Preliminary Treatment Facility at the Gene Gustin Plant. The Wet Weather Pump Station is to be used as the bypass pumps for the Dry Weather Pump Station.
   ii. Activity Start and End:
      i. Start: Redirection of dry weather pump station flows to 30" force main to allow 36" force main to be taken out of service.
      ii. End: Restoration of discharging flows to the 36" force main.
   iii. Preceding Work
      i. Coordinate with and obtain approval from the Owner at least 24-hours prior to start of activity.
      ii. Obtain Owner's approval of receiving manhole for waste hauling necessitated by force main Work.
   iv. Activity Limitations
      i. Install 30" bypass connection point on the 30" concrete force main at 6th and Gene Gustin Way. This force main is not currently in service.
      ii. Install the 30" overland bypass piping to the nose of the PTF. Secure to minimize movement or splashing.

5. ADDENDA

5.1 Addendum #1
A. Issued 7/1/2025 with additional information to address questions received from plan holders and reissue two sheets with no changes due to corrupt PDF files.
5.2 Addendum #2o0
A. Issued 7/7/2025 with additional information to change the mandatory pre-bid hearing date from July 8, 2025 to July 15, 2025.
5.3 Addendum #3
A. Issued July 15, 2025 with additional information including reissuing of sheet E104, issuing of new sheet E104A, reissuing of the agreement document to add project specific information, reissuing of 01140 to remove non-project related information, and addressing questions received from plan holders.
5.4 Addendum #4
A. To be issued July 18, 2025 with additional information including bidder questions received with answers.

6. PRE-BID ISSUES

6.1 Access to sites
A. Bidders are responsible for visiting the project site(s) to familiarize themselves with field conditions that may affect their bid.

6.2 Last Day for Questions: July 17, 2025

6.3 Final Addendum: July 18, 2025

7. BID TYPE

7.1 Unit Price

8. ITEMS TO BE SUBMITTED WITH BIDS

8.1 Bid Form (Section 00410)
A. Acknowledge addenda on page 00410-02

8.2 Bid Form Attachment A (Section 00410A)

8.3 Bid Proposal Form 96 (Section 00411)

8.4 Bid Security (Bid Bond form in Section 00431)

8.5 Required Bidder Qualification Statement with Supporting Data

8.6 Evidence to do business in the state of Indiana or written covenant to obtain such authority within the time of acceptance of Bids

Due within 5 days of bid opening if requested by Owner and become a condition of the bid:

8.7 List of Proposed Subcontractors

8.8 List of Proposed Suppliers

8.9 Affirmative Action Plan

8.10 Company Wide/Project Workforce Breakdown Forms

8.11 Non-Discrimination Affidavit

9. BID DATE

9.1 Bid Opening: July 22, 2025 at 1:30 pm local time; as part of the Board of Works meeting

9.2 Bids Due: July 22, 2025 at 1:15 pm local time (The gap is to allow time for staff to walk to the meeting room. Bids will remain sealed until they are opened during the advertised public meeting.)

9.3 Location: City of Anderson Board of Public Works, 120 East 8th Street, Anderson, IN 46018

10. BID HOLDING

10.1 Held 90 days

10.2 All but lowest 3 bids will be returned

11. OTHER COMMENTS AND QUESTIONS

SEE QUESTION AND RESPONSE LIST NO. 1

City Of Anderson Water Pollution Control
Dry Weather Pump Station and Forcemain Rehabilitation Project

July 15, 2025 @ 9:00 AM Local Time

SIGN-IN SHEET

NAME	COMPANY	PHONE	E-MAIL
Matt Hudson	Blue Tank	317-801-7775	mHudson @ BlueTankandPump.com
Ryan Hardwick	Xylem	317-439-932	RYAN.hardwick@xylem.com
ROMEO MARROQUIN	TCI	317-760-4211	ESTIMATING@T-C-I.net
Josue Rodas	TCI	317.515.5929	estimating@T-C-I.net
RON WESTON	RANGELINE	231-499-6608	RWESTON@RANGELINE.com
VANCE RATH	MICHELS	414-232-4426	VRATH@MICHELS.US
ALEX SHARPE	THIEMEMAN	317.910.3895	ALEX.SHARPE@T-C-I.NET ESTIMATING@T-C-I.NET
GARY KREHM	BL ANDERSON	765-426-0829	GKREHM@BLANDERSON.com
David Howard	Gaylor	864-714-6911	dhoward@gaylor.com
Chera Howard	Gaylor	317-908-6090	Choward@gaylor.com
Jason Dougherty	Sherwin Williams	317-314-2180	jason.f.dougherty@sherwin.com
Sam Byler	Liner Solutions	574-536-4845	sam.byler@puriscorp.com
PATRICK EHRET	HANKELCAN	317-938-0330	pehret@HANKELCAN ST.

SmartBall® PWA Inspection Report

of the Dewey Street Force Main

Report Prepared for:

The City of Anderson Water Pollution Control
2801 Gene Gustin Way
Anderson, Indiana 46011

By:

Pure Technologies U.S. Inc.
(July 2015)

3040 Route 22 West, Suite 130 | Branchburg, NJ, USA 08876 | Tel: +1 (908) 526-6600 | **puretechltd.com**

SmartBall® Inspection Report of the Dewey Street Force Main

Prepared for

The City of Anderson Water Pollution Control

By

Pure Technologies U.S. Inc.

July 2015

Quality Assurance/Quality Control Statement

By my signature I attest that this report has been prepared and reviewed in accordance with Pure Technologies U.S. Inc.'s Quality Assurance/Quality Control procedures:

7/10/2015

Matthew Roth, Project Manager Date

DISCLAIMER

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Table of Contents

Executive Summary

The City of Anderson Water Pollution Control (Anderson) retained the services of Pure Technologies U.S. Inc. (Pure Technologies) to perform an inspection of the Dewey Street Force Main (Dewey Force Main). The purpose of the inspection was to detect and locate leaks, gas pockets, and stress anomalies within the force main at the time of the inspection. This inspection was completed using the SmartBall® Pipe Wall Assessment (PWA) free swimming inspection system. The inspection was performed on February 25, 2015. The Dewey Force Main is comprised of 3,596 feet of 36-inch ductile iron pipe (DIP) that transfers wastewater from the Dewey Street Pump Station to Gene Gustin Treatment Facility.

The SmartBall PWA tool was inserted into the pipeline through a 4-inch air release valve located on the grounds of the Dewey Street Pump Station. The SmartBall PWA tool collected acoustic and PWA data from within the pipeline, while the SmartBall Receivers (SBR) collected tracking data which was used to locate the inspection findings. This data has been evaluated to identify and locate areas of interest along the Dewey Force Main. Details of the Dewey Force Main are provided in Table ES.1.

Table ES.1: Pipeline Details	
Total Length of Pipe Inspected:	3,596 feet
Pipe Material:	DIP
Diameter of Pipe:	36 inch
Fluid Conveyed:	Wastewater

No leaks or stationary gas pockets were detected during the inspection of the Dewey Force Main. However, two (2) gas slugs and eight (8) PWA anomalies were found during the time of the inspection. The results of the inspection are summarized in Table ES.2.

Table ES.2: Summary of Inspection Results	
Acoustic Anomalies Characteristic of Leaks:	0
Acoustic Anomalies Characteristic of Pockets of Trapped Gas:	0
Acoustic Anomalies Characteristic of Gas Slugs:	2
Pipe Wall Anomalies:	8
Duration of Inspection:	52 minutes
Average SmartBall Velocity:	1.2 feet/sec

Gas slugs are transient accumulations of gas that move through the pipeline with flow and are expelled through air release valves. Providing that all air release valve are functioning and there are no localized high points without air release valves, gas slugs are typically not of concern.

PWA anomalies likely indicate areas of increased stress in the pipe wall. Causes for increased stress may include reduced wall thickness due to corrosion, bending moments, point loading, and cracking. Further investigation such as an external visual inspection and ultrasonic thickness measurements is needed to determine the cause of the eight (8) PWA anomalies.

During the analysis of the data obtained during the inspection, Pure Technologies identified discrepancies between the velocity profile of the SmartBall tool and the drawings provided by Anderson. Due to these discrepancies Pure Technologies has less confidence in the reported location of the PWA anomalies and the gas slugs detected. Prior to any additional condition assessment including excavations to investigate these results, the discrepancies need to be resolved.

Based on the inspections of the Dewey Force Main, Pure Technologies concludes the following:

1. The average velocity of the SmartBall PWA tool during the inspection was estimated to be 1.2 ft/sec.
2. There were no leaks or gas pockets detected in the force main at the time of inspection.
3. There were two (2) gas slugs detected during the inspection. Gas slugs are transient conditions and are not typically of concern.
4. Eight (8) PWA anomalies were detected in the force main, two (2) were classified as small and six (6) were classified as medium. Additional investigation is needed to determine the cause of the PWA anomalies. Pure recommends test pitting to determine the source and severity of the stress at these locations.
5. A discrepancy between the velocity profile of the SmartBall PWA device and the distances between features indicated on the provided drawings of the Dewey Force Main was identified during data analysis. This discrepancy results in less confidence in the reported location of gas slugs and PWA anomalies. Additional distance measurements are need to more accurately locate the inspection results.

1. Introduction and Background

1.1 Project Background

On February 25, 2015, Pure Technologies conducted a SmartBall PWA inspection of the 36-inch Dewey Force Main located in Anderson, Indiana. The Dewey Force Main is comprised of 36-inch DIP and was constructed in July, 1974. The force main conveys combined wastewater and storm water and flows westerly along the White River.

The inspection proceeded approximately 3,596 feet from the Dewey Street Pump Station to the Gene Gustin Treatment Facility. For the entirety of the inspection the Dewey Street Pump Station ran only Pump RSP-3 which provided an operational pressure of approximately 17.5 psi.

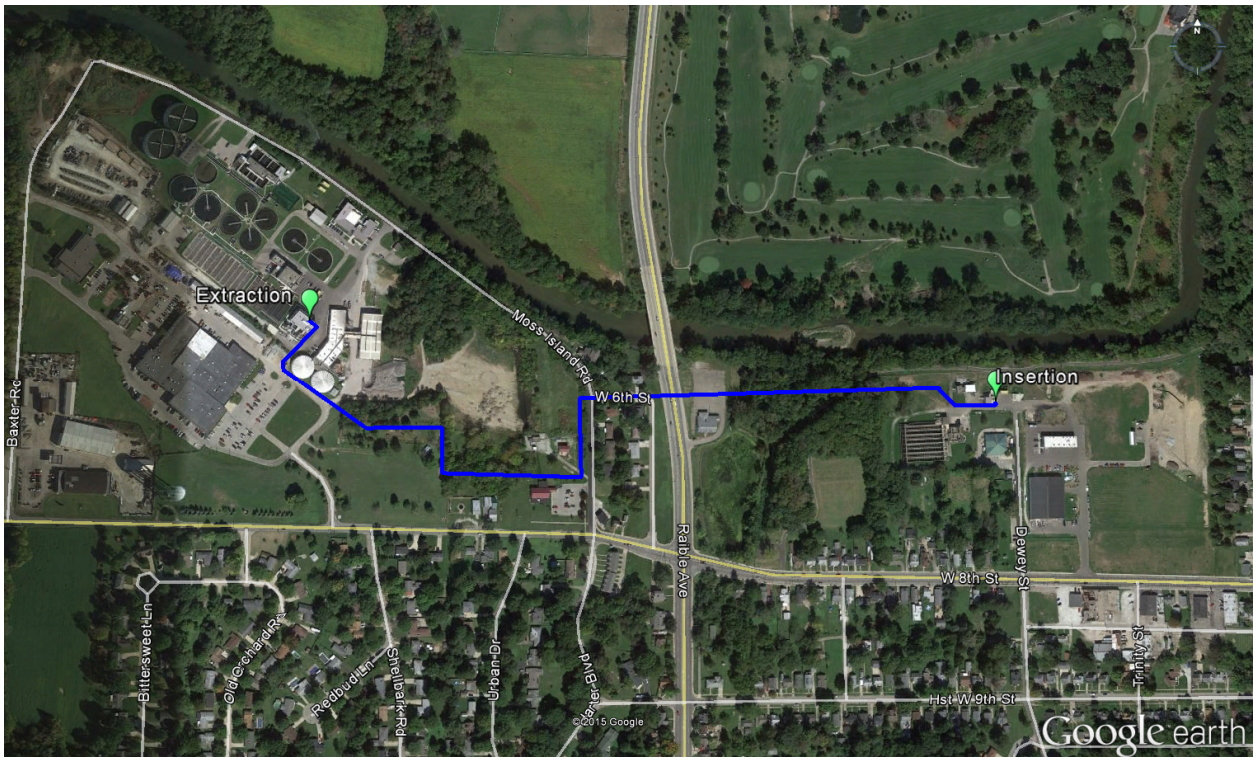


Figure 1.1: Approximate Location of the Dewey Force Main

1.2 Project Scope

The scope of this project was to inspect for leaks, gas pockets, and pipe wall anomalies occurring in the Dewey Force Main. This report provides the results of the inspection. The assessment of the Dewey Force Main utilized SmartBall leak and gas pocket detection technology with pipe wall assessment. This report details the results and provides information to assist Anderson in their management of the Dewey Force Main.

1.3 Reviewed Documents

To complete the assessment of the Dewey Force Main, Pure Technologies reviewed the following documents:

- Henry B. Steeg & Associates A Division of Howard Needles Tammen & Bergendoff Engineers. *Division II Wastewater Force Main, Force Main Plan and Details, City of Anderson, Indiana Water Quality Control Project.* September 1968.
- Greeley and Hansen. *Drawing G6, General Dewey Street New Piping Plan, City of Anderson, Indiana Water Pollution Control Plant Facility Improvements Division I.* July 17, 2009.
- Greeley and Hansen. *Drawing AM1, Piping and Equipment Lift Station, Screen Structure & Junction Chamber Sect Plan. City of Anderson, Indiana Water Pollution Control Plant Facility Improvements Division I.* July 17, 2009.
- Greeley and Hansen. *Drawing AM3, Piping and Equipment Lift Station and Screen Structure Sections, City of Anderson, Indiana Water Pollution Control Plant Facility Improvements Division I.* July 17, 2009.
- Greeley and Hansen. *Drawing AG10. City of Anderson, Indiana Water Pollution Control Plant Facility Improvements Division II, General Gene Gustin Way, Enlarged New Site and Utility Plan*. September 2011.
- Greeley and Hansen. *Drawing BM2, Enlarged New Site and Utility Plan, City of Anderson, Indiana Water Pollution Control Plant Facility Improvements Division II, General Gene Gustin Way.* September 2011.

1.4. Inspection and Failure History

Pure Technologies was not made aware of any prior inspections of the Dewey Force Main. Additionally, Pure Technologies is not aware of any past failures of the Dewey Force Main.

Although two sections of the pipeline were replaced. These have been replaced within the last eight years. The first of which was replaced on the site of the Dewey Street Pump Station for the first few hundred feet. The second of which was replaced from just upstream of the air release valve location on the Gene Gustin Treatment Facility up to the treatment plant. Drawings of the replaced section of the pipeline were not available, which may have affected the accuracy of the inspection data.

2. Description of SmartBall Technology

2.1 Overview

Pure Technologies' SmartBall leak and gas pocket detection system is a free-swimming, acoustic-based technology that detects acoustic activity associated with leaks or gas pockets as well as stress in pressurized pipelines. Advantages and limitations of the SmartBall tool can be referenced in Appendix B. The SmartBall core is comprised of a water-tight aluminum alloy shell that contains a power source, electronic components, and instrumentation including an acoustic sensor, accelerometer, magnetometer, ultrasonic transmitter, and a temperature sensor. The aluminum core is encapsulated by a protective foam shell. The foam outer shell provides a larger surface area by which the device is pushed by the flow of the fluid conveyed while reducing low frequency ambient noise that is typically present in a pipeline. The SmartBall tool is deployed into the flow of a pipeline, traverses the pipeline, and is captured and extracted

at a point downstream. During the inspection, the SmartBall tool's location is tracked at known points along the pipeline to correlate the inspection data with the inspected distance.

2.2 Identifying Leaks and Gas Pockets

2.2.1 Acoustic Anomalies Representing Leaks

A leak inside a pressurized pipeline produces sound as the fluid escapes into the lower pressure atmosphere outside the pipeline. While a SmartBall tool traverses a pipeline, it continuously records acoustic data, which is later evaluated to identify acoustic anomalies consistent with leaks. As the SmartBall tool is rolling along the bottom of a pipeline, it will always pass within one (1) pipe diameter of a leak.

As the SmartBall tool moves toward a leak the amplitude of the sound created increases, peaking at the exact location of the leak, and then diminishes as the tool travels away. The increase and decrease of the amplitude of the audio data is critical to precisely locate leaks. Figure 2.1 depicts the audio data of a leak when viewed in the leak and gas pocket detection analysis software.

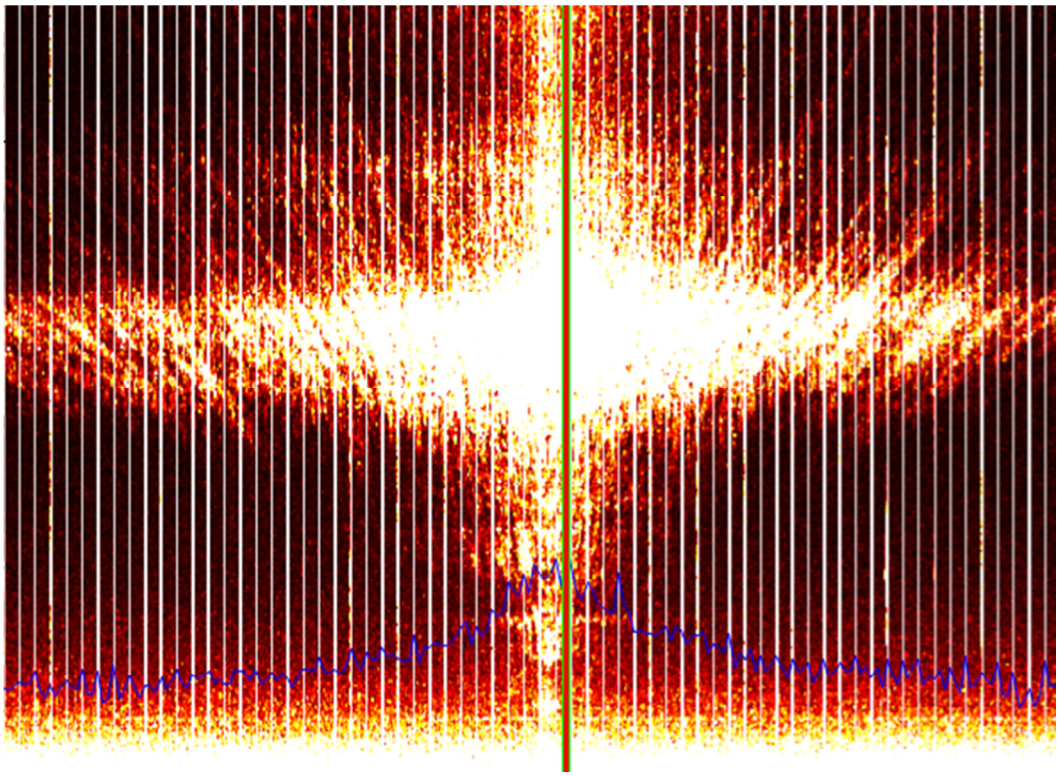


Figure 2.1 : Leak detected in Analysis Software

During the data analysis process, the acoustic properties of potential leaks are evaluated to estimate their magnitude. Pure Technologies reports leaks in three (3) categories: small, medium and large. Small leaks are estimated to be in the range of 0 - 2 gallons per minute (GPM). Medium leaks are estimated to be in the range of 2 - 10 GPM and large leaks are estimated to be greater than 10 GPM.

Pure Technologies has invested heavily into identifying the characteristics of an acoustic anomaly that would be representative of a leak. The characteristics typical of a leak include:

- The range of frequencies present increases as the ball approaches the leak
- The frequencies that appear first intensify as the SmartBall tool approaches the leak
- The frequencies that indicate a leak are consistent as the SmartBall tool approaches the leak

2.2.2 Acoustic Anomalies Representing Gas Pockets

Gas trapped in a pipeline may present itself as entrained gas, gas slugs/developing gas pockets, or fully developed gas pockets. Each of these distinct forms of gas accumulations have acoustic signals that can be detected using the SmartBall tool.

A gas pocket inside a pipeline generates a distinct acoustic signal that is detectable using the SmartBall leak and gas pocket detection system. Gas pockets in pressure pipes are typically found at high points in the pipeline often due to malfunctioning or misplaced air release valves. The acoustic signal is created by the liquid turbulence at the air/water interface. In full, pressurized pipes, this turbulence is not present.

Entrained Gas

Entrained gas is characterized by small bubbles within the pipeline moving with flow. Entrained gas is not typically static in force mains and frequently migrates with the flow. These small moving pockets of gas can be introduced at the pumping station as a result of air becoming entrained in the sewage as it enters the wet well, or by inefficiencies within pump stations. Entrained gas can also be created at the tail of a hydraulic jump at the end of a fully developed gas pocket whereby small pockets of gas diffuse into the liquid and are carried downstream with the flow. Lastly, entrained gas may be created by the biochemical processes inherent to sewage mains. A depiction of entrained gas can be seen in Figure 2.2.

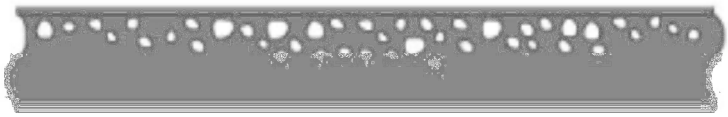


Figure 2.2: Entrained Gas (Pothof, 2011)

Slug or Developing Gas Pockets

A gas slug can be characterized as small pockets of trapped gas that often develop when entrained gas amalgamates, or are introduced via air release valves or vacuum breaks. Slugs can be either static or migratory. If they are detected at a localized high point they are likely static, if detected elsewhere they are likely migrating towards a high point. A diagram of gas slug is provided in Figure 2.3.

Figure 2.3 : Gas Slugs (Pothof, 2011)

Fully Developed Gas Pockets

Gas pockets are generally located at localized high points along a force main. These develop as a result of slugs that have accumulated at a high point, and have extended into the downward slope of the pipe. A fully developed gas pocket typically has a hydraulic jump prior to the point where the pipeline resumes full flow which creates an area of turbulent flow and gas dissolution into the liquid phase. Due to the turbulent nature of the hydraulic jump and frequent wet/dry cycles at these locations, these areas are at a higher risk of failure than other portions of the gas pocket. An illustration of a fully developed gas pocket and hydraulic jump is provided in Figure 2.4. Figure 2.5 depicts the audio data of a gas pocket when viewed in the leak and gas pocket detection analysis software.

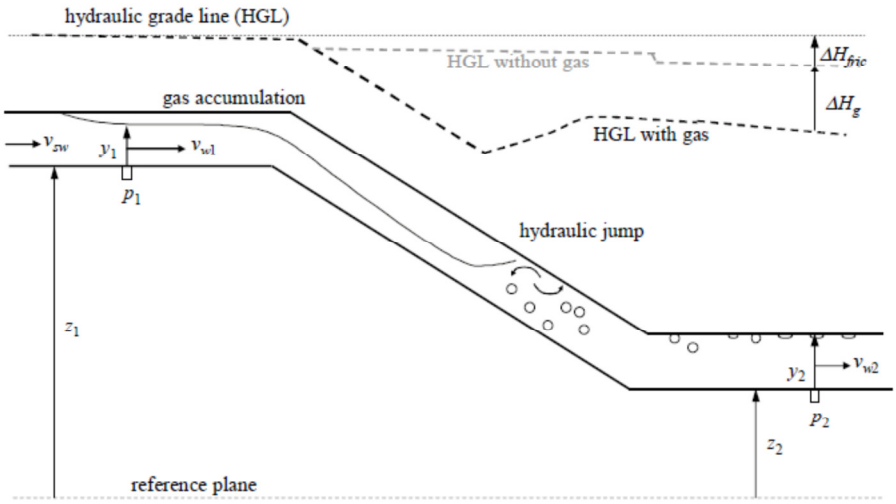


Figure 2.4: Diagram of a fully developed gas pocket (Pothof, 2011)

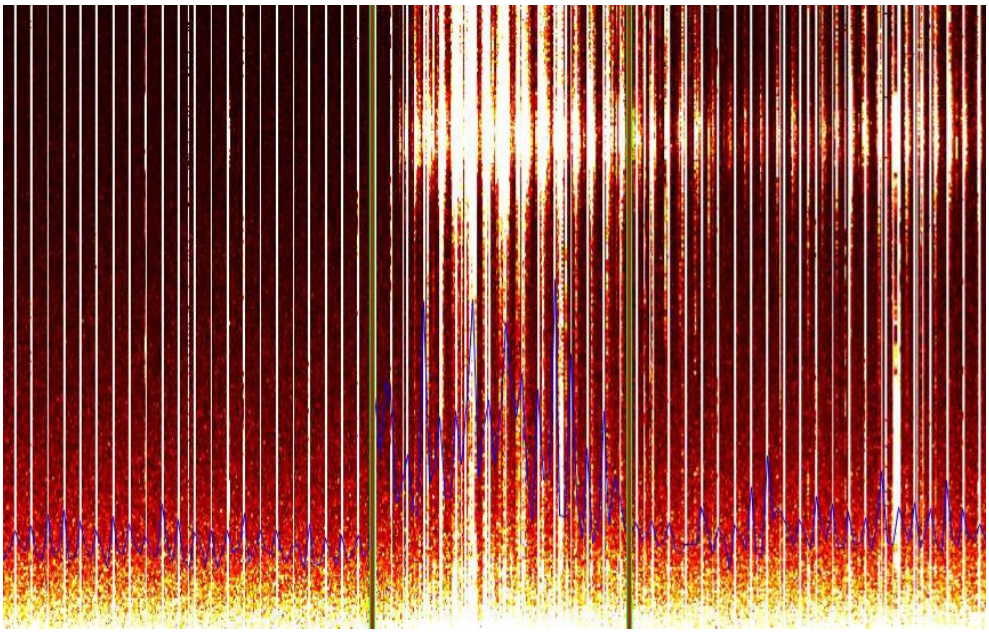


Figure 2.5: Gas Pocket detected in Analysis Software

2.3 Pipe Wall Assessment

Pure Technologies SmartBall PWA technology is used to evaluate metallic pipelines by detecting and measuring the changing levels of stress in the pipe wall. PWA technology is a screening tool that provides a low-resolution indication of the condition of the pipe. The technology can be used as a first stage of pipeline condition assessment to help make informed decisions to focus higher resolution investigations, inspection, data collection and subsequent management or rehabilitation.

The PWA technology measures the change in the self-generated magnetic field produced by ferromagnetic materials in stress. The level of stress and amount of material under that stress is proportional to the change in the magnetic field measured by the SmartBall PWA tool. The data is collected using Pure Technologies' SmartBall PWA tool which rolls through the pipeline, thus, the sensors are never more the one pipe diameter from the pipe wall. The SmartBall PWA tool's sensors sample data hundreds of time per second gathering detailed data over each pipe section (joint to joint). Data analysts then carefully analyze the signal response, measure these changes and report the location and relative size of anomalies. Figure 2.6 shows metallic materials in stress change the magnetic field produced.

Stress in metallic pipe is increased wherever the wall is thinned, where cracks have developed even if they are not through the wall, where the pipe has been damaged or pitted externally or internally, where the pipe is under severe bending, compressive, tensile, or torsional stress, where the original construction of the pipe wall is anomalously thin, or where a pipe is under-designed for its current loading conditions. Figure 2.6 shows metallic materials in stress change the magnetic field produced. The instrument can detect joints, material changes, some appurtenances, and many other features relevant to the operation and mapping of the pipe. Currently, it is not possible to distinguish the cause of stress, for example between wall loss and point loading, as our data dictionary is still being populated. It is important to consider when excavating pipes for validation of SmartBall PWA data that if the stress is caused by bending or

overloading, it may be difficult to confirm or measure the impact of the stress in these locations when the earth loads have been removed. With further validations on this pipeline, a better understanding can be gained of the correlation between the anomalies identified in the data and the actual conditions causing the stress on the pipeline.

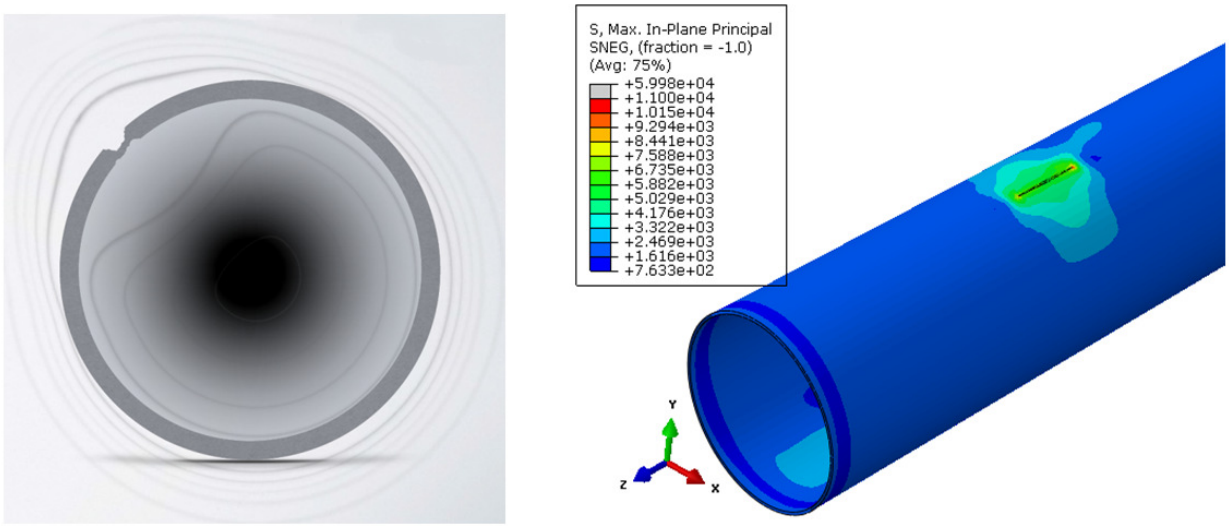


Figure 2.6: Example of Metallic Materials in Stress

Figure 2.7 and 2.8 are examples of SmartBall PWA data collected. Distance is represented on the x-axis and magnetic field on the y-axis. Joints produce a visible signature in the data as they produce a large response in the data (seen aligning with the ends of the pipes in the figures below). Figure 2.7 shows the PWA data for a nominal pipe, the large response at the left and right of the trace are the joints. Across the barrel of the nominal pipe, there is minimal response indicating minimal change in the magnetic field and therefore minimal change in the stress present in the wall of the pipeline. Figure 2.8 shows the data response to damage in the barrel of the pipe. The damage causes stress in the pipeline, which produces a change in the self-generated magnetic field in that area. The SmartBall PWA tool measures this change in the magnetic field and a stress anomaly is indicated.

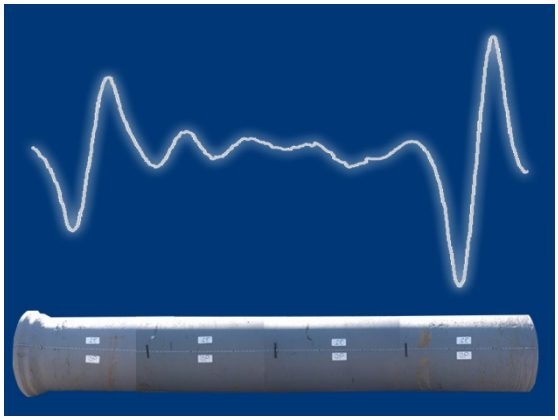


Figure 2.7: PWA Data for Nominal Pipe

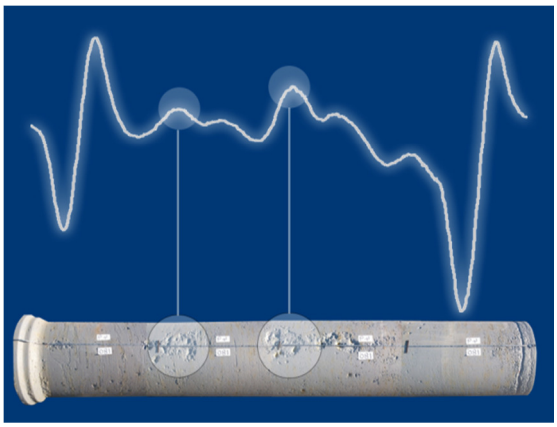


Figure 2.8: PWA Data for Pipe with damage

Once PWA data is collected and analyzed, it can provide semi-quantitative information regarding the condition of each pipe section (joint to joint). The size of the anomaly (change in the magnetic field) may not be indicative of the size/severity of the source of stress in the pipe wall. Further investigation is recommended to understand the conditions of the pipeline that create the stress anomalies found. Having this understanding will guide the next steps of assessment or rehabilitation. Anomalies are reported based on a distance from a known appurtenance or from the start of the inspection.

Turbulence in the pipe from open channel flow, bends, gas pockets or pump cycling can introduce noise into the PWA data. Advanced filtering and algorithms are used to reduce the effect of the noise in the data; however, under some conditions noise levels in the data may mask defects. These areas are identified in the pipe list.

2.4 SmartBall Tracking

The on-board accelerometer records the rotation of the SmartBall tool whereby this data can be translated to a rate of rotation and from there, to a velocity profile of the device as it travels the entire length of the pipeline. This data is aligned with the acoustic recordings to give a precise location of any recorded anomaly. To correlate the accelerometer data to an absolute position and time, a reference point is required. Tracking the position of the SmartBall tool via SBR provides a time and position to be stamped on the velocity profile, resulting in a position versus time relationship for the entire run of the device that is used to report the location of the leak or gas pocket.

The SBR is a device that is used to track the position of the SmartBall tool as it traverses the pipeline. The SBR is comprised of a surface mounted sensor (SMS), GPS receiver, and a processing computer. Both the SmartBall tool and the SBR are synchronized to standard GPS time.

Figure 2.9: SMS Adhered to Flange

An SMS is mounted to the pipeline at planned locations and is connected to an SBR via a coaxial cable. The SBR and SMS combination detect ultrasonic pulses emitted from the SmartBall tool. The SBRs determine the time taken for the pulse to travel from the SmartBall tool to the SBR, and calculate the location of the SmartBall tool at any given time.

This locational data is paralleled with the data extracted from the SmartBall tool which is then used to identify the locations of leaks and gas pockets. Figure 2.9 shows an SMS, which is typically mounted to the pipeline itself or pipeline appurtenance.

3. Inspection Methodology and Results

3.1 SmartBall Inspection Methodology

SmartBall Tool Insertion

The SmartBall PWA tool was inserted through a 4-inch air release valve at the Dewey Street Pump Station. The air release valve was removed from the pipeline and replaced with a custom SmartBall insertion assembly. A photograph of the insertion point is provided in Figure 3.1.

Figure 3.1: Insertion Site

SmartBall Tracking

Two (2) SMSs were attached to the Dewey Force Main to track the progress of the SmartBall PWA tool during the inspection. The SBRs were connected to the SMSs attached to the pipeline. The location of the tracking points, and the times the tool passed, is provided in Table 3.1. Additional information on the tracking locations is provided in Appendix A.

Table 3.1: SmartBall Tracking Locations				
Tracking Location	**Passage Time Run 1 (hh:mm:ss)**	**Distance from Insertion (ft)**	**SBR No.**	**Approximate GPS Location**
Insertion	9:31:00	0	N/A	40° 6'36.17"N 85°42'24.06"W
1	9:32:44	164	SBR #1	40° 6'36.02"N 85°42'25.87"W
2	10:18:27	3,217	SBR #2	40° 6'38.12"N 85°42'59.62"W
Extraction	10:22:00	3,596	N/A	40° 6'39.32"N 85°42'58.79"W

During the inspection the average velocity of the SmartBall PWA tool was 1.2 ft/sec.

SmartBall Extraction

The SmartBall PWA tool was extracted at Fine Screen #2 in the Gene Gustin Treatment Plant. Flow was diverted to Fine Screen #2, and the tool was removed using the automatic rake. A photograph of the SmartBall tool extraction site is provided in Figure 3.2.

Figure 3.2: Extraction Site

3.2 Leak and Gas Pocket Inspection Results

Immediately following the inspection, the data collected was downloaded, verified for quality, and sent to Pure Technologies' analysis team for review. The data collected was internally peer reviewed to verify that all acoustic anomalies detected were analyzed and accurately classified. During the analysis process, the anomalies detected were located by correlating the inspection results to the drawings provided by Anderson. The accuracy of the reported anomaly locations is directly affected by the accuracy of the provided drawings.

Though no leaks or pockets of gas were detected, two (2) acoustic anomalies consistent with gas slugs were found during the inspection. Table 3.2 summarizes the gas slugs found during the inspection. Additional details on each of these anomalies are presented in Appendix C.

Table 3.2: Gas Slug Results of the Inspection

Distance from Insertion (Start)	Distance from Insertion (End)	Length	SmartBall Passage Time (Beginning)	Description	Approximate GPS Location (Start)
67 feet	108 feet	41 Feet	10:02:32 AM	Gas Slug (~41ft)	40.1100, -85.7069
3,198 feet	3,222 feet	24 Feet	10:14:33 AM	Gas Slug (~24ft)	40.1102, -85.7165

Gas Slug #1 was located 67 feet to 108 feet from insertion, just outside the pump station. The start of the gas slug is 97 feet before the first tracking location at the meter vault. Figure 3.3 provides the location of the gas slug identified during analysis.

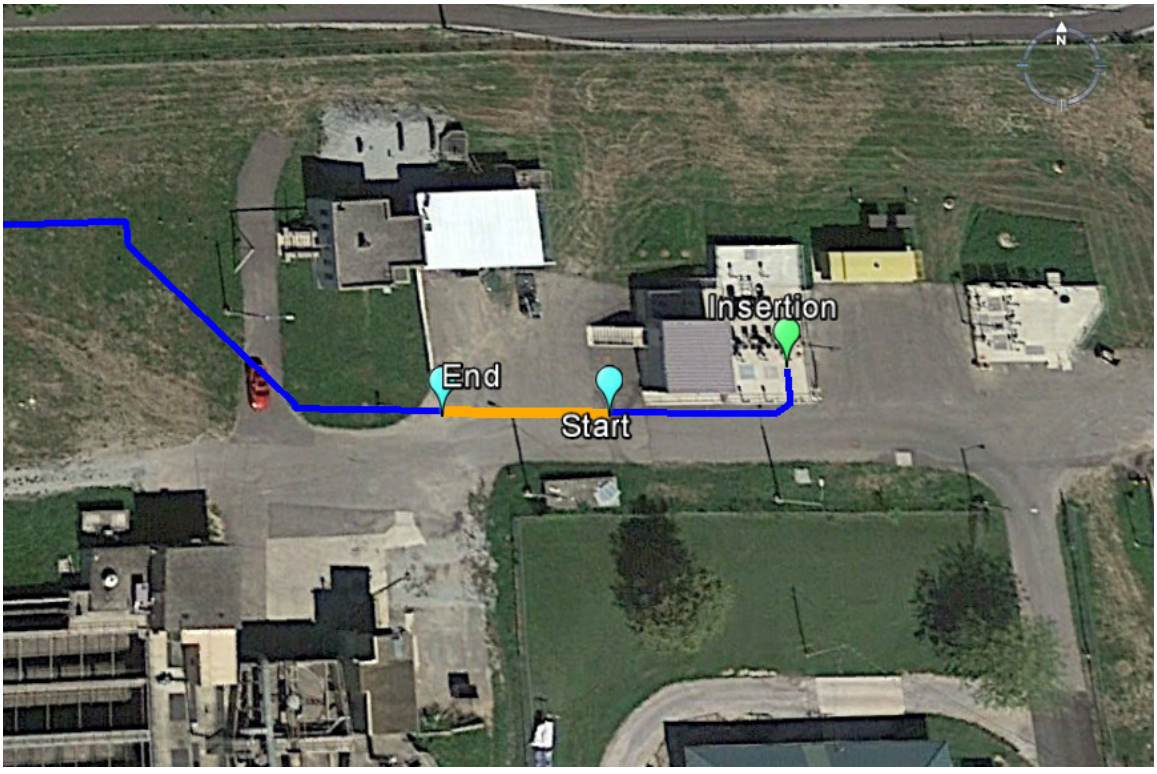


Figure 3.3: Approximate Location of Gas Slug #1

Gas Slug #2 was located 3,198 feet to 3,222 feet from insertion on the grounds of the Gene Gustin Treatment Facility. Figure 3.4 shows the location of the gas slug detected.

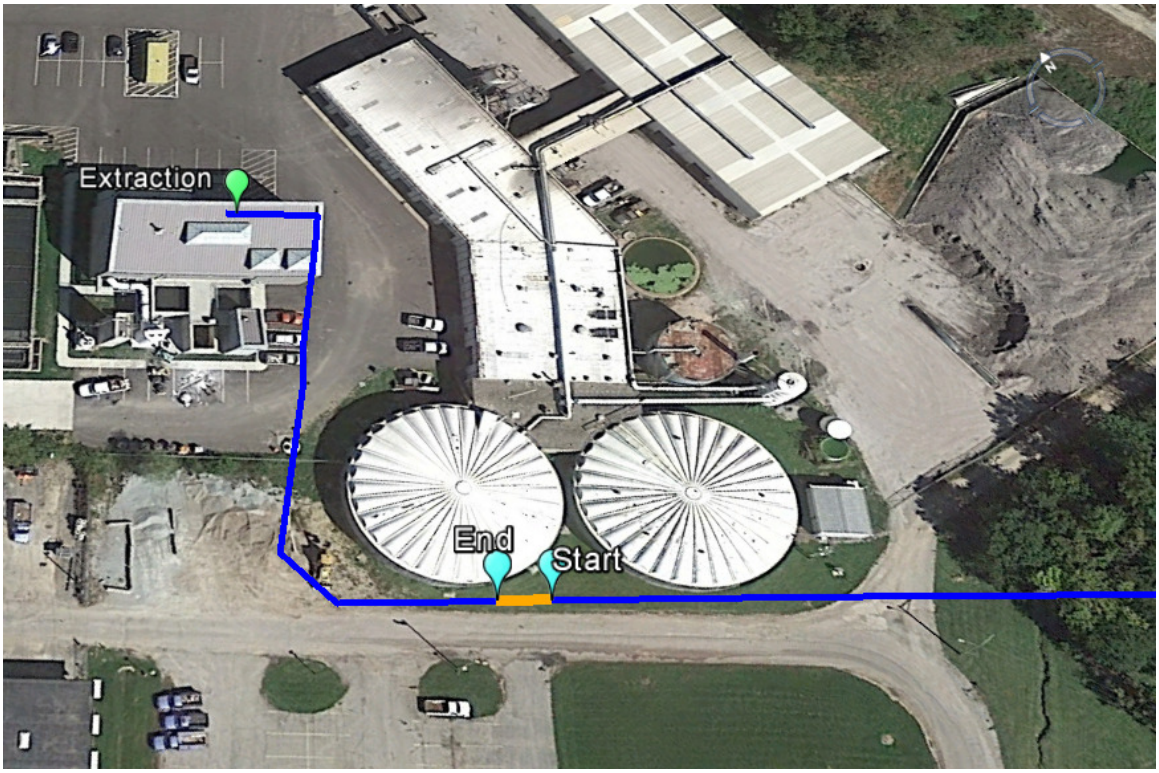


Figure 3.4: Approximate Location of Gas Slug #2

The locations of the gas slugs found in the Dewey Force Main are determined using the tracking data gathered during the inspection and the distances provided in the pipeline drawings provided to Pure Technologies by Anderson. Any inaccuracies in the drawings may create error in the reported locations of anomalies.

3.3 PWA Inspection Results

The analysis of the SmartBall PWA data determined the presence of eight (8) small to medium pipe wall anomalies in the Dewey Force Main that are indicative of a change in stress. Table 3.3 summarizes the anomalies and features identified during the inspection. A full list of PWA collected can be found in Appendix C.

Table 3.3: PWA Distance Discrepancies

Distance from Insertion (ft)	Classification	Size	Comments
164	Feature	N/A	Meter vault (SBR1)
248	Feature	N/A	45 degree bend
339	Anomaly	Medium	
1071	Anomaly	Small	Inconsistent PWA readings at joints
1333	Anomaly	Medium	
1620	Feature	N/A	90 degree bend

Table 3.3: PWA Distance Discrepancies			
Distance from Insertion (ft)	**Classification**	**Size**	**Comments**
1698	Anomaly	Medium	
1889	Anomaly	Medium	
1941	Feature	N/A	90 degree bend
1963	Anomaly	Medium	Possible turbulence in pipeline
2127	Anomaly	Medium	
2374	Anomaly	Small	
2522	Feature	N/A	90 degree bend
2648	Feature	N/A	Short pipe
2674	Feature	N/A	90 degree bend
3148	Feature	N/A	Short pipe
3158	Feature	N/A	Short pipe
3304	Feature	N/A	45 degree bend
3320	Feature	N/A	45 degree bend
3381	Feature	N/A	Air release valve (SBR2)
3482	Feature	N/A	45 degree bend
3490	Feature	N/A	45 degree bend
3538	Feature	N/A	Possible interference after this point

Figure 3.5 below, shows the PWA data collected on a nominal pipe from the Dewey Force Main. Distance is plotted on the x-axis and the magnetic field on the y-axis. Joints are marked by the vertical blue lines. There is minimal response in the data across the barrel of the pipe indicating minimal change in the magnetic field and therefore minimal change in the stress in the pipe wall.

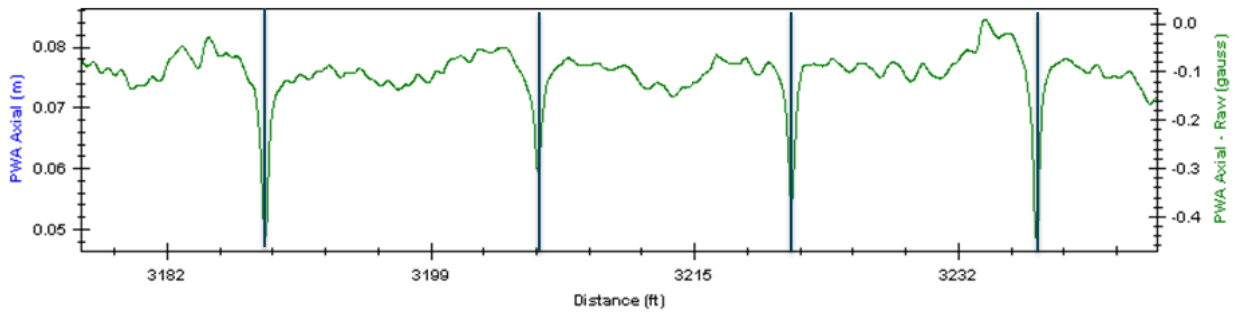


Figure 3.5: Nominal PWA Signal

Figure 3.6 shows the data for pipe with a small anomaly while Figure 3.7 shows a medium anomaly. The joints are visible and marked by vertical blue lines. The anomaly is marked with a vertical green line where the data indicates a change in the magnetic field and therefore a change in the stress in the pipe at this location.

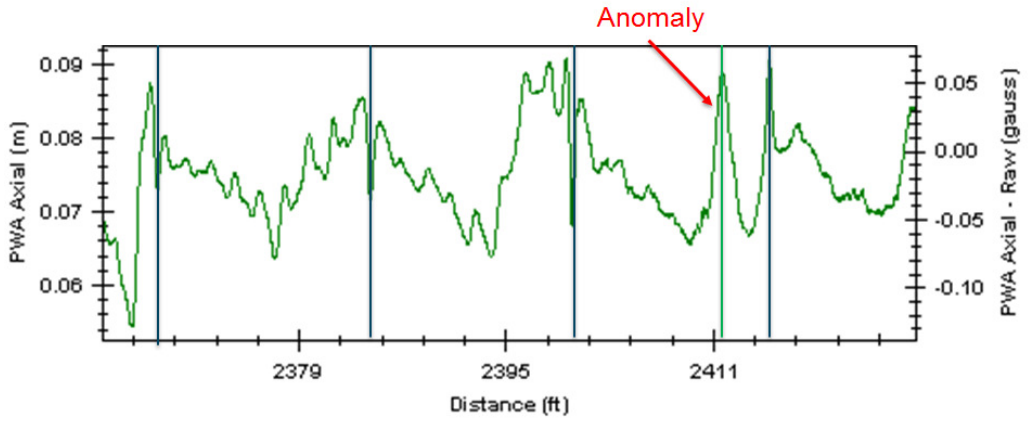


Figure 3.6: PWA Anomaly Classified as Small

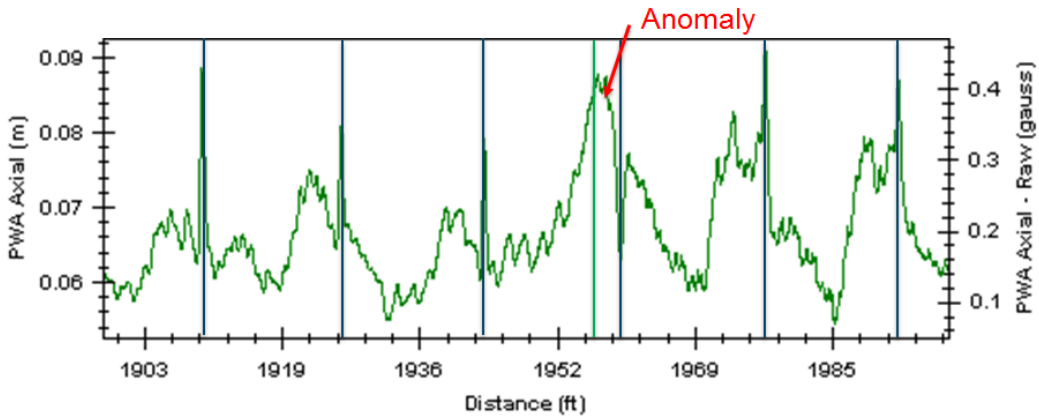


Figure 3.7: PWA Anomaly Classified as Medium

4. Analysis and Discussion

No acoustic anomalies consistent with leaks or gas pockets were detected during the SmartBall PWA inspection of the Dewey Force Main. Two (2) gas slugs were identified, as were eight (8) pipe wall anomalies.

4.1 Gas Slugs Detected

Two (2) acoustic anomalies consistent with gas slugs were identified during the inspection of the force main. Gas slugs are transients that move through the pipeline with flow, and are typically expelled at air release valves. It is possible that the gas slugs detected during the inspection were introduced into the pipeline when the 4-inch air release valve was replaced with the SmartBall tool insertion assembly. Gas slugs are typically not of concern providing that all air release valves are functioning properly and there are no localized high points without air release valves. Additional details on the gas slugs detected are located in Appendix D.

4.2 Pipes with PWA Anomalies

In total eight (8) PWA anomalies were present in the Dewey Force Main during the SmartBall PWA inspection. Two (2) of these anomalies are classified as small and six (6) are classified as medium. PWA anomalies indicate areas of increased stress in the pipe wall. Causes for increased stress may include reduced wall thickness due to corrosion, bending moments, point loading, and cracking. Further investigation such as an external visual inspection and ultrasonic thickness measurements is needed to determine the cause of the eight (8) PWA anomalies.

4.3 Locating Detected Anomalies in the Dewey Force Main

During the analysis of the SmartBall inspection data, discrepancies were identified between the data collected from the SmartBall PWA sensors and the provided drawings of the Dewey Force Main. Using the approximate distance of the pipeline and the duration of the inspection, the SmartBall tool was calculated to move at approximately 1.2 feet per second. One of the sensors onboard the SmartBall tool indicated that the rolling rate was consistent during the inspection. The consistent rolling rate was expected because the Dewey Street Pump Station provided a constant flow rate during the inspection. Consistent rolling rates and consistent flow rates both indicate that the tool moved at constant velocity during the inspection.

The SmartBall tool also has sensors that detect when the tool passes elbows and changes direction. When applying the distances between the elbows provided by the drawings to the direction changes in the data there was considerable variation in the calculated velocity between the elbows. As the rolling rate and flow rate of the pipeline were consistent during the inspection, it is possible that there is some error in the provided drawings.

Table 4.1 highlights the discrepancies between the data collected and the drawings that were provided. A table in Appendix E shows a review of all drawings used to reference a total distance of the pipeline for the SmartBall inspection.

Table 4.1: PWA Distance Discrepancies

Feature and Associated Station Number[1]	Distance from Insertion of Feature on Drawings	Distance from Insertion of Feature Determined by Gyroscope of the SmartBall PWA Tool	Discrepancy Between the Drawings and SmartBall PWA Results
90 Degree Elbow STA. # 18+42	1,700 feet	1,620 feet	80 feet
90 Degree Elbow STA. # 15+34	2,008 feet	1,941 feet	67 feet
90 Degree Elbow STA. # 9+90	2,552 feet	2,522 feet	30 feet
90 Degree Elbow STA. # 8+12	2,730 feet	2,674 feet	56 feet

[1] *All stations referenced in above table were derived from Henry B. Steeg and Associates, Inc. Force Main Plan and Details Sheet 2.*

Due to these discrepancies Pure Technologies has less confidence in the reported location of the PWA anomalies and the gas slugs detected. Prior to any additional condition assessment

including excavations to investigate these results, the discrepancies need to be resolved. Accurate measurements between the elbows in Table 4.1 need to be taken. One way to obtain more accurate measurements is to locate the elbows above ground and take Global Positioning System (GPS) points of their exact location. With additional analysis, the distances obtained from the new GPS coordinates can then be incorporated into the SmartBall PWA results.

5. Conclusions

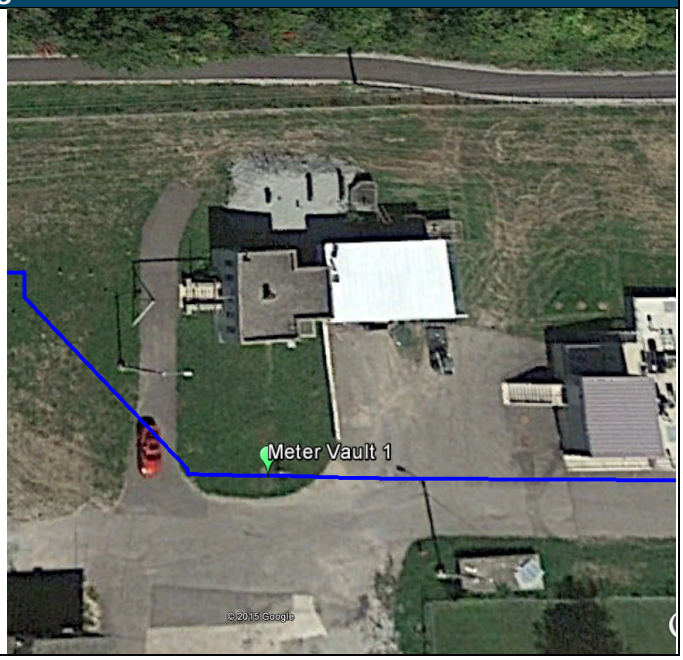
Based on the inspections of the Dewey Force Main, Pure Technologies concludes the following:

1. The average velocity of the SmartBall PWA tool during the inspection was calculated to be 1.2 ft/sec.
2. There were no leaks or gas pockets detected in the force main at the time of inspection.
3. There were two (2) gas slugs detected during the inspection. Gas slugs are transient conditions and are not typically of concern.
4. Eight (8) PWA anomalies were detected in the force main, two (2) were classified as small and six (6) were classified as medium. Additional investigation is needed to determine the cause of the PWA anomalies. Pure recommends test pitting to determine the source and severity of the stress at these locations.
5. A discrepancy between the velocity profile of the SmartBall PWA device and the distances between features indicated on the provided drawings of the Dewey Force Main was identified during data analysis. This discrepancy results in less confidence in the reported location of gas slugs and PWA anomalies. Additional distance measurements are need to more accurately locate the inspection results.

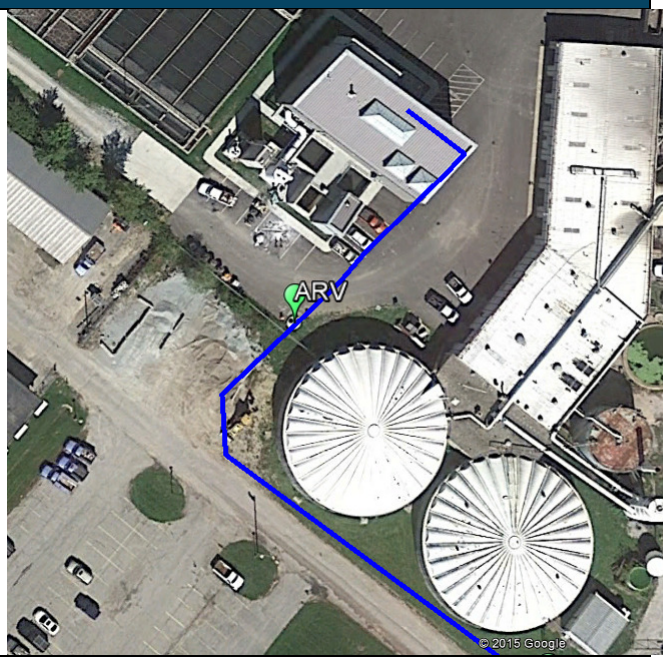
APPENDIX A

Tracking Points Used

Tracking Location 1	
Distance from Launch	164 feet
Feature	Meter Vault
Latitude, Longitude	40° 6'36.02"N 85°42'25.87"W
Traffic Control	NO



Tracking Location 2	
Distance from Launch	3,381 feet
Feature	Air Release Valve
Latitude, Longitude	40° 6'38.12"N 85°42'59.62"W
Traffic Control	NO



APPENDIX B

Advantages and Limitations of the SmartBall Tool

The SmartBall technology acquires high quality acoustic data which is then evaluated to identify leaks and pockets of trapped gas. While other leak detection techniques such as noise loggers and correlators may identify a single leak or gas pocket between each sensor, they cannot accurately locate the limits of the anomaly nor identify multiple anomalies, whereas the SmartBall tool travels directly past each acoustic anomaly of interest, and thus significant advantages are recognized:

- Medium and Large Diameter Pipe: SmartBall technology has successfully inspected and detected leaks on a wide range of medium and large diameter pipelines (greater than 12 inches and over 96-inch diameter) . Many conventional leak detection technologies (e.g., correlators) have limitations that preclude their use on medium and large diameter pipe.

- Pipe Material: The SmartBall tool's leak detection ability is not affected by pipe material. Because the tool passes by the point at which the acoustic event is being created, the pipe wall is not relied on to transmit the acoustic event through the line to a sensor located far away from the actual event of interest. This greatly increases the SmartBall tool's sensitivity and ability to distinguish between separate acoustic events.

- Sensitivity: The sensitivity of all leak detection technologies is a function of several variables and as a result, no resolute thresholds can be established. However, the acoustic sensor inside the SmartBall tool always passes within one (1) pipe diameter of an acoustic anomaly and therefore, it can be used to identify very small leaks due to the proximity of the SmartBall tool to the leak. It should be noted, the SmartBall technology cannot differentiate between a true leak, a simulated leak, and the potential noise of a pressure reducing valve. As such, the acoustic anomalies corresponding to features on the main should be investigated further in the field.

- Length of Survey: SmartBall technology has the ability to record acoustic data for over 12 hours. Depending on flow rates, the tool can inspect long lengths of pipe during a single deployment. The longest single recording within a water pipeline with a single deployment had the SmartBall tool record acoustic data and inspect a length of pipeline exceeding 30 miles.

All non-destructive testing technologies have unique capabilities and limitations that affect the accuracy and efficacy of the technology. The SmartBall tool has the following limitations:

- Minimum Pressure: The acoustic activity associated with a leak is derived from the pressure differential across the pipe wall. With little to no pressure differential, the SmartBall tool will not detect leakage as there will be no associated acoustic activity. Pure Technologies recommends a minimum pressure of 15 pounds per square inch (psi) for leak detection inspections however, under ideal conditions leaks have been detected in pipelines with pressures as low as 5 psi. There is no minimum pressure recommendation for the detection of areas of trapped gas.

- Ambient Noise: The SmartBall technology detects and reports anomalies that have acoustic characteristics similar to leaks on pressurized pipelines. However, other forms of ambient noise may be identified during the data analysis. For medium and large leaks, there is very little that can match these acoustic characteristics and therefore, these

events are certainly leaks. For small leaks, there may be other forms of ambient noise that are difficult to evaluate. Pure Technologies has invested significant resources into characterizing acoustic anomalies and consequently believes leaks described in this report are leaks, unless otherwise noted. However, unknown pressure reducing valves, cracked valves in close proximity, interconnected pipelines that have not been completely isolated, and leaks in pipelines immediately adjacent to the subject pipe do contain a similar acoustic signature and could be reported as leaks in this report. Cars, pumps, boat traffic, and other forms of common ambient noise should not be reported as leaks as they contain different acoustic signatures.

- Reported Locations: Reported locations contained in this report are believed to be accurate to within +/- 100 feet. This estimation is based on project experience and the limitations of the technologies used to calculate location. This is also due to known station numbering for tracking locations. There are also several other factors that would decrease the accuracy of locating leaks and gas pockets: if SBR devices are more than 3,300 feet apart (pipe distance/station numbers), the location/station of SBRs are unknown, or the drawings or dimensions provided by the client are incorrect.

APPENDIX C

PWA Data List

PWA Data List				
Distance from Insertion (ft)	**Classification**	**Size**	**Time SmartBall passed Anomaly**	**Comments**
164	Feature	N/A	9:32:33	Meter vault (SBR1)
248	Feature	N/A	9:33:42	45 degree bend
339	Anomaly	Medium	9:34:59	
1071	Anomaly	Small	9:45:30	Inconsistent PWA readings at joints
1333	Anomaly	Medium	9:49:24	
1620	Feature	N/A	9:53:37	90 degree bend
1698	Anomaly	Medium	9:54:43	
1889	Anomaly	Medium	9:57:27	
1941	Feature	N/A	9:58:13	90 degree bend
1963	Anomaly	Medium	9:58:32	Possible turbulence in pipeline
2127	Anomaly	Medium	10:00:51	
2374	Anomaly	Small	10:04:30	
2522	Feature	N/A	10:06:33	90 degree bend
2648	Feature	N/A	10:08:21	Short pipe
2674	Feature	N/A	10:08:41	90 degree bend
3148	Feature	N/A	10:15:12	Short pipe
3158	Feature	N/A	10:15:20	Short pipe
3304	Feature	N/A	10:17:28	45 degree bend
3320	Feature	N/A	10:17:41	45 degree bend
3381	Feature	N/A	10:18:30	Air release valve (SBR2)
3482	Feature	N/A	10:20:23	45 degree bend
3490	Feature	N/A	10:20:31	45 degree bend
3538	Feature	N/A	10:21:23	Possible interference after this point

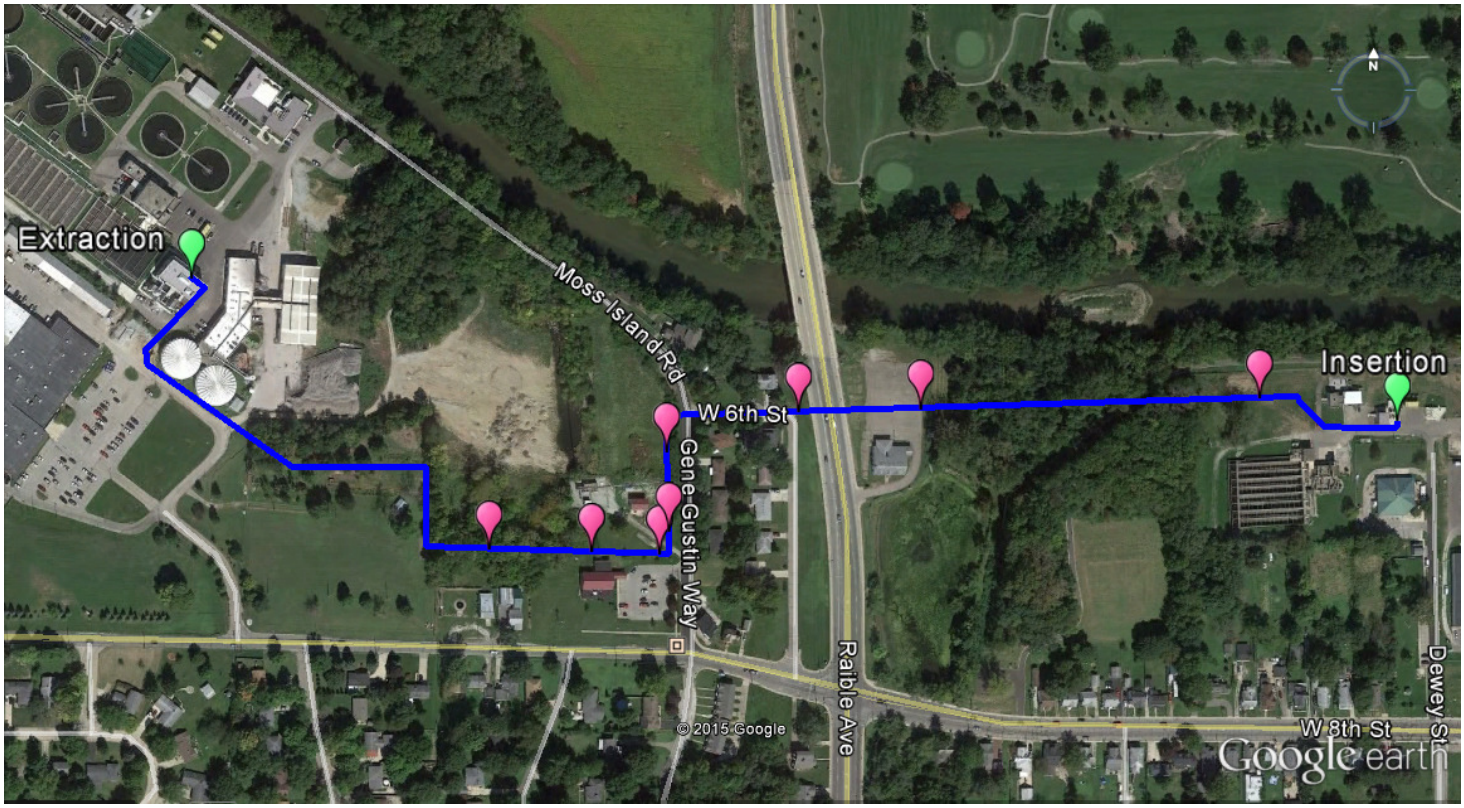


Figure C.1: Appoximate locations of PWA anomalies, additional surveying/ locating of the Dewey Street Force Main's key features is needed to accurately locate PWA anomalies.

APPENDIX D

Gas Slugs Sites of Interest Details

Details on acoustic anomalies of interest that were detected during the SmartBall survey are provided below.

Site of Interest #1 - Gas Slug	
Start of Gas Slug:	67 feet
End of Gas Slug:	108 feet
Distance to Nearest Sensor (Start Pocket):	97 feet before SBR 1
Time Since Insertion (Start Pocket):	00:01:13
Time Since Insertion (End Pocket):	00:01:52
Time of SmartBall Pass (GMT-5:00) (Start Pocket)	09:32:24 AM
Time of SmartBall Pass (GMT-5:00) (End Pocket):	09:33:03 AM
Approximate Location (Start Pocket):	40° 6'36.01"N, 85°42'24.84"W
Approximate Location (End Pocket):	40° 6'36.01"N, 85°42'25.55"W
Estimated Size:	~ 41feet

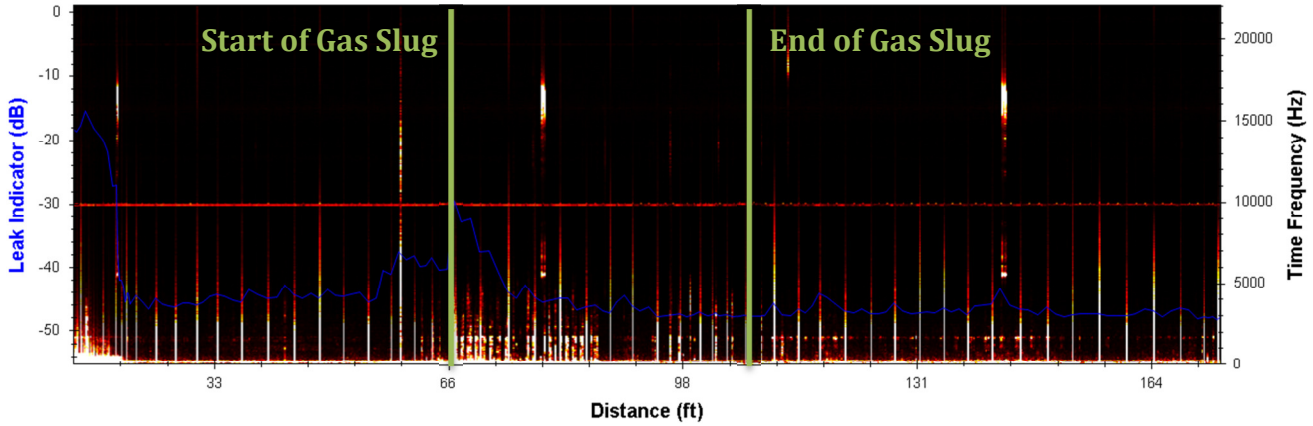


Figure 1: Acoustic Intensity of Gas Slug #1 Anomaly

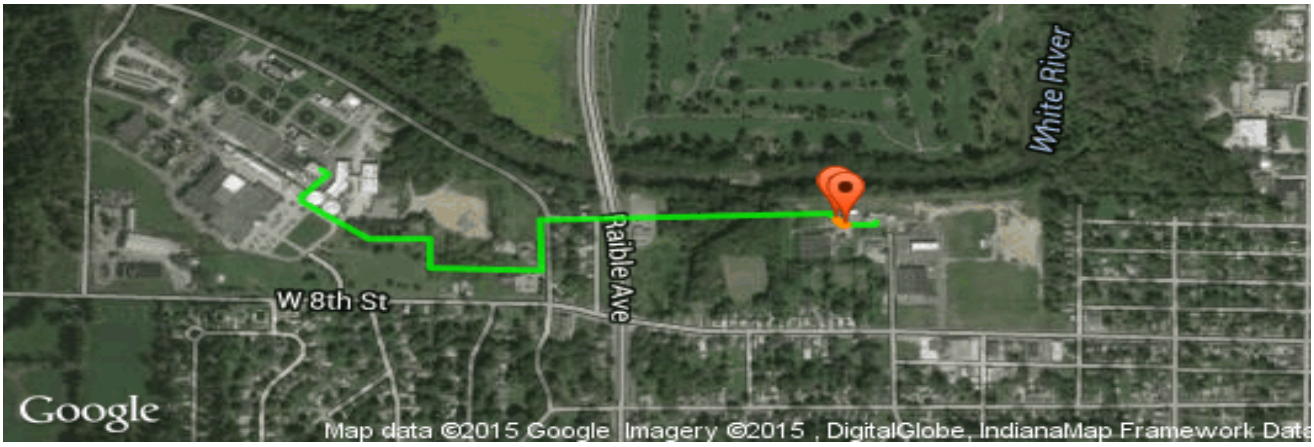


Figure 2: Approximate Location of Gas Slug #1 Acoustic Anomaly

Site of Interest #2 - Gas Slug	
Start of Gas Slug:	3,198 feet
End of Gas Slug:	3,222 feet
Distance to Nearest Sensor (Start Pocket):	182.6 feet before SBR 2
Time Since Insertion (Start Pocket):	00:44:54
Time Since Insertion (End Pocket):	00:45:14
Time of SmartBall Pass (GMT-5:00) (Start Pocket)	10:16:05 AM
Time of SmartBall Pass (GMT-5:00) (End Pocket):	10:16:24 AM
Approximate Location (Start Pocket):	40° 6'36.91"N, 85°42'59.13"W [I]
Approximate Location (End Pocket):	40° 6'37.03"N, 85°42'59.37"W [I]
Estimated Size:	~ 24feet

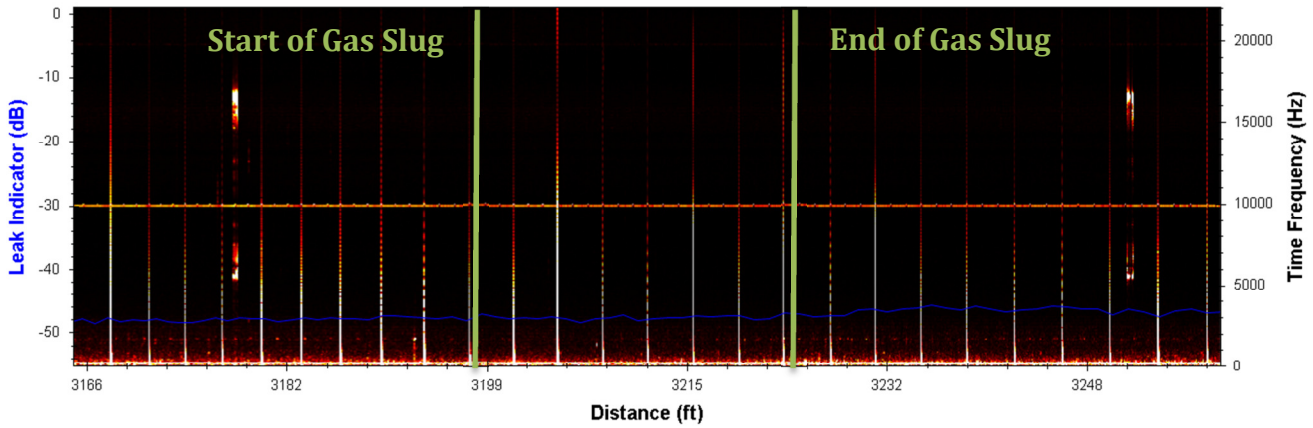


Figure 3: Acoustic Intensity of Anomaly Gas Slug #2

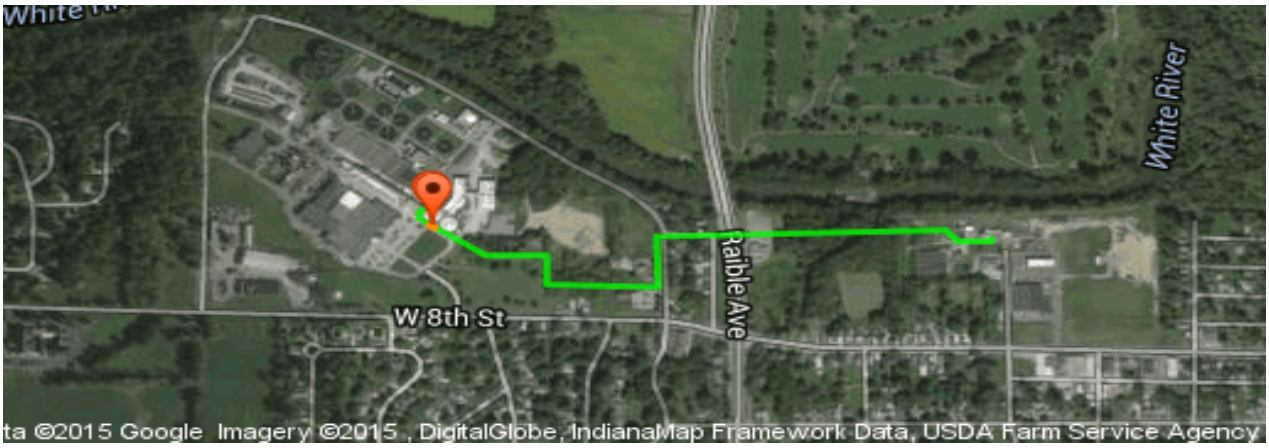


Figure 4: Approximate Location of Gas Slug #2 Acoustic Anomaly

[I] *Based on data obtained through Google Earth*

APPENDIX E

Drawing Review

Drawing Review of 36-inch Dewey Street Force Main							
Diameter	**Drawing Referenced**	**Station**	**Feature**	**Description**	**Total (ft)**	**Total (mi)**	**Notes**
24"	FM3	0+00.00	ARV	4-inch ARV with pipe access	0	0.00	**Insertion**
24"	FM3	0+15.00	EL	Vertical 90 degree	15	0.00	
24"	FM3	0+22.00	EL	Vertical 90 degree	22	0.00	
24"	Sectional Plan	0+27.00	EL	45 degree	27	0.01	
24"	Sectional Plan	0+34.00	EL	45 degree	34	0.01	
36"	Sectional Plan	0+51.00	Tye In	End of Page	51	0.01	
36"	AG16	1+42.00	RE	Reducer	142	0.03	
36"	AG16	1+64.00	Meter	Metering Device	164	0.03	**SBR 1**
36"	AG16	1+82.00	RE	Reducer	182	0.03	
36"	AG16	1+93.00	Tee	Tee	193	0.04	
36"	AG16	1+95.00	EL	45 Degree	195	0.04	
36"	AG16	2+75.00	EL	45 Degree	275	0.05	
36"	AG16	2+84.00	EL	45 Degree	284	0.05	**Station Equation where it is assumed to tie into Drawings**
36"	2	32+58.00	Start	Start Prints Page 2	284	0.05	
36"	2	18+42.00	EL	90 Degree	1700	0.32	
36"	2	15+34.00	EL	90 Degree	2008	0.38	
36"	2	9+90.00	EL	90 Degree	2552	0.48	
36"	2	8+12.00	EL	90 Degree	2730	0.52	
36"	2	5+56.00	EL	45 Degree	2986	0.57	
36"	2	2+41.00	End	45 Degree	3301	0.63	**Station Equation where it is assumed to tie into Drawings**
36"	AG10	0+00.00	EL	45 Degree	3301	0.63	
36"	AG10	0+30.00	EL	45 Degree	3331	0.63	
36"	AG10	0+80.00	ARV	4-inch ARV	3381	0.64	**SBR2**
36"	AG10	1+04.00	EL	45 Degree	3405	0.64	
36"	AG10	1+08.00	EL	Vertical 90 degree	3409	0.65	
36"	AG10	1+09.00	EL	Vertical 90 degree	3410	0.65	
36"	AG10	2+24.00	EL	45 Degree	3525	0.67	
36"	AG10	2+32.00	EL	45 Degree	3533	0.67	
36"	AG10	2+70.00	Wall	Tank Wall	3571	0.68	
36"	AG10	2+80.00	EL	Vertical 90 degree	3581	0.68	
36"	BM4	2+95.00	End of Pipe	End of Pipe	3596	0.68	**Extraction**

Drawing Review Key	
Color	**Referenced in Table**
Blue	Start & End on Inspection
Yellow	SBR Locations
Green	Station Equations

2 Wet Weather Pumps

Pump Data Sheet - Fairbanks Morse Pump, 60 Hz

Company: BBC Pump & Equipment
Name: Rick Littlepage
Date: 8/8/2013

Fairbanks Morse
Pentair Water

Wet Weather

Pump:

Size: 24"VTSH (B)
Type: VTSH
Synch speed: 720 rpm
Speed: 705 rpm
Dia: 22.0625 in
Curve: 902410B
Impeller: V24B1A
Specific Speeds:
Ns: 3308
Nss: 7646
Dimensions:
Suction: ---
Discharge: 24 in

Pump Limits:

Temperature: 160 °F
Pressure: ---
Sphere size: 6 in
Power: ---
Eye area: ---

Search Criteria:

Flow: 14000 US gpm
Head: 45 ft

Fluid:

Water
Density: 62.25 lb/ft³
Viscosity: 1.105 cP
Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a
NPSHa: ---

Motor:

Standard: NEMA
Enclosure: TEFC

Speed: ---
Frame: ---
Sizing criteria: Max Power on Design Curve

---- Data Point ----

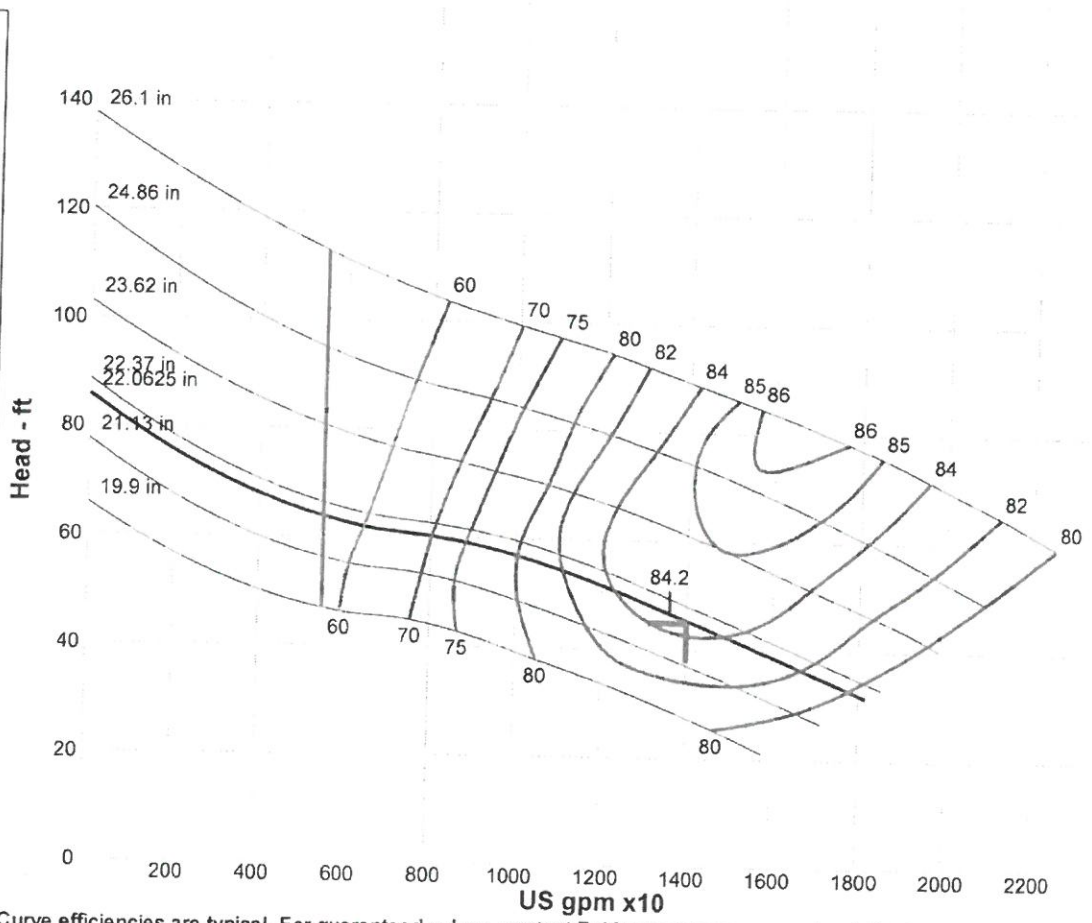
Flow:	14000 US gpm
Head:	45.4 ft
Eff:	84%
Power:	190 hp
NPSHr:	20.3 ft

---- Design Curve ----

Shutoff head:	85.9 ft
Shutoff dP:	37.1 psi
Min flow:	5500 US gpm
BEP:	84% @ 13587 US gpm
NOL power:	191 hp @ 14845 US gpm

-- Max Curve --

Max power: 424 hp @ 21207 US gpm



Curve efficiencies are typical. For guaranteed values, contact Fairbanks Morse or your local distributor. Las eficiencias en curvas son típicas. Para valores garantizados contacte a Fairbanks Morse o a su distribuidor local.

Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
16800	705	36.2	82	188	26.9
14000	705	45.4	84	190	20.3
11200	705	53.9	82	186	18
8400	705	59.8	72	175	18
5600	705	65.1	55	165	18

Selected from catalog: Fairbanks Morse Centrifugal.60 Vers: 3

LETTER OF TRANSMITTAL

9616- - Anderson Water Pollution Control Plant
Facility Improvements

DATE: 12/12/2012
TRANSMITTAL #:676

To:	Rick Littlepage Fairbanks Morse Pump C/O BBC Pump & Equipment Company 3601 Fairbanks Avenue Kansas City, KS 66106	**From:**	Derek Carlson F.A. Wilhelm Construction Co., Inc.
Phone:	(317) 636-1111	**Phone:**	(317)359-5411
Fax:		**Fax:**	
Email:	RLittlepage@bbcpump.com	**Email:**	derekcarlson@fawilhelm.com

CC: Nate Crowell - F.A. Wilhelm Construction Co., Inc. - Phone: (317)359-5411 - Fax: ,
Derek Carlson - F.A. Wilhelm Construction Co., Inc. - Phone: (317)359-5411 - Fax:

Attached and/or enclosed are the following documents and/or items for your action as noted below.

Please review and respond to Derek Carlson by 12/26/2012.

Additional Notes:

DOC TYPE	DOCUMENT #/DESCRIPTION	COPIES	ACTION	REMARKS
Close-Out	11311-003A:O & M's - Vertical Column Solids Handling Pumps	1	Approved as Noted	

Derek Carlson

GREELEY AND HANSEN

6640 Intech Boulevard, Suite 180
Indianapolis, Indiana 46278
p 317 924 3380
f 317 925 3811
www.greeley-hansen.com

TO: **F.A. Wilhelm Construction Co., Inc.**
3914 Prospect Street
Indianapolis, IN 46203

Attn: **Derek Carlson**

Specification Section: 11311

Date: December 6, 2012

Project: Anderson WPC Improvements Division 2

G & H Transmittal No. SD 328

Please find below our comments on your submittal.

Quantity	Submittal	Title	Action
1	11311-003A	O&M Manual – Vertical Column Solids Handling Pump	3,7

These are:
1. To be checked.
2. Examined and returned for correction.
3. Approved subject to corrections marked.
4. Approved.
5. For your information and use.
6. Incomplete submittal.
7. See Remarks.

REMARKS:

1. Full Data nameplate needs pertinent information provided where necessary in the final manual
   a. Any items (installation records, nameplates, etc…) left blank within this submittal must be completed and double-checked before acceptance of final manual
2. Provide full-length serial numbers for all equipment included within this submittal throughout the manual so there is no confusion to those who will be reading the manual (-0 & -1 is confusing and not acceptable)
3. Provide warranty start and end dates in final O&M manual in accordance with Specification Section 01783, Paragraph 1.4.A.1.
4. Provide equipment layout drawings complete with as-built information and dimensions in final O&M manual in accordance with Specification Section 01783, Paragraph 1.4.A.1.
5. Provide manufacturer's certificates of proper installation in final O&M manual in accordance with Specification Section 01783, Paragraph 1.4.A.1.
6. Included certified equipment test results in final O&M manual in accordance with Specification Section 01783, Paragraph 1.4.A.1.

Yours Very Truly
Greeley and Hansen LLC

Bill Porter

CC: File (G&H)
Webb Bernhardt (American Structurepoint)
Nara Manor (Anderson) –Transmittal only

[ ] APPROVED [X] APPROVED AS NOTED

Review and approval of this submittal are expressly limited as provided in the Contract Documents and are only to determine conformance with information given in the Contract Documents and compatibility with the design concept of the completed project as a functioning whole as indicated in the Contract Documents. CONTRACTOR remains solely responsible for its duties under the Contract Documents including matters relating to fabrications, shipping, handling, storage, assembly, dimensions, measurements, installation, construction (including all safety aspects of performing the Work) and for coordinating the Work. No addition to the Contract Time or Price is authorized hereby.

[ ] REVISE AND RESUBMIT

GREELEY AND HANSEN LLC

DATE: 12/6/2012 BY: WSP

Installation, Operation & Maintenance Manual

For

Anderson WPC

Anderson, IN

Serial Number 2186049-0 & -1

Wet Weather Pump

24" VTSH-UWF

Specification Section 11311

CHECKED and APPROVED as noted

The architect's corrections supersede our approval.
Our approval does not relieve the supplier of complying with the contract documents.

F.A. WILHELM CONSTRUCTION CO., INC.

By: Derek Carlson

Date: 11/26/12

FAW Job No.: 9616

Submittal No.: 11311-003A

Fairbanks Morse
Pentair Water

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Supplier:	F. A. Wilhelm Construction Co., Inc. 3914 Prospect St. Indianapolis, IN 46206 (317) 359-5411 Fax: (317) 359-8346
Manufacturer:	
Pump:	Fairbanks Morse Pump 3601 Fairbanks Ave. Kansas City, Kansas 66106-0906 (913) 371-5000 Fax: (913) 748-4025
Fairbanks Morse Project Number:	064585
Fairbanks Morse Sales Order Number:	2487333
Service:	Wet Weather Pump
Quantity:	2
Pump Size & Model:	24” VTSH-UWF
Motor:	U S Electrical Motors P. O. Box 3946 St. Louis, MO 63136 (314) 553-2000
Local Parts & Service Contact:	B B C Pump & Equipment 777 N. Tibbs Avenue Indianapolis, IN 46222 (317) 636-1111 Fax: 317-636-5467

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Section 1 Warranty & Storage

Warranty Highlights

1. Seller warrants products of its own manufacture against defects in materials and workmanship under normal use and service for one (1) year from date of installation or start-up, but not more than eighteen (18) months after date of shipment.
2. Accessories and components not manufactured by seller are warranted only to the extent of the original manufacturer's warranty.
3. No allowances will be made for repairs or alterations effected without specific written authorization from Seller.
4. The equipment as manufactured by Fairbanks Morse Pump is precision machinery. Proper care can give a lifetime of satisfactory service. Guarantees of performance and warranties are based on the use of original equipment manufactured (OEM) replacement parts. Fairbanks Morse Pump assumes no responsibility when alterations, non-authorized design modifications and/or non OEM replacement parts are incorporated.
5. This warranty is VOID unless the purchaser provides protective storage, installs and maintains the equipment in accordance with manufacturer's instructions.
6. Under the terms of this warranty, Seller shall not be responsible or liable for:
    a. Consequential, collateral or special losses or damages.
    b. Equipment conditions caused by fair wear and tear, abnormal conditions of use, accident, neglect, or misuse of said equipment.
    c. Labor charges, loss or damage resulting from supplying of defective part(s) or improper repairs by unauthorized person(s).
    d. Damage caused by abrasive materials, chemicals, scale deposits, corrosion, lightning, improper voltage or mishandling.
    e. Labor charges for installation, removal or reinstallation of equipment.
7. The above listed warranty highlights do not constitute our total terms and conditions regarding warranty. For complete warranty information please refer to complete warranty statement herein.

Loss or Damage in Transit

1. Immediately upon receipt a complete inspection and accounting against the packing list should be made of all major components, and accompanying boxes or pallets.
2. All material is shipped F.O.B. our factory, or our vendor's shipping point unless optional contractual arrangements are made. Under these terms, any claims for loss or damage in transit should be immediately directed to the delivering freight carrier.
3. Fairbanks Morse will assist the customer in receiving fair compensation, but assumes no responsibility to mediate such claims. This policy includes shipments wherein Fairbanks Morse pays freight costs as part of the sales terms.

Safety

Safety should be of utmost importance when in close proximity of this pumping equipment. Before attempting to operate this equipment, you should read this manual in its entirety, taking special notice of all cautions, warnings and/or danger notifications. These Warnings apply to pumps supplied by Fairbanks Morse. Refer to the manuals supplied by the driver and control manufacturer for additional Warnings before operating this equipment.

The words **DANGER**, **WARNING** and **CAUTION** have different connotations and are generally defined as follows:

DANGER: Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING: Indicates a potentially hazardous situation which, if not avoided, will result in serious injury.

CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or may indicate that improper practices will result in equipment malfunction or failure. It may also be used to alert against unsafe practices.

IMPORTANT: Another notation will appear throughout this manual. IMPORTANT indicates the highlight or accent of specific information.

The installation, use and operation of this type of equipment are affected by various Federal, State and Local Laws and the regulations concerning OSHA. Compliance with such laws relating to the proper installation and safe operation of this type of equipment is the responsibility of the equipment Owner and all necessary steps should be taken by the Owner to assure compliance with such laws before operating the equipment.

DANGER: Do not attempt to service the pump until the electrical power has been disconnected and it has been verified that the pump cannot start. Because many Installations utilize automatic starting equipment, the pump unit may start at any time without warning. Proper precautions should be taken to avoid injury as a result of automatic starting of the equipment.

DANGER: Do not operate the pump without guards In place over the rotating parts. Exposed rotating parts can catch clothing, fingers, or tools, causing severe injury to personnel. Any operation of this machine without a protective guard can result in severe bodily injury. The responsibility for the installation of protective guards is that of the equipment owner.

DANGER: This pump is designed for the exclusive use of pumping water. It should not be used for pumping other media unless a specific Purchase/Buyer agreement is negotiated.

WARNING: Do not attempt to try to clean the pump with bare hands. The pumped material may contain items that may present health hazards such as needles, and other sharp objects. Always wear heavy puncture resistant gloves.

WARNING: Before attempting to service this pump:

1. Familiarize yourself with this manual.

2. Disconnect or lock out the power source to insure the pump will not start. Confirm power source disconnect with appropriate electrical test equipment.

3. Close the discharge valve.

After the pump has been installed, make certain that the pump and all piping connections are tight and are properly supported prior to start-up and operation.

WARNING: Certain procedures in disassembly and assembly require parts be heated to high temperatures. Heat resistant gloves must be worn when handling heated parts. Heated parts can cause severe personal Injury.

CAUTION For pumps used in potable water service, all thread lubrication, grease, cleaning materials and paint must be suitable for potable water.

Storage of Pumps

CAUTION: If the equipment is not to be immediately installed and operated, **THE FOLLOWING INSTRUCTIONS SHOULD BE ADHERED TO AS A MINIMUM.**

Consider a unit in storage when:

1. It has been delivered to the job site and is awaiting installation.
2. It has been installed but operation is delayed pending completion of plant construction.
3. There are long (30 days or more) periods between operation cycles.
4. The plant (or facility) is shut down.

NOTE: Improper storage could result in product failures or restoration not covered by warranty.

Assembled Pumps:

1. Remove the gland halves, packing and seal water rings from the stuffing box.
2. When pumps with rubber bearings are stored assembled in horizontal position, it is necessary to rotate the entire pump and column assembly 90 degrees once per month. This practice will help prevent the weight of the shafts from deforming the rubber bearings. Pumps with metal bearings stored in horizontal positions are to have shafts rotated once per month to prevent line shafts; from deforming or bowing under their own weight.
3. Pumps stored fully assembled and installed are to be rotated once per week to prevent brinelling of motor thrust bearings. Packing or mechanical seals are to be serviced as noted above.

Unassembled Pumps:

1. Store the unassembled components in a clean, dry well-ventilated place free from vibrations, moisture, and temperature variation.
2. Wipe clean all exposed machined surfaces and coat with a heavy layer of grease or other equivalent rust preventative material.
3. Cover the suction and discharge of the pump with cardboard or wood to prevent entry of foreign material or varmints. This also applies to column sections.
4. The enclosing tube, bearings, shaft, and couplings should be stored as components, i.e. shaft with couplings installed on lower ends inserted into enclosing tubes with bearings installed in upper ends. The ends should then be wrapped with heavy plastic or protective material and secured tightly to prevent entry of foreign matter and varmints.

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Section 2 Introduction

Congratulations! You are the owner of the finest pump commercially available. If you give it the proper care as outlined and recommended by this manual, it will provide you with reliable service and long life.

IMPORTANT: Read this complete manual and manuals for all component equipment before assembly or installation is started. It contains information which is the result of engineering and research efforts. It is designed to supply adequate instructions for the installation, operation and maintenance of your pump. Failure or neglect to properly install, operate or maintain your pump may result in personal injury, property damage or unnecessary damage to the pump.

This manual applies to the pump installation, operation and maintenance. They are intended to be general and not specific. If your operating conditions ever change, always refer to the factory for reapplication. Always refer to the manuals provided by manufacturers of the accessory equipment for their separate instructions.

Variations exist in both the equipment used with these pumps and in the particular installation of the pump and driver. Therefore, specific operating instructions are not within the scope of this manual. The manual contains general rules for installation, operation and maintenance of the pump. If there are questions regarding the pump or its application which are not covered in this manual, please contact the factory as follows:

Fairbanks Morse Pump
3601 Fairbanks Avenue
P.O. Box 6999
Kansas City, KS 66106-0999
(913) 371-5000
Fax: (913) 748-4025

To obtain additional data on hydraulics and pump selection and operation, we suggest you purchase both of the following reference books:

1. Fairbanks Morse "Hydraulic Handbook" available from the Kansas City factory.

   Fairbanks Morse Pump
   3601 Fairbanks Avenue
   P.O. Box 6999
   Kansas City, KS 66106-0999
   (913) 371-5000
   Fax: (913) 748-4025

2. Hydraulic Institute Standards

   Hydraulic Institute
   9 Sylvan Way
   Parsippany, NJ 07054-3802

Pump Identification

Important identification is given in the following tables. Some of the information may not be available at the time this manual is prepared. Fill in the missing information from nameplate(s) supplied with the equipment. In addition to the nameplate, the serial number is stamped on the discharge flange.

Nameplate Data

Pump	
Serial Number	2186049-0 & -1
Size	24”
Model Number	VTSH-UWF
Capacity (GPM)	14,000
Head (Ft.)	40
Motor	
Manufacturer	U. S. Electrical Motors
Serial Number	20113356-1 & -2
Horsepower	200
Frame	5807P
Full Load Speed (RPM)	710
Full Load Amps	258.3
Phase/Hz/Volts	3/60/460

Lubrication Water

VTSH pumps are designed with external water flushed pump and lineshaft bearings. Fairbanks Morse recommends the lubrication system be adequate to provide a continuous supply of flush water to the bearings. If a continuous supply is not possible, then a timer must be installed to start the lubricating water system at least 5 minutes before starting the pump. Flushing water requirements for the pump on this order are shown below in **Error! Reference source not found.**

Table 1, Flush Water Requirements

Pump Size	Nominal Flow (GPM)	Alarm Flow (GPM)	Pressure (PSI)
24”	1.2	0.5	50

Component Description

General

The VTSH® pump consists of six major components. These components are the pump bowl assembly, column pipe, enclosing tube, line shafting, discharge head, and the driver.

Bowl Assembly

The VTSH pump bowl assembly consists of the suction bell, diffuser bowl, bowl bearings, impeller, and pump shaft. The bowl assembly is available only as a single stage unit. Bearing lubrication is by water flush lubrication injection into the enclosing tube.

The suction bell serves as the intake for the pump bowl assembly. The impeller through the diffuser bowl where it is directed moves liquid into the pump column pipe. The suction bell is fitted with a wear ring.

The diffuser bowl contains two bearings of different size installed in the top and bottom of the bowl hub. Water lubricated bowl bearings are of fluted rubber bonded to a metal shell. The bowl bearings receive lubrication through the enclosing tube.

The impeller is secured to the pump shaft with a hex head capscrew, washer and key.

Column Pipe

Column pipe for the VTSH pump is flanged with bolted connections and registered fits for accurate column alignment. A splitter vane integral within the column prevents fibrous and stringy material from entanglement around the enclosing tube. Column pipe is supplied in standard 5 ft. & 10 ft. lengths with a variable length top section to make up specific overall length.

Enclosing Tube

The enclosing tube surrounds the shafting and protects both the line shaft and the bearings from the pumped liquid. It provides a channel for lubricating the shaft bearings. The connector bearings for the shafting are threaded on the outside diameter and connect the 5 ft. enclosing tube sections. The bottom section of enclosing tube threads to an adapter bolted or threaded to the diffuser bowl hub. The packing box assembly tensions the enclosing tube assembly.

Line Shafting

The line shaft transmits torque from the pump driver to the pump bowl assembly and operates inside the enclosing tube. Both ends are precision machined and threaded. They are secured together with threaded couplings. Line shafting is supplied in standard 5 ft. & 10 ft. lengths with a variable length top section to make up specific overall length. The shafting is supported by bearings.

The water flush-lubricated shafting has bronze connector bearings with longitudinal holes allowing the water to flow to the pump bearings.

A shaft sleeve is fixed to the top shaft at the packing box location.

Clean water for lubrication must be supplied from an external source connected to the packing box.

Discharge Head

The discharge head performs multiple functions. First, it directs the flow from the pump column to the piping system. Secondly, it contains a seal for the lineshaft and the enclosing tube. Thirdly, it serves as a base from which the pump is suspended. Finally, it provides a mounting surface for the driver.

The discharge head is fabricated from high quality steel plate and pipe with an integral splitter vane.

Underground discharge pumps use a pedestal to provide a method for sealing the line shaft, provide a base from which the pump is suspended, and provide a mounting surface for the driver.

Refer to the setting plan and assembly drawings found in the Section 7 of this manual for your specific configuration and technical data.

A soleplate is supplied standard

Driver

The driver supplied is a vertical solid shaft motor. Solid shaft drivers require adjustable couplings in order to attach to the pump shaft and to accommodate impeller adjustment.

Refer to ***Section 7*** for coupling information and to **Section 8** for specific driver submittal.

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Section 3 Installation

General

Prior to assembly and/or installation, the pump and loose parts are to be inspected for completeness, correctness and cleanliness. During this inspection, all parts are to be thoroughly cleaned and any burrs removed by filing. The pump bowl assembly, including the line shaft coupling, is normally shipped completely assembled. Both the suction and discharge openings should be inspected for damage and for foreign materials. Rotate the shaft by hand, and move in and out to check for endplay. Place all parts in an orderly arrangement for convenient assembly.

WARNING: Extreme caution is to be exercised when hoisting components with open lifting lugs. Precautions should be taken to prevent hoisting slings from coming out of the lugs.

WARNING: Never attempt to mount the driver on the discharge head prior to installation of the pump.

WARNING: Never attempt to hoist the entire pump by the driver lifting lugs or eyes. These lifting points designed only to hoist the weight of the driver, not other attached components

IMPORTANT: All shafting has been pre-straightened to a tolerance of 0.005" in 10 feet prior to leaving the factory or assembly plant. Care in handling must be taken to insure that the shafting is not bent prior to and during installation.

Foundation

A foundation must be supplied consisting of any material that will provide a permanent, rigid support. This support is to be of sufficient size and depth to fully carry the weight of the pump (full of water) and rigid enough to prevent vibration.

Anchor bolts are to be supplied and set in place by the installing contractor. Anchor bolts of appropriate size; length and configuration are required to adequately secure the discharge head/pedestal to the foundation.

When the pump is to be mounted over a pit on structural steel framing, it should be located as close to the main structure or wall as possible. Cross members are to be used to prevent distortion and vibration of structural mounting frame.

Well and Pit Inspection

Prior to installation and start-up, the well or pit must be cleaned of all loose material and debris. Both the suction and discharge openings should be inspected for damage and for foreign materials.

CAUTION: Reduced performance and possible equipment damage may result from ingestion of foreign material by the pump.

NOTE: Before proceeding, measure and record the pump bowl assembly endplay. This information will be needed later.

Shaft projection can be defined as the distance from the diffuser bowl mounting to the end of the pump shaft. Nominal standard shaft projection for the model VTSH is 17-1/2".

Shaft endplay is the amount of axial movement available in the pump bowl assembly. Measure and record the pump bowl endplay. This can most easily be accomplished with the bowl assembly in a horizontal position. Grasp the pump shaft and move the shaft through its maximum axial travel.

Refer to the technical data page in the Section 7 of this manual for the correct amount of endplay for your specific pump.

Hoisting, Leveling, Grouting & Piping

If your pump was shipped completely assembled, it is now vertically in the well. ready to install.

Prior to assembly, all, components are to be identified and laid out in order of assembly.

WARNING: A journeyman mechanic, experienced with lifting heavy equipment, using adequate crane and sling capacity is required to lift this equipment into place. All applicable safe hoisting practices should be employed.

The pump is to be hoisted by the discharge head. Pumps thirty feet or more in overall length should also be supported at the column midpoint to avoid column/shaft distortion and possible pump damage.

The pump is to be lowered onto the anchor bolts and leveled. This can be achieved by applying a good quality machinist's spirit level to the machined motor mounting surface or to the below-grade pump column, if accessible.

After leveling, the base plate is to be grouted in place with a good quality non-shrinking grout. After the grout is fully dry, the base plate is to be tightened solidly in place against the grout bed.

Leveling devices are to be removed or backed off and the pump base plate tightened solidly against the grout bed.

All pockets and/or holes left by removal of leveling devices are to be filled with grout.

IMPORTANT Damaging vibration may result if the base plate is not solidly in contact with the grout bed. Even the highest quality non-shrink grouts contract slightly during drying. All leveling wedges, nuts or jackscrews are to be removed or backed off prior to final tightening of the base plate fasteners. Failure to do so will result in the pump base plate resting on the leveling devices rather than the grout bed.

Piping is to be brought in direct axial alignment with the pump discharge. Flange faces are to fit closely and squarely. The pump discharge is to have no strain imposed upon it by piping misalignment.

Pump Assembly

If the pump has been shipped disassembled, the following instructions are to be employed to assemble the unit vertically in the well.

Prior to assembly, all components are to be identified and laid out in order of assembly Standard length intermediate column, enclosing tube and shafts are interchangeable and can be assembled in any order. However, shorter non-standard column, enclosing tube and shaft sections are provided to accomplish the required overall pump length, and must be installed at the top of the pump directly under the discharge head. The top enclosing tube also has longer threads to engage the top tube tension nut.

Bowl Assembly Installation

A. Using an appropriate hoisting system, lift the pre-assembled bowl assembly and position it above the well.

B. Lower the bowl assembly partially into the well and attach a pipe clamp to the upper most bowl, directly under the bowl flange.

C. Lower the assembly, allowing it to be suspended on the foundation via the pipe clamp.

Column & Shaft Assembly

IMPORTANT: All joints must be properly cleaned, de-burred and firmly seated. Any misalignment of these joints may cause vibration and/or excessive bearing wear.

NOTE: Maintain constant shaft projections during column assembly.

NOTE: Each column contains a splitter vane. Column sections must be assembled so that the splitter vanes are in line.

Shaft Coupling Installation

Examine and clean all shaft (23) and coupling (31) threads carefully. Apply a thin coat of anti-seize lubricant to the threads. Wipe off excess lubricant after making up shaft joints. Thread a coupling (31) onto the shaft by hand. If force is required, look for damaged or dirty threads. Damaged threads may cause misalignment of the coupled shaft.

NOTE: All shaft, tube and coupling threads are left-hand.

Column, Tube & Shaft Assembly

NOTE: If this is an underground elbow (52) installation, determine the position of the elbow section. Refer to the setting plan found in Section 7.

A. Before proceeding with assembly, lay out all line shaft, enclosing tube, column and connectors. Inspect and identify all items and arrange them in the order in which they will be assembled.

   1. Pre-assemble matching sets of shaft, enclosing tube and column by sliding them inside each other and attaching connectors and couplings. This will allow each set of column/enclosing tube/shaft to be hoisted into place and assembled.

   2. Non-standard lengths of column, enclosing tube and line shafting must be assembled at the top of the pump as previously outlined.

B. Lower the shaft/tube/column assembly into position. A line shaft coupling is to already be in place on the pump shaft.

C. Assure that all enclosing tube threads and connector bearing threads are clean and free of burrs. Coat the connector bearing threads with a sealant such as Loctite PST

#567, Permatex No. 2 Non-hardening, Gasket Sealant prior to assembly. Silicone sealants are also permissible. This step is very IMPORTANT in, preventing entry of the pressurized pumped media into the enclosing tube. Thread the enclosing tube onto the connector bearing and secure with chain wrenches.

D. Clean all coating or foreign materials from the column flange face prior to assembly. Lower the shaft/tube/column assembly into position and coat the flange faces with sealant. Assure that the flange faces engage squarely and that all bolt holes align. Install bolts and nuts and tighten.

E. Lift the column and bowl assembly slightly. Remove the pipe clamp from the bowl and lower the assembly into the well. Reinstall the pipe clamp on the upper end of the column directly below the upper flange. Lower the assembly until the pipe clamp supports the assembly on the foundation.

F. Install the elbow (52) in its proper location so that it matches the connecting discharge piping.

G. Repeat the above steps until complete. Continue to measure the shaft projection after assembly of each shaft/tube/column section.

Driver Pedestal Installation

DANGER: DO NOT mount the driver before the pedestal is assembled to the column.

A. Lightly coat the top column (21) flange face and register with grease and install the column gasket (16) if furnished.

B. Using cable slings through the driver pedestal windows, position the pedestal (62) over the unit.

DANGER: Use a guide rope going from the sling joint, above the head, attached to the discharge flange. This will keep the head from tipping over, possibly causing personal injury.

1. Lower the pedestal to within 1/4" of the flange, taking care not to bump the shaft. Slowly lower the pedestal until it rests fully on the flange, being sure the flange register is located inside the head. Install and tighten all the flange bolts.

C. Lift entire unit and remove the pipe clamp. Rotate the unit into the proper position over the anchor bolts and lower it to the foundation.

NOTE: Care should be taken to not damage the anchor bolts.

D. Coat both sides of the copper gasket and the tension nut threads with sealant prior to installation. Install the bronze top tube tension nut gasket onto the top tube tension nut.

E. Install the combination top tube tension nut/packing box over the projecting line shaft and thread it into the top enclosing tube and seated in position on the pedestal (62). The threads should engage the tube smoothly and allow the washer and nut to seat squarely in the counter bore of the driver pedestal. Torque the combination top tube tension nut/packing box. Refer to Table 5 for correct torque values.

F. Install the packing and glands into the packing box. Install the gland bolts and nuts. Allow the gland nuts to remain loose. Packing adjustment will be performed late with pump operating.

G. Refer to Mechanical Seals and install the mechanical seal.

Driver Installation

IMPORTANT: Read and understand the driver manufacturer's manual before proceeding. Refer to the driver manufacturer's printed instructions found in Section 8 of this manual.

CAUTION: Grease lubricated drivers are shipped pre-lubricated. Oil lubricated drivers and right angle gears are shipped dry and require an initial fill of the manufacturer's recommended lubricant prior to start-up. See driver manufacture's manual for lubrication specifications. The manufacturer does not supply initial start-up lubricants.

DANGER: Electrical motors must be installed and operated only by qualified, trained electrical technicians. Consult the motor manufacturer or the motor manual to assure that all installation and safety procedures are fully understood and implemented. Always lock out all controls and or supplies and verify driver cannot be started before installing or servicing electrical apparatus.

General

Solid shaft drivers have a vertical main shaft projecting from the bottom of the driver base. The shaft projection has a vertical keyway to transmit torque and an annual groove to suspend the pump shaft/impeller assembly. Solid shaft drivers require the use of rigid adjustable couplings to facilitate pump impeller adjustment.

Register fits on the bottom of the driver base and on the top of the motor pedestal will facilitate approximate driver positioning. The fits are generally loose enough to accommodate the additional movement required for precision alignment. After precision alignment is achieved, the driver is permanently held in position by the clamping force of the mounting bolts. Doweling or pinning of the driver is not required, but may be implemented at the owner's option.

CAUTION: Before installing the driver, read and understand the driver manufacturer's instruction manual.

DANGER: Electric motors must be installed and operated only by qualified, trained electrical technicians. Consult the motor manufacturer or the motor manual to assure that all installation and operation safety procedures are fully understood and implemented. Always lock out all controls and/or power supplies before installing or servicing.

NOTE: It is generally most convenient to install the driver, coupling hub on the driver shaft before hoisting the driver into position.

A. Check both driver and pump shafts for burrs or dirt, cleaning as necessary. Also check the coupling parts for burrs and dirt, cleaning as required. If force is required to position the couplings on the shafts, non-metallic dead blow hammers should be used to prevent damage to the machined surfaces.

B. Install the coupling hubs on the driver shaft and top shaft prior to installing the driver according to the following procedure:

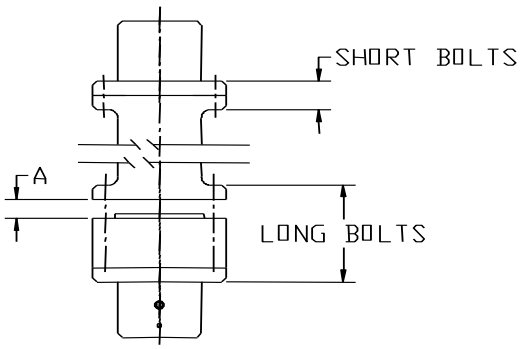

Figure A, Style IV Coupling

1. Insert the square key into the driver shaft keyway and slide the driver coupling hub onto the driver shaft until the circular keyseat is exposed. Install the thrust rings. When a spacer is used, pilot the spacer in to the driver hub and secure with the short bolts.
2. Install a dowel pin into the hole provided in the pump coupling hub. Drive the pin through the coupling hub until it protrudes slightly into the coupling keyway. The purpose of this pin is to prevent the key from falling out of the hub until the setscrew has been secured. Slide pump coupling half hub over top shaft threads.
3. Align the keyway in the shaft with the keyway in the coupling hub and insert the key.
4. Thread the coupling adjusting nut onto the top line shaft.

C. Using an appropriate hoisting system, lift the driver over the discharge head, mounting surface and carefully lower into position. Engage the base over the register fit of the mounting surface. Temporarily bolt the driver down. If an electric motor is used, now is the time to connect to the electrical source per manufacturers instructions and verify correct rotation. If a right angle gear is used proceed to step 4.

DANGER: Make sure the main power source is locked off before any electrical connections are made and verify driver cannot be started. After the start has been performed, again lock off the main power source to guard against accidental starting and electrical shock.

CAUTION: Oil lubricated drivers and right angle gears are shipped dry and require an initial fill of the manufacturer's recommended lubricant prior to bump-start.

WARNING: Make sure all loose coupling parts are off the motor half coupling and that no part of one coupling half will contact the other half during the bump start, otherwise personal injury could occur.

WARNING: Make sure the protective guard is in place on the discharge head before the bump start is done. Do not operate this machine, even to check rotation, without protective guards in place.

D. Disable or remove the non-reverse ratchets and, "bump start" the motor for rotation. Bump Start is generally accomplished on three-phase motors by engaging and immediately disengaging the power switch. It is seldom necessary to engage the power source for more than one second to determine motor rotation.

NOTE: the direction of motor rotation. If the motor rotates counter clockwise as viewed from the top, the rotation is to correct and installation may proceed. If the motor rotates clockwise as viewed from the top, reverse any two of the three power leads and motor rotation will be reversed.

CAUTION: Operation of the pump in a clockwise (as viewed from the top) direction will cause the line shaft couplings to unthread, causing serious damage to the pump.

E. Impeller adjustment is required to achieve the preferred running position of the impeller within the pump bowl. Also, the impeller must not rub on the bowl seat.

Impeller Adjustment

A. Determine the correct impeller position from Impeller Running Position Table 3, below.

B. Thread the adjusting nut upwards toward the driver half coupling until the correct amount of gap “A” is reached (refer to the above illustration). Refer to the Inches per Turn,

C. Table 4, below to determine the correct number of turns of the adjusting nut to achieve the Gap A dimension.

D. Adjust to the position that boltholes line up and insert coupling bolts. Refer to Table 2, Coupling Torque Values table below and torque to the values shown. Install the setscrew in the pump coupling hub and secure.

E. Install protective guards.

WARNING: Make sure the protective guard is in place on the discharge head before operating the pump.

CAUTION: Refer to the driver manual to assure that all lubrication instructions have been followed completely.

WARNING: Consult the driver manufacturer's manual to assure that all safety procedures are completely understood and implemented prior to operation.

Table 2, Coupling Torque Values

Coupling Size	Torque (Ft-Lbs.)
3125	115

F. Refer to the driver manual to assure that all lubrication instructions have been followed completely.

G. Refer to the driver manual to assure that all safety procedures are completely understood and implemented prior to operation.

CAUTION: Grease lubricated drivers are shipped pre-lubricated. Oil lubricated drivers and right angle gears are shipped dry and require an initial fill of the manufacturer's recommended lubricant prior to start-up. See driver manufacture's manual for lubrication specifications. The manufacturer does not supply initial start-up lubricants.

Table 3, Impeller Running Position

Bowl Size	Impeller Position[1] (1)
24"	0.030

1 Dimension shown is the amount the impeller is to be raised above the bowl seat.

Table 4, Shaft Turns

Shaft Diameter	Number of Turns				
	1	2	3	4	5
2 15/16”	.10	.20	.30	.40	.50

Table 5, Tube Tension Nut Torque Values

Tube Size	Required Torque
5”	1200 Ft.-Lbs.

Section 4 Operation

General

Because variations may exist in both the equipment and in the particular installation of the pump and driver, specific operating instructions are not capacity at the best within the scope of this manual. However, there are general rules and practices that apply to all pump installations and operation.

CAUTION: Before starting or operating the pump, read this entire manual, especially the following instructions.

Before starting the pump:

1 Rotate the unit or assembly by hand to assure all on moving parts are free.

2 Install packing.

3 If pump has a packed box, adjust the packing gland finger tight. Refer to *Packing Adjustment* in the maintenance section to properly adjust packing.

4 Check to make sure the flow meter is operational and connected to an appropriate water source.

5 Install coupling guards around all exposed rotating parts. Guards are mandatory on motor pedestal openings if the pump is equipped with an adjustable coupling.

6 Observe all **DANGER**, **WARNING** and **CAUTION** tags attached to this equipment

7 Ensure water in sump is at the specified level for adequate submergence.

If excessive vibration or noise occurs during operation, shut the pump down and review the *Troubleshooting* section. If the problem cannot be corrected, consult a Fairbanks Morse representative.

Operating at Reduced Capacity

In a typical application covering a wide range of flow rates a variable speed driver is often used to adjust pump and Fairbanks Morse when selecting the pump and impeller trim takes this into consideration. Although these pumps are applicable over a wide range of operating conditions, care should be exercised when doing so when the actual conditions differ from the sold conditions. You should always contact your nearest Fairbanks Morse distributor or factory before operating the pumps at any condition other than that for which they were sold.

Generally, these pumps can be operated continuously at capacity equal to 60% (BEP) of the pump capacity at the best efficiency point, and at higher capacities. The preferred operating range is 70%-120% BEP.

Initial Startup

Inspect the complete installation to ensure that the installation instructions of this manual, and the manuals of all the related equipment, have been followed and that the installation is complete. Use the "pre-start-up and Start-Up Check List" found in this manual as a guide.

Ensure that the driver is properly serviced, and that the proper pump rotation is obtained.

Rotate the pump shaft by hand. It should rotate freely on motor driven installations.

Ensure the discharge valve is open.

Start the pump according to the following procedure:

1. Start the driver according to the driver manufacturer's instructions.
2. Immediately after the pump has been started, check lubrication system, stuffing box lubrication and operation, and pump noise level. Continue to monitor these for the first several hours of operation.
3. Check the driver and other necessary equipment for satisfactory operation following their manuals.
4. Check the foundation for integrity.
5. After the first shutdown, repeat the impeller adjustment. Running may have tightened up some of the shaft joints, changing the original setting.

Normal Operation

Monitor the following during running cycles:

1. Unit vibration or noise.
2. Driver lubrication levels and flow.
3. Packing box leakage.

Check the following before normal startup:

1. Driver lubrication levels and flow.
2. General condition of all equipment.

Shutdown

Pump stations are usually designed to have the pumps started and stopped automatically. Since this is a function of station design, the operators should be familiar with the systems operating parameters. The general procedure to shut down the pump is as follows:

1. Disconnect the electrical power source.
2. If the pump is to be removed for repair, close the discharge valve.

> **WARNING:** After removal of pump, ensure pump opening is adequately covered and secured.

Seasonal Operating Instructions

If the pump is located in an area that is subject to below freezing temperatures and will not be operated enough to prevent freezing, it should be drained to prevent damage to the casing caused by freezing.

Emergency Procedures

Many installations are equipped with emergency shut off switches near the pump location. These locations should be plainly marked and readily accessible at all times.

The control panel (if used) may be equipped with an emergency start/stop button or switch.

> **IMPORTANT:** The operator or persons working around the equipment should be familiar with locations of emergency start-up & shut off points.

Start-Up

1. Open the suction valve.
2. Start the driver
3. Open the discharge valve.

Shut-Down

Shut off the power at the nearest switch.

Troubleshooting

If you have followed the installation and start up procedures outlined in this manual, your pump should provide reliable service and long life. However, if operating problems occur, significant time and expense can be saved if you use the following check list to eliminate the most common causes of those problems.

Insufficient Pressure or Flow

1. Wrong direction of rotation.
   a. Reverse any two motor lead connections. Check driver 0 & M.
2. Discharge head too high.
   a. Change system.
   b. Raise wet well level.
   c. Install larger impeller & driver.
3. Impeller running clearance too great
   a. Reset impeller clearance per 0 & M manual.
4. Insufficient suction bell submergence.
   a. Raise wet well level.
5. Speed too low,
   a. Check driver speed and voltage.
6. Bowl passage partially plugged.
   a. Clean bowl passages
7. Impeller passage partially blocked.
   a. Clean impeller passages.
8. Clogged suction.
   a. Clean suction passages.
9. Low water level.
   a. Raise wet well.
10. Air in liquid
    a. Increase submergence to prevent vortexing.
11. Improper sump design.
    a. Change sump design.
    b. Increase submergence to prevent vortexing.
12. Impeller damaged.
    a. Check and repair or replace.
13. Impeller diameter too small.
    a. Replace impeller with larger diameter. Check driver HP.

Loss of Suction Operation

1. Low water level.
   a. Raise wet well level.
2. Insufficient suction bell submergence.
   a. Raise wet well level.
3. Wrong direction of rotation.
   a. Reverse any two motor lead connections. Check driver 0 & M.
4. Air or gasses in liquid.
   a. Deareate liquid.
   b. Increase submergence to prevent vortexing

Excessive Power Consumption

1. Improper impeller adjustment causing rubbing.
   a. Readjust impeller clearance setting as outlined in this manual.
2. Head lower than rating, pumps operating over capacity.
   a. Change system. Reduce pump speed. Trim impeller.
3. Speed too high.
   a. Check driver speed and voltage.
4. Improper voltage to driver.
   a. Check driver voltage.
   b. Change power source or driver.
5. Misalignment.
   a. Check motor/pump to base connections. Realign coupling.
6. Packing box gland too tight.
   a. Readjust packing gland.
7. Incorrect impeller diameter.
   a. Determine correct impeller diameter and replace or trim impeller.
8. Shaft bent.
   a. Replace shaft.
9. Specific gravity or viscosity of liquid pumped is too high.
   a. Reduce pump capacity.

Vibration or Noise

1. Foundation bolts loose or defect in grouting.
   a. Tighten foundation bolts and/or re-grout.
2. Worn pump bearings.
   a. Replace pump bearings.
3. Pipe strain -Improperly supported or aligned.
   a. Check pipe supports and adjust or realign.
4. Head lower than rating, pumps too much liquid.
   a. Increase system head.
   b. Reduce pump speed. Trim impeller.
5. Misalignment between driver and pump
   a. Realign driver and pump.
6. Shaft bent.
   a. Replace shaft.
7. Pump running at shut-off condition.
   a. Open discharge valve. Check for obstructions.
8. Insufficient suction bell submergence.
   a. Increase submergence.
9. Low water level.
   a. Increase wet well level.
10. Air in liquid.
    a. Increase submergence to prevent vortexing.
11. Impeller passages clogged.
    a. Clean impeller passages.
12. Foreign object in pump.
    a. Remove foreign object.
    b. Check for damage.
13. Bad driver bearing.
    a. Replace driver bearing.
14. Improper sump design.
    a. Change sump design. Increase submergence to prevent vortexing.

Excessive Seal Box Leakage

1. Gland not properly tightened
   a. Adjust packing gland.
2. Worn packing or sleeve.
   a. Replace packing and/or sleeve.
3. Ends of packing not staggered.
   a. Repack to stagger packing ends.
4. Bypass is plugged or restricted.
   a. Clean by-pass line.

Over-Heating

1. Packing gland too tight.
   a. Adjust packing gland.
2. Water flush line plugged.
   a. Clean water flush line.
3. Shaft bent.
   a. Replace shaft.

Motor Symptoms

The trouble or symptoms, their probable causes and suggested remedies contained in this troubleshooting guide will assist you in quickly determining and correcting most problems should they occur. It is not the intent of

Fairbanks Morse does not intend to replace the recommendations of the motor manufacturer in regard to operation and maintenance of the motor. Rather this guide is offered as a supplement to such data. Any specific questions or problems should be directed to the manufacturer of the motor. Be sure to supply

relevant data from the motor nameplate when inquiring about service or maintenance.

DANGER: Electrical power must be disconnected and locked to prevent accidentally starting during mechanical systems check.

DANGER: Qualified electricians skilled in the use of electrical instruments must perform electrical troubleshooting

Motor Does Not Start

1. Break in power supply circuit.
   a. Blown or defective primary fuses or open circuit breakers.
      (1). Check voltage across all phases above the disconnect switch. Replace fuses or reset breakers.
   b. Blown or defective secondary fuses or open circuit breakers.
      (1). Check voltage across all phases below disconnect (with disconnect closed). Replace fuses or reset breakers.
2. Open control circuit
   a. Overload trips are open.
      (1) Push reset button.
   b. Defective holding coil in magnetic switch.
      (1) Push start button and allow sufficient time for operation of time delay.
      (2) If voltage is measured, coil is defective.
      (3) If no voltage is measured, control circuit is open
   c. Loose or poor connections in control circuit.
   d. Make visual inspection of all connections.
      (1) Tighten as necessary
3. Magnetic switch closes.
   a. Poor switch contact.
      1) Open manual disconnect switch, close magnetic switch by hand and examine contactors and springs.
   b. Open circuits in control panel.
      (1) Open manual disconnect switch, close magnetic switch by hand and examine contactors and springs.
   c. Open circuits in leads to motor.
      (1) Check voltage at T1-T2-T3
   d. Leads improperly connected.
      (1) Check lead numbers and connections.

Motor Fails To Come Up To Speed

1. Low or incorrect voltage
   a. Check voltage at T1-T2-T3 in control panel
2. Incorrect connections at motor.
   a. Check for proper lead connections at motor.
      (1) Compare with connection diagram of motor.
3. Mechanical overload.
   a. Check for tight or locked shaft.
4. Hydraulic overload
   a. Check pump flow and head against performance curve.

Motor Runs Hot

1. Inadequate ventilation.
   a. Assure adequate supply of fresh air.
      1) Check air blast through motor by feeling air discharge at bottom of motor.
2. Overload
   a. Check for tight or locked shaft.
   b. Check pump flow and head against performance curve.
3. Unbalanced supply voltage.
   a. Check supply voltage with volt meter.

Motor Vibrates

1. Motor and pump misaligned.
   a. Re-align pump and motor
2. Worn bearings or bent shaft.
   a. Disconnect pump from motor and run motor only.
      (1) Repair as necessary.
3. Hydraulic disturbance in discharge piping.
   a. Check piping.
4. Unbalanced rotor assembly
   a. Balance rotor.
5. Motor not mounted securely.
   a. Secure properly and check alignment.

Motor Is Noisy

1. Worn thrust bearings.
   a. Remove dust cover; rotate rotor by hand and make visual inspection of balls and races.

(1) Bearing noise is usually accompanied by high frequency vibration.

2. Electrical Noise.
   a. Most electrical motors are noisy during the starting period. The noise should diminish as motor reaches full speed.

Incorrect Rotation

1. Incorrect connections.
   a. Refer to connection diagram and reconnect according to instructions. Usually switching any two wires on a 3 phase motor will change rotation.

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Section 5 Maintenance

Preventive Maintenance

To assure satisfactory operation of the pump, scheduled inspection and periodic maintenance are required. We suggest an inspection and maintenance log be kept and the inspector immediately reports any problems.

This Fairbanks Morse model VTSH pump is supplied with water flush lubricated column and bowl bearings.

A guide for preventative maintenance for normal applications is given below in Table 6. Unusual applications with abnormal heat, moisture, dust, etc., may require more frequent inspection and service.

Table 6, Preventative Maintenance

Item	Action Required
Packing box	Should be checked on a weekly basis for excess leakage. Adjust or replace packing as required.
Lube System	Check lubrication system for proper operation on a daily basis.
Alignment	Should be monitored for changes on a yearly basis.
Vibration	Should be monitored for changes on a yearly basis.
Noise level	Should be monitored for changes on a yearly basis.
Driver bearings	Follow driver manufacturer's instructions for driver bearing lubrication.

Packing

All packing is subject to wear and should be given regular inspection. Generally, packed box pumps should be checked every 150 hours of operation and the glands should be readjusted if necessary.

Initial adjustment is accomplished by tightening the gland nuts finger tight.

CAUTION: Excessive tightening of the glands may cause shaft sleeve damage.

Packing Replacement

For general service application with pump temperature 32° F to 200° F (O° C- 93° C) use a good grade of soft, square, long fiber graphite packing that is thoroughly lubricated.

Use only genuine Fairbanks Morse replacement packing. The replacement procedure should be as follows:

A. Stop the pump.

DANGER: Lock out electrical power to prevent accidental starting and causing possible personal injury.

B. Unbolt and remove the gland.

C. Use a flexible packing tool*[2] with a hook attachment for removal of the packing.

D Clean the packing box and shaft sleeve.

E Inspect the shaft sleeve for wear or rough finish and replace the sleeve with a genuine Fairbanks Morse sleeve if necessary.

F Install the new packing.

IMPORTANT: Stagger the packing end joints 180° and firmly seat each ring of packing as you install it.

G. Refer to the technical data page for pertinent stuffing box, and packing dimensions.

H. Reinstall the gland and tighten the gland nuts finger tight. After the pump has been started, adjust the glands so that there is a steady stream, approximately 1/8" diameter, from the packing box. Refer to Figure #7 for flush water requirements.

Pump Disassembly

WARNING: Read this entire disassembly procedure and refer to the sectional drawings in this manual before starting.

Major maintenance beyond lubrication, adjustment of impeller or wear ring clearance, and replacement or adjustment of the packing will require disassembly of the pump. The following are step-by-step instructions and are essentially the reverse of the installation procedure.

Driver Removal

DANGER: Check with proper electrical testing equipment to be certain all-electrical power to the driver and accessories associated with the pump is disconnected.

---

[2] The packing tool can be purchased from the factory or local supply house.

A. Stop the pump and lock out the power to the driver.

   1. Close the discharge valve.

   2. Disconnect the electrical cables from the driver.

   3. Disconnect and remove gauges and all other auxiliary piping. (Stuffing box lubrication, oil, or grease lines, etc.)

B. Remove the bolts holding the coupling halves together slowly so that the impeller does not drop.

C. Remove the capscrews holding driver to discharge head or pedestal.

D. Lift the driver from the head and set aside.

E. Remove the packing gland bolts (8, 8A), glands (9), water slinger (6) and packing (15).

F. Disconnect the water flush supply line.

> **CAUTION:** Always use protective eyewear.

Driver Pedestal Removal

A. Loosen and remove the packing box (63) and connector bearing (63B). Set aside for inspection.

B. Loosen and remove the discharge elbow (52) flange bolts.

> **DANGER:** Remove the bolts holding the column to the driver pedestal. Lift the pedestal (62) off the unit and set aside.

C. Lift entire unit by slinging through the windows of the pedestal (62). Install a column clamp just below the upper column flange leaving room to remove the flange bolting. Lower unit so that the column clamp rests on adequate supports.

> **DANGER:** Use a crane or hoist of adequate capacity to prevent serious personal injury.

D. Remove the bolts holding the column to the discharge head. Lift the pedestal (62) off the unit and set aside.

E. Refer to Pump Bowl Disassembly for detailed bowl disassembly procedures.

Column Removal

A. Install eyebolts of sufficient size in the column flange holes and lift the unit and reposition the clamp below the next column flange.

B. Use column and shaft clamps (or other acceptable method) to safely support and lift this assembly.

C. Unbolt column flange and lift column enough to loosen the shaft coupling. When all components are loose, carefully lift this assembly from the pump unit. With soft skid boards under the column to protect the flange, slowly lower the column and shaft assembly onto the floor and move to a convenient work area.

> **IMPORTANT:** Shaft threads are left-hand
>
> **IMPORTANT:** Enclosing tube threads are left-hand.

D. Repeat above steps A, B, and C until all column and shaft sections have been removed from the unit.

E. Remove shaft and tube section from column pipe. Remove the shaft from the tube section. Remove couplings from shafts and inspect for wear or damage.

F. Inspect connector bearings (50) for wear or damage.

G. Refer to Pump Bowl Disassembly for detailed bowl disassembly procedures.

Pump Bowl Disassembly

> **IMPORTANT:** Read This Entire Procedure Before Starting Disassembly.

For disassembly of the bowl, proceed in accordance with steps listed below. Select a clean area for work. Refer to assembly drawing and parts list for part identification.

A. Place the bowl assembly in a horizontal position, blocked to prevent rolling.

B. Measure and record the axial end play of the shaft (4).

C. Return the bowl assembly to an upright position, resting on the suction bell (33), and restrained from falling over.

D. Remove the suction bell flange cap screws.

E. Remove the shaft coupling (31).

F. Lift the diffuser bowl (30), leaving the pump shaft (4) and impeller (1) at rest on the bowl seat. Place the diffuser bowl (30) in a horizontal position, blocked to prevent rolling.

   1. Remove the snap ring (27).
   2. Remove the restrictor bushing (163B).
   3. Visually inspect the throttle ring (41) for damage. If no damage or signs of wear is apparent, leave the throttle ring (41) on the bowl (30). If the throttle ring must be removed, drive or cut it off of the bowl.
   4. Remove the lower bearing (163).
   5. Remove the upper bearing (168).

G. Remove the shaft and impeller assembly from the suction bell.

H. Remove the impeller cap screws (9) and washer (9A). It will be necessary to heat the cap screws to 350-400^{o}F to break the Loctite bond on the cap screw threads.

WARNING: The impeller hub bore has a taper fit with the shaft. Use a hub puller and apply heat to the impeller hub to expand the bore for easier removal. Use heat resistant gloves to handle heated parts.

I. Remove the pump shaft (4) and key (102) from the impeller (1), being careful not to bend the shaft and not to damage the threads at the coupling end.

CAUTION: Care should be taken not to damage the impeller when using a puller or similar device. Attach the puller or other equipment at the impeller vane area only.

CAUTION: Care should be used in removing the impeller. Because of the taper fit, the impeller may come loose suddenly and will be completely loose.

Inspection For Replacement

After the components are disassembled, each part should be thoroughly cleaned and inspected for wear and physical damage. During cleaning, do not allow any petroleum-based solvents on the rubber bearings.

It is not necessary to remove bearings unless inspection indicates replacement is necessary. If it is necessary to remove bearings, they should be pressed from their seats and discarded.

IMPORTANT: Use care not to damage bores or hubs during bearing removal.

Any parts showing signs of excessive wear or damage should be replaced with genuine Fairbanks Morse parts.

Maximum clearances are shown on the technical data page located in the drawing section of this manual.

A. Inspect the shafting (23) at each bearing location for damage or excessive wear and replace shaft if not salvageable.

B. Inspect all line shaft bearings (50) and packing box bushing (17A) bores for damage and wear. If the diametric bearing clearance exceeds the limits shown the bearings must be replaced.

C. Inspect all bowl bearings, (163 &168) for wear & excessive clearance. If the diametric bearing clearance exceeds the limits shown, the bearings must be replaced

D. Inspect the bowl ring for wear and excessive clearance. The correct clearance is shown on the pump technical data page in the drawing section of this manual. The ring should be replaced with a Fairbanks Morse replacement part, available from the parts supplier shown in the repair section of this manual or directly from the factory.

E. Inspect the shaft sleeves for wear. Replace as necessary. If the sleeve (13) shows wear or damage, remove the sleeve by heating it to 350-400^{o}F to break the Loctite bond.

G. Inspect the mechanical seal for wear and damage.

NOTE: If it is found that any of the bearings or sleeves have excessive wear, it is recommended that all bearings and sleeves be replaced (including bowl bearings).

NOTE: Measure and record the position of the sleeve (13) on the shaft (19A) before removal.

WARNING: To prevent possible serious personal injury, heat resistant gloves must be worn when handling heated parts.

Shaft Straightness

Prior to installation or reassembly, bowl shafts and lineshaft should be checked for

straightness. The maximum allowable total indicated runout must be less than .005".

Refer to the illustration at the end of this section for the proper positions at which dial indicator readings should be taken. The shaft should be supported in V-blocks; or on rollers as shown. Position the dial indicator and zero the dial face. Slowly rotate the shaft and observe the maximum runout.

If the shafts exceed the.005" maximum limit, straightening will be required. Consult the Fairbanks Morse factory for straightening recommendations, or a local qualified machine shop.

Pump Bowl Reassembly

Clean all components before starting the assembly. Do not apply any petroleum-based compounds to the rubber bearings.

NOTE: Apply gasket sealant to the bowl registers to improve assembly alignment.

A. If the suction bell wear ring is being replaced, refer to the ***Wear Ring*** section for complete instructions on removal & replacement of wearing rings.

B. Place the suction bell (33) in an upright position.

C. Clean the threads on the impeller fastener (9) and the mating threads in the shaft (4) of all contaminants and of oil.

D. Install the pump shaft (4) with its key (102) into the impeller hub. Apply heat to the impeller hub to expand the bore for easier assembly.

   1. Apply 6 drops of Loctite 609 on the cap screw threads, then install with the impeller washer (9A) and torque to the required value as shown in Table 7 below:

Table 7, Impeller Fastener Torque Values

Pump Size	Bolt Size	Qty	Torque (Ft. Lbs.)
24” VTSH	7/8-9	3	200

NOTE: The 24” pumps use 3 impeller capscrews.

E. Place the impeller and shaft assembly into the suction bell (33) with the impeller (1) resting inside the suction bell wear ring (16).

F. Place the diffuser bowl (30) in horizontal position and block from rolling.

G. Install the upper bowl bearing (168) and the lower bowl bearing (163), restrictor (163B) and snap ring (27).

H. If the bowl throttle ring (41) was removed, install the throttle ring. The throttle ring must be heated to slip onto the bowl surface.

WARNING: To prevent possible serious injury, heat resistant gloves must be worn when handling heated parts.

I. Return the diffuser bowl to an upright position.

J. Lift the diffuser bowl into position above the pump shaft. Guide the diffuser bowl and bearing assembly down over the pump shaft (4) until it registers on the suction bell flange.

WARNING: Restrain the bowl assembly so that it cannot be turned over.

NOTE: Apply grease to the bowl registers to improve assembly alignment.

K. Install the suction bell flange cap screws and tighten them securely.

L. Thread the shaft coupling (31) onto the pump shaft (4) until half of the coupling is engaged. Apply an anti-seize lubricant to the shaft and coupling threads.

M. Measure the axial play of the shaft. If it differs unexpectedly from the amount measured prior to disassembly, make sure that all parts are correctly installed and positively seated in their respective positions.

N. Refer to ***Pump Assembly*** in the ***Installation*** section of this manual and complete pump installation.

Wear Rings

If replacement of the wear rings is required, refer to *Wear Ring Removal* below.

Wear Ring Removal

A. If the wear ring requires replacement it can be more easily removed by heating it to 250° - 400° F.

WARNING: Wear heat resistant gloves to prevent possible serious personal injury, when handling heated parts.

B. The ring may also be removed by splitting with a chisel and removed or machined.

Installing New Wear Ring

CAUTION: Care should be used to avoid damage to the bowl ring seat.

IMPORTANT: If this bowl assembly is to be fitted with wear rings and was not equipped with wear rings at the factory, contact the factory for correct dimensions.

CAUTION: A qualified machinist experienced in similar machining work should do Machine work. If the wear rings are to be replaced they should be replaced with genuine Fairbanks Morse wear rings. Install the wear rings as follows.

CAUTION: To prevent possible serious personal injury, approved safety glasses must be worn when grinding.

A. To ensure proper bonding, thoroughly clean all mating parts with solvent to remove all grease, oil, dirt, etc.

B. Apply a bead of Loctite 290 completely around the middle of the impeller or bowl wear ring fit, and press the wear ring(s) in place.

IMPORTANT: To avoid distortion and ensure proper installation, be careful to press the wear rings evenly and completely in place. They should be firmly butted against the corresponding impeller or bowl shoulder at the bottom of the wear ring fit.

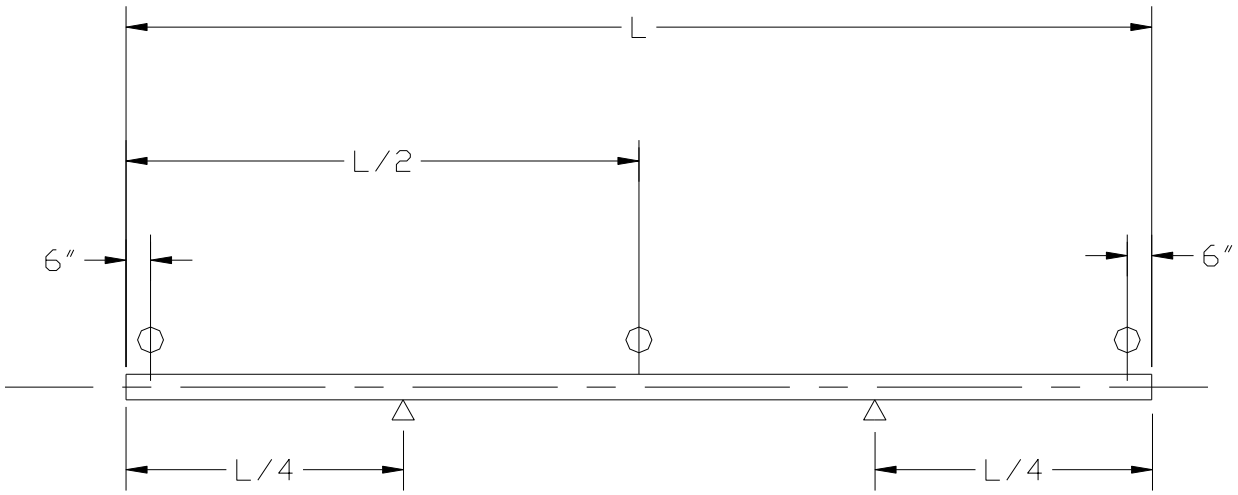

Figure B, Shaft Straightening Illustration
(Shafts 10 ft long or less)

Preventative Maintenance Schedule

Task	Freq	Time	Date	Date	Date	Date	Date
Check Seal Box Leakage Adjust Packing	W	.5					
Lube System Check lubrication system for proper operation on a daily basis.	W	.5					
Housekeeping Inspect area surrounding the pumping equipment for cleanliness.	W	1					
Motor Bearing Temperature Check bearing temperature and compare with initial readings	Q	2					
Gauge Readings Check to confirm operating point	Q	1					
Motor Amps Run an amperage reading to verify that the motors are running normally	S	2					
Fasteners and Flange Joints Inspect fasteners and tighten any fasteners that may be loose. Inspect flange joints for leakage.	S	1					
Safety Guards Ensure safety guards are in place and functional.	S						
Lubricate Motor Bearings	A[3]	2					
Pump Alignment Check for changes & correct as necessary	A	8					
Noise Level Check for changes & correct as necessary	A	2					
Vibration Check for changes & correct as necessary	A	2					
Paint or Coatings Inspect equipment paint or coatings for chips etc. Touch up as required.	A	1					

Frequency: A: Annually; W: Weekly; S: Semi-Annually; Q: Quarterly

[3] Or as recommended by the Motor Manufacturer. Refer to the motor Operation and Maintenance manual or the motor nameplate for specific guidelines.

Preventative Maintenance Notes

Maintenance History

Date	Maintenance Performed	Part Used	Part Numbers.

Maintenance Notes

Section 6 Repair Parts

Ordering Parts

To order spare or replacement parts, give the pump serial number, size, model number, a complete description, and item number of each part. Refer to the drawings and parts list in the drawing section of this manual. You may order parts from your local Fairbanks Morse distributor whose name and address are found on page 3 of this manual or you may order parts from the factory at the following address:

Fairbanks Morse Pump
3601 Fairbanks Ave.
Kansas City, KS 66106
(913) 371-5000
Fax: (913) 748-4025

Attn: Debra Smith

Recommended Spare Parts

Refer to table 1 for a list of recommended spare parts. This list is for normal duty. Where severe conditions exist or minimum down time is critical additional quantities and those items indicated should be considered.

Table 1 Recommended Spare Parts List

Item	Description	Quantity
15	Packing, set	1
50	Bearing Connector, set	1
168	Bearing, Upper	1
163	Bearing, Lower	1
	Gasket, Set	1

Returning Parts

All materials or parts returned to the factory must have prior approval and a “Returned Goods Tag”, listing the material to be returned and the reasons for the return. All material to be returned should be carefully packaged to avoid damage in route from rough handling or exposure to weather. Contact the factory for shipping instructions. All material is to be returned freight prepaid.

Fairbanks Morse makes improvements on its products from time to time and reserves the right to furnish improved parts for repairs. A part that is received and is not identical in appearance, or has a different symbol from the original part may be interchangeable. Examine the part carefully before contacting your Fairbanks Morse representative. The parts should never be returned to the factory without first obtaining proper authorization from your Fairbanks Morse representative.

Predicted Life

The predicted life of significant parts subject to wear, shown in table 2, is based on pumping liquid without abrasives, the pump operating at sold conditions and that proper maintenance is performed.

The actual life encountered for the specific parts may vary significantly as a result of the content of liquid pumped, maintenance performed, actual operating conditions and other factors.

Table 2 Predicted Lives of Component Parts

Item	Description	Predicted Life[4]
1	Impeller	10
4	Pump Shaft	10
8	Gland	10
13	Top Shaft Sleeve	5
15	Packing	1
16	Bell Wear Ring	5
17	Impeller Wear Ring	5
19	Top Shaft	10
23	Lineshaft	10
28	Top Column	20
31	Shaft Coupling	10
33	Suction Bell	20
41	Bowl Throttle Ring	5
50	Connector Bearing	10
51A	Top Enclosing Tube	20
51B	Enclosing Tube	20
52	Elbow	20
62	Pedestal	20
63	Seal Box	10
63B	Seal Box Bearing	5
102	Impeller Key	10
163	Lower Bearing	5
168	Upper Bearing	5

[4] Values shown are in years unless otherwise noted.

Service

Warranty Service

For Warranty Service contact the facility from which your pump was shipped.

Shipping facility addresses:

Kansas City, Kansas

Fairbanks Morse Pump
3610 Fairbanks Ave.
Kansas City, KS 66106
(913) 371-5000
Fax: (913) 748-4025

Attn: Steve Wilson

Service after Warranty

For service after warranty on this pump or any other pumping equipment contact your local Fairbanks Morse distributor or by contacting:

Pump Services Group, 1-800-648-PUMP

Or Write:

Pump Services Group

Fairbanks Morse Pump
3610 Fairbanks Ave.
Kansas City, KS 66106
(913) 371-5000
Fax: (913) 748-4025

Attn: Tom Hoffman

Section 7 Pump Submittal

Certified Curves

Certified performance curves are not yet available. Please insert in this location upon receipt.

Approved Submittal

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1. **Comment:** Confirm that the pump column is not less than 3/8-inches thick, column sections are no more than 10 feet in length, and that the column pipe and discharge head are fabricated with splitter vanes per Specification Section 11311, Paragraph 2.3.D.

   Response: FM confirms that the pump column is not less than 3/8-inch thick, the column sections are not longer than 10 feet in length and the column pipe and underground elbow are fabricated with splitter vanes per specification section 11311, paragraph 2.3.D.

2. **Comment:** Provide special tools in accordance with Specification Section 11311, Paragraph 1.8.C.

   Response: This pump is designed to be disassembled and assembled without the use of special tools.

3. **Comment:** All anchor bolts, nuts, and washers shall be provided in accordance with Specification Section 11311, Paragraph 2.5.A.

   Response: Anchor bolts are not in Fairbanks Morse Scope of Supply and shall be supplied by others.

4. **Comment:** Submit hydro-cone and splitter fabrication drawings in accordance with Specification Section 11311, Paragraph 1.5.B.3.

   Response: FM fabrication drawings are proprietary information. Please see the setting plan which has the hydro-cone dimensions.

5. **Comment:** Contractor is to ensure approved field coatings are compatible with rectory primer.

   Response: Acknowledge

6. **Comment:** Sole plate anchors shall not interfere with existing slab reinforcing steel. Drilling anchor through reinforcing steel is not acceptable. Contractor is to field locate reinforcing steel and modify sole plate dimensions accordingly.

   Response: Acknowledged. FM has communicated with the contractor and they will advise FM if the soleplate dimensions need revision.

7. **Comment:** “Certificate of Unit Responsibility” only covers the pump and motor. This is not acceptable. Provide an Adjustable Frequency Drive for each pump unit from the pump manufacturer in accordance with Specification Section 11311, Paragraph 2.1.A.1. Resubmittal will not be reviewed until evidence of single point of responsibility for the pump, motor and adjustable frequency drive is provided.

   Response: The Contractor will be providing the VFD. FM’s certificate will not be revised.

8. **Comment:** Provide motors with space heaters as shown on Drawing FE3.

   Response: Space heaters have been added to the motor. Please see the revised motor submittal.

9. **Comment:** Provide product data for proposed Inpro MGS and demonstrate equivalence with specified AEGIS SGR.

   Response: Information on the Inpro MGS has been included in front of the revised motor submittal.

10. **Comment:** Revise proposed pump test set-up to locate the power meter directly at the motor terminals. Confirm that the true efficiency of the test motor has been established for each speed point used in testing.

    Response: FM has revised the test set up drawing. Please see revision 2 in the revised submittal.

11. **Comment:** Contractor to field verify all dimensions.

    Response: Acknowledge

Certification made to: Wilhelm General Contractors
Reference: City of Anderson WPC Facility Improvements Division II
Fairbanks Morse Pump Project #: 064585

CERTIFICATE OF UNIT RESPONSIBILITY

For Specification Section:

11311 – Vertical Column Solids Handling Pumps
&
16220 Electric Motors

Fairbanks Morse Pump accepts unit responsibility for all components of equipment in which we are furnishing under Specification Sections referenced above. We hereby certify that these components are compatible and comprise a functional unit which meets the performance and design requirements of these specification sections, as clarified and submitted.

SS: State of Kansas
County of Wyandotte

Signed before me this 10th day of January, 2012.

Connie Groves
Notary Public

Commission expires:

CONNIE J. GROVES
Notary Public - State of Kansas
My Appt. Expires 9-20-15

Fairbanks Morse Pump
3601 Fairbanks Avenue
P.O. Box 6999
Kansas City, Kansas 66106-0999

Michael T. Wiley
Director of Marketing

Certification made to: Wilhelm General Contractors
Reference: City of Anderson WPC Facility Improvements Division II
Fairbanks Morse Pump Project # 064585

CERTIFICATE OF UNIT COMPATIBILITY

For Specification Sections:

11311- Vertical Column Solids Handling Pumps
&
16220- Electric Motors

Fairbanks Morse certifies that the pumps and motors are compatible with and can be driven by a variable frequency drive as long as the drives are properly sized for the full load amps, inrush code and are properly interfaced with accessories as shown below:

Full load amps: 258.3
Starting code: G
Thermostats: Normally Closed

SS: State of Kansas
County of Wyandotte

Fairbanks Morse Pump Corporation
3601 Fairbanks Avenue
P.O. Box 6999
Kansas City, Kansas 66106-0999

Notary Public – Connie Groves

Michael T. Wiley
Director of Marketing

My Commission Expires:

CONNIE J. GROVES
Notary Public - State of Kansas
My Appt. Expires 9-20-15

Fairbanks Morse Pump
Included Features

- Shipped Assembled
- Variable Speed
- Dynamically Balanced Impeller
- 316 Stainless Steel Hydrocone
- Stainless Steel Impeller Fastener
- Stainless Steel Impeller Wear Ring 190-241 BHN
- Stainless Steel Bell Wear Ring 300-350 BHN
- 316 Stainless Steel Bowl Bolting
- 24” Flanged Column with 2-15/16” Lineshaft and 5” Enclosing Tube
- 304 Stainless Steel Lineshaft Sleeves
- 316 Stainless Steel Column Bolting
- 24” Type “UF” Underground Discharge Elbow
- Variable Speed Pedestal
- Soleplate
- Water Flush Packing Box with Bronze Glands
- Stainless Steel Top Shaft Sleeve – 350 BHN Minimum
- Water Flush Control System
- Adjustable Flanged Coupling
- Certified Non-Witness Performance Test
- Certified Non-Witness Hydro Test per Specifications
- Curve Approval Required Prior to Shipment
- Lateral Critical Speed Analysis
- Torsional Critical Speed Analysis
- Lot of Spare Parts
- 200 HP, 720 RPM, 3/60/460 V, Inverter Duty Motor

Fairbanks Morse Pump
Technical Clarifications & Exceptions

1. Refer also to clarifications that may be included on the vendor submittal.
2. VTSH pumps are designed with external water flushed pump and lineshaft bearings. Fairbanks Morse recommends the lubrication system be adequate to provide a continuous supply of flushing water to the bearings. If a continuous supply is not possible, then a timer must be installed to start the lubricating water system at least five (5) minutes before starting the pump. Flushing water flow and pressure requirements for the pump are listed below. Refer to the *Seal Water Schematic & Specifications* page contained in this submittal for additional details.

Flow Rate (GPM)	Pressure (PSI)
1.2	50

3. (11311 1.5 B) Pump will ship assembled, less the motor. FM will provide a shipping and handling drawing after the setting plan has been approved and prior to shipping in lieu of an erection drawing.
4. (11311 1.8 D) Pump, less motor, should be lifted by use of a sling through the windows of the discharge head in lieu of lifting lugs. The motor will have its own lifting provision.
5. (11311 2.3 C.3) The throttle bushing will be 300-350 BHN in lieu of 400-450 BHN. The throttle bushing is designed not to make contact with the rotor and does not need to be any harder than 300 BHN.
6. (11311 2.3 H.1) First critical speed of the rotating assembly shall be not less than 130% of either the maximum operating speed or maximum reverse runaway speed, whichever is greater, in lieu of 150%.
7. (11311 2.2 H.2) The pump shaft is the only shaft that is chrome plated.
8. (11311 2.2 H.4) Shaft connected with a threaded coupling in lieu of a solid sleeve type couplings fitted with shaft keys and split locking rings.
9. (11311 2.3 K) Lantern ring is not applicable on a VTSH style pump.
10. (11311 2.4 A) Anchor bolts for installation of the hydro-cone and splitter are the responsibility of others.
11. (11311 2.5 A, B and C) Accessories to be provided by others and not included in FM Scope of Supply.
12. (11311 2.6 B) Non-reverse ratchets are not recommended but can be provided. It is recommended that a check valve be installed after the discharge of the pump.
13. (11311 2.8 A) SCADA system to be provided by others and not included in FM Scope of Supply.
14. (11311 Part 3) Execution – To be provided by others. A FM representative will be on site to inspect removal and installation and assist with testing, but actual removal and installation and testing is the responsibility of others. Field painting is also the responsibility of others. Pumps will be shipped with a factory prime coating.
15. Lateral critical speed analysis and torsional critical speed analysis, will be submitted under a separate cover after being reviewed by FM engineering. Analyses will also be included in the record submittal.

Nidec (USEM)
Technical Clarifications & Exceptions

1. (16220 2.2.B.10) Motors will be designed & built in accordance with NEMA MG1 Standard. Motors have been quoted with typical features of IEEE 841, so to meet the intent of IEEE 841. Motors will not be rated or namplated IEEE 841. Motors will receive a Non-Witnessed IEEE 841 Enhanced No Load Test.
2. (16220 2.2.B.11g.2) Providing INPRO MGS Ground Seal.
3. (16220 2.2.B.11.g.4) Exception to Colloidal Silver Shaft Coating (PN CS015).

Fairbanks Morse
Pentair Water

TEST PROCEDURE
FOR
FM Project #: 064585
REVISION: 0

PUMPS
Model: 24"-VTSH
Quantity: 2

Pump tests conducted by Fairbanks Morse Pump meet the following standards:
Hydraulic Institute, Centrifugal Pump Tests 1.6-2000 and Vertical Pump Test 2.6-2000
AWWA, Horizontal and Vertical Line-Shaft Pumps E-103-07

Tests will be conducted to assure pump(s) performance meets the requirements of sold conditions, as shown on the Fairbanks Morse submittal curve.

Tests will be conducted at Fairbanks Morse Pump's factory, located in Kansas City, Kansas. Sufficient test points (at least 8) will be taken to assure the pump(s) performance is established. A certified pump performance curve, based on the actual pump tested will be plotted on an 8-1/2" x 11" sheet of graph paper.

Measurements will be taken using calibrated equipment and the values of each measurement will be determined as follows:

TOTAL HEAD (T.D.H.)

The total head will be the summation of the pressure transducer reading, plus velocity head difference between the suction flange and discharge flange, plus or minus the vertical difference between the gauges zero reference point. Pump datum will be the centerline of the shaft on horizontal pumps and the entrance eye of the impeller on vertical pumps.

RPM

The rpm will be determined by means of a calibrated electronic speed counter.

EFFICIENCY

From the values of input horsepower, total dynamic head, and capacity obtained, the pump(s) efficiency will be calculated for each individual test run.

HORSEPOWER (B.H.P.)

The power KW input to the motor will be measured with a calibrated power meter and by using the drive motor efficiencies, the pump(s) horsepower will be calculated.

CAPACITY (GPM)

The capacity will be measured with a venturi meter. The head differential across the venturi will be measured with a differential pressure transducer, calibrated to read feet of water, and gpm will be derived using the constant from the curve data.

SPECIFIC REMARKS:

- Non-witness certified performance test as specified below and *per Specification.*

ANSI/HI 14.6-2011 Acceptance grade 1U.

Due to Factory Test facility limitation, we can not test vertical pump with under ground discharge elbow. Job Bowl assembly will be test with Test Column, Test Discharge Head and Test Motor. Performance will be adjusted to Job Full Length performance.

Reduced Speeds will be test with Test Motor and Factory Test VFD.

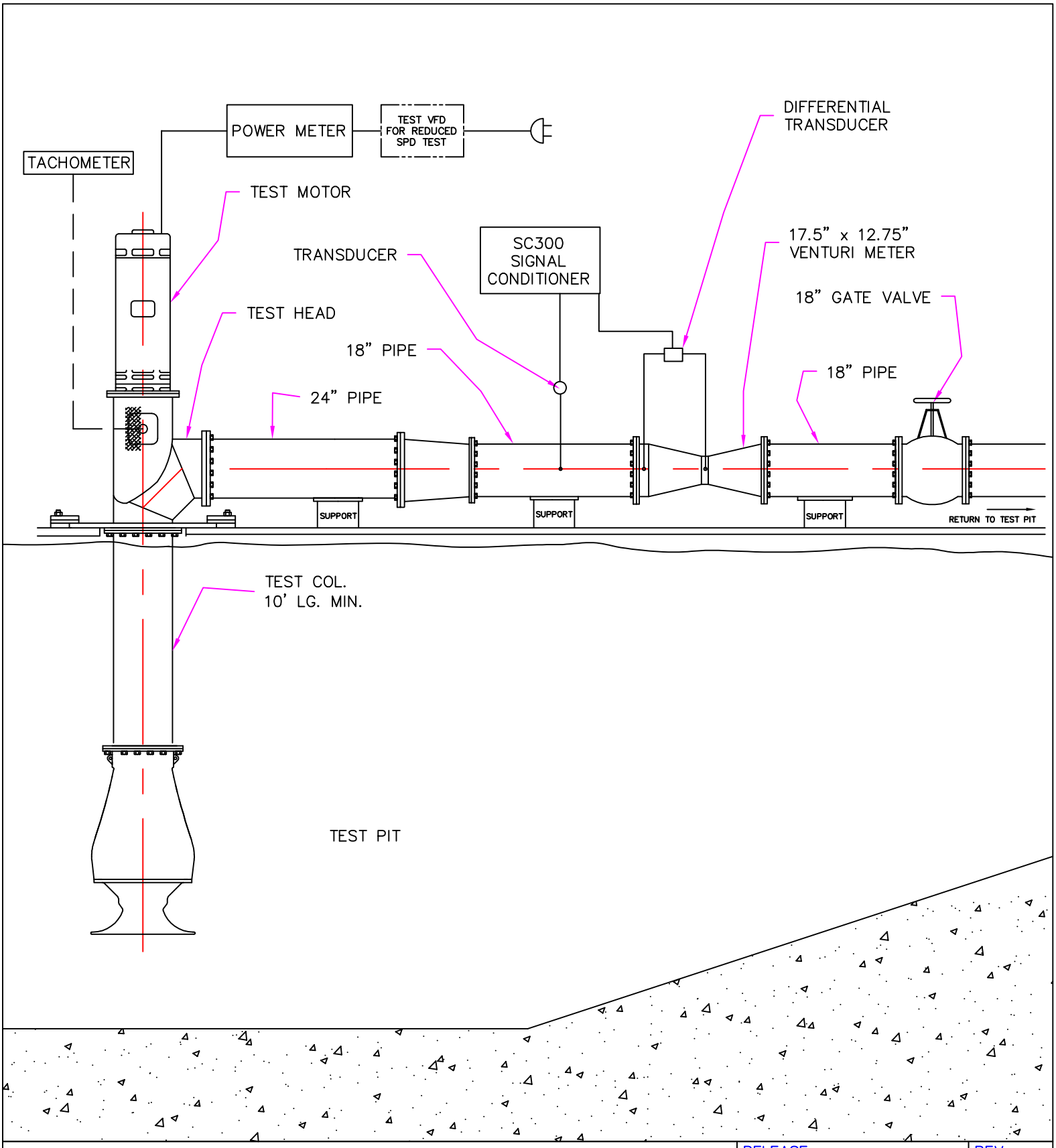
(Note: Test Motor is Calibrated and we are using it's true efficiency.)

Perform test at rated speed, and determine the curve of head, brake horsepower, and pump efficiency as a function of capacity. Take a minimum of tem points including shutoff. Take at least one point of the ten as near as possible to each specified condition of head and capacity, one at or slightly above the maximum head specified, one at the minimum head specified and one at the rating. Express capacity in gallons per minute and total head in feet of water on the curves. Speed corrects the data and curves to the actual motor speed for the horsepower required at the rated condition. Furnish certified copies of the curves, raw test data, calculated results and sufficient information for computation and plotting of the curves.

Subject each pump in the shop to a hydrostatic test. Apply a test pressure not less than 1-1/2 times the shutoff head of the pump as shown by the characteristic curve. Under this test pressure, verify that no part shows undue defection, sign of leakage or other defects. Furnish certified copies of hydrostatic test results.

Certified by: 4/25/12

Max Du P.E.
Product Engineer
Fairbanks Morse Pump



NOTES:
1. DRAWING NOT TO SCALE.
2. GAUGE LOCATIONS AND PIPE DISTANCES BEFORE THE VENTURI METER ARE PER HYDRAULIC INSTITUDE STANDARDS LATEST EDITION.

REVISION:
1. Was testing with Job Motor.
2. Relocate power meter (MD 5/21/12)

RELEASE NUMBER	XX	REV NO	2

Fairbanks Morse
Pentair Water

24" VTSH TEST SET UP

DWG. NO. 064585TS

Fairbanks Morse
Pentair Water

24"-VTSH SUBMITTAL CURVE

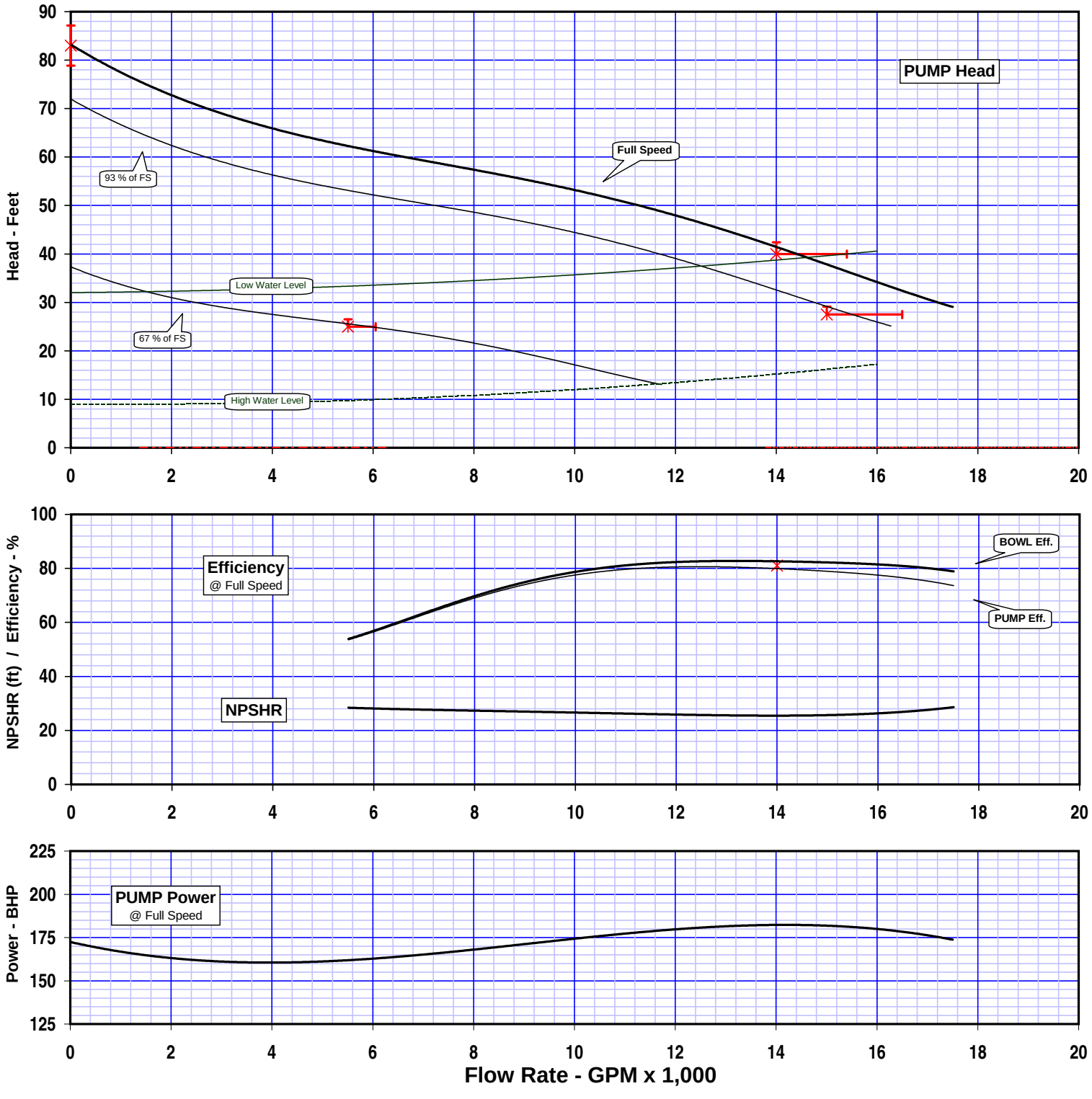
CURVE NO.:	064585C
REV.	0
PROJECT NO.:	064585

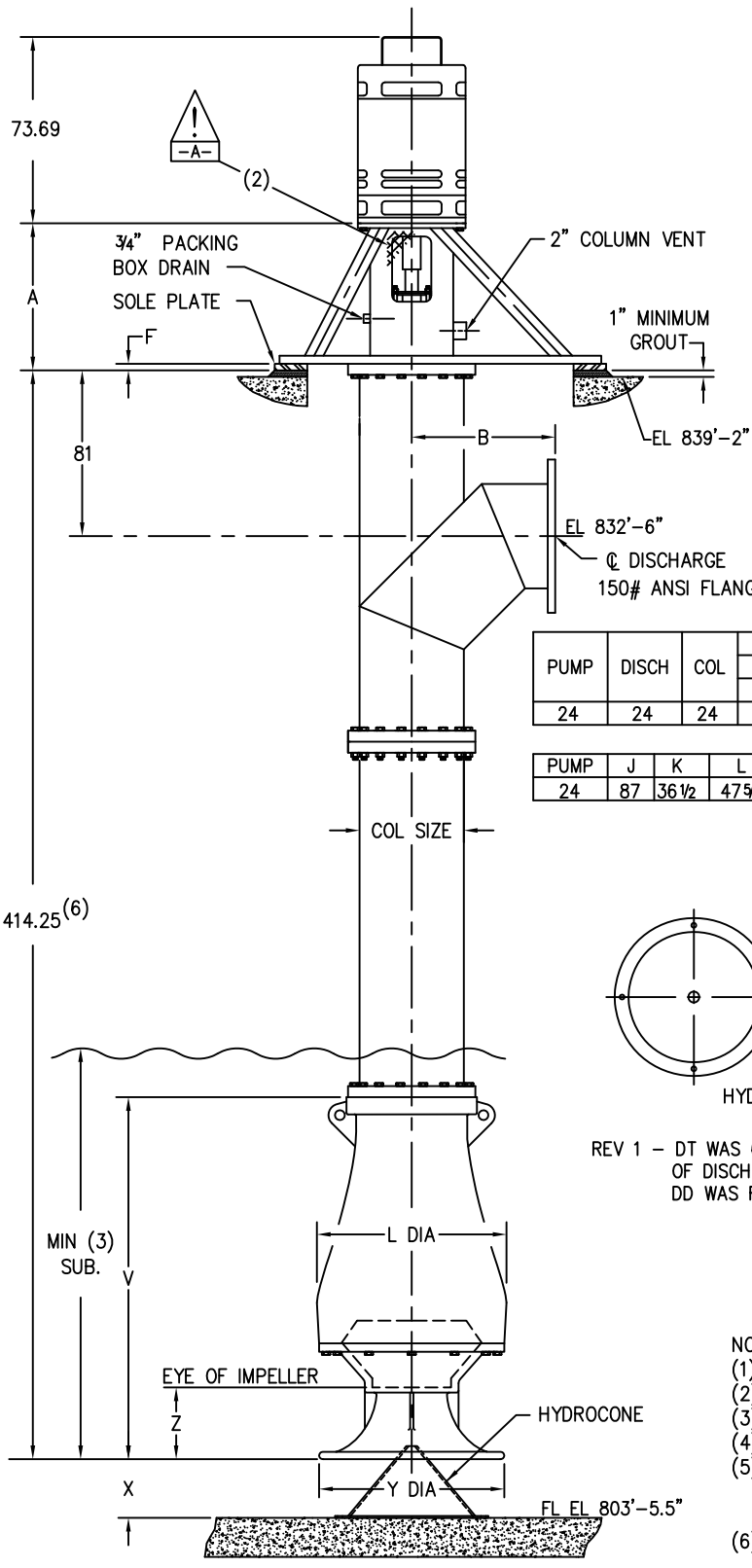
Full Speed	IMPELLER	DIAMETER	SPHERE
710	V24B1A	21.70	6"
VANES	DRIVER	DATE	BY
TWO	200 HP	2/14/2012	MD

THIS CURVE IS BASED ON THE ACTUAL TEST PERFORMANCE OF A SIMILAR PUMP. ONLY THE INDICATED POINT(S) IS GUARANTEED, (EXCEPT SHUT-OFF) **PER ANSI / HI 14.6 - 2011 GRADE 1U.**

GUARANTEED VALUES			
FLOW	HEAD	BOWL EFF.	SPEED
14,000	40.0	81	Full
15,000	27.5	-----	Reduced
5,500	25.0	-----	Reduced
0	83 ± 5%	-----	Full

Performance based on **18.1 feet** of 24" column, 24" **type "UF"** underground elbow.

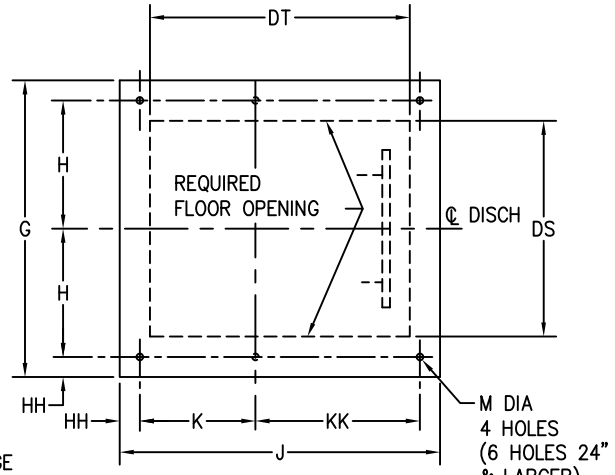




WARNING

DO NOT OPERATE THIS MACHINE WITHOUT PROTECTIVE GUARD IN PLACE. ANY OPERATION OF THIS MACHINE WITHOUT PROTECTIVE GUARD CAN RESULT IN SEVERE BODILY INJURY.

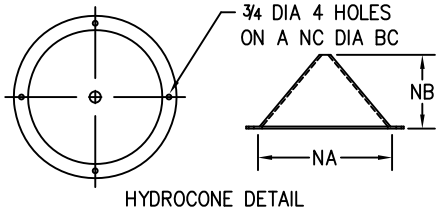
-A- SUPPLIED BY FMPC -B- SUPPLIED BY OTHERS



SOLE PLATE ANCHORING DIMENSIONS

PUMP	DISCH	COL	A MOTOR BASE DIAMETER 30½	B	F	G	H
24	24	24	31	32	1	70	32

PUMP	J	K	L	M	V	X	Y	Z	DS	DT	HH	KK
24	87	36½	47⅝	1¼	83¼	15¼	48	14⅜	52	69	3	44½



HYDROCONE DETAIL

PUMP	NA	NB	NC
24	34	18	36

REV 1 – DT WAS 60, CL OF DISCHARGE WAS 832'-8", BOTTOM OF SOLEPLATE TO CL OF DISCHARGE WAS 79", FL EL WAS 803-8", OAL WAS 411.75 DD WAS REMOVED, J WAS 70, K WAS 28 AND KK WAS 36

NOTES:
(1) ALL DIMENSIONS ARE IN INCHES UNLESS NOTED.
(2) GUARD FURNISHED WHEN FLANGED COUPLING IS USED.
(3) REFER TO SUBMERGENCE CHART FOR MIN. SUBMERGENCE.
(4) SOLEPLATE TO HAVE FULL CONTACT WITH GROUT.
(5) NOT FOR CONSTRUCTION, INSTALLATION, OR APPLICATION PURPOSES UNLESS CERTIFIED. DIMENSIONS SHOWN MAY VARY DUE TO NORMAL MANUFACTURING TOLERANCES.
(6) CONTRACTOR TO VERIFY AND CONFIRM OVERALL LENGTH PRIOR TO OR AT RELEASE.

CUSTOMER: F. A. WILHELM CONSTRUCTION CO., INC.					P.O. NO.: 9616-130234	
JOB NAME: ANDERSON WPC WET WEATHER PUMP					TAG NAME:	
PUMP SIZE AND MODEL: 24" VTSH UWF		GPM: **	TDH: **	RPM: **	ROTATION: CCW	
MOTOR: USEM	HP: 200	FRAME: 5807P	PHASE: 3	HERTZ: 60	VOLTS: 460	ENCLOSURE: TEFC
CERTIFIED FOR: PROJECT # 064585			CERTIFIED BY: SMF		DATE: 01/2012	

Fairbanks Morse® Pentair Water

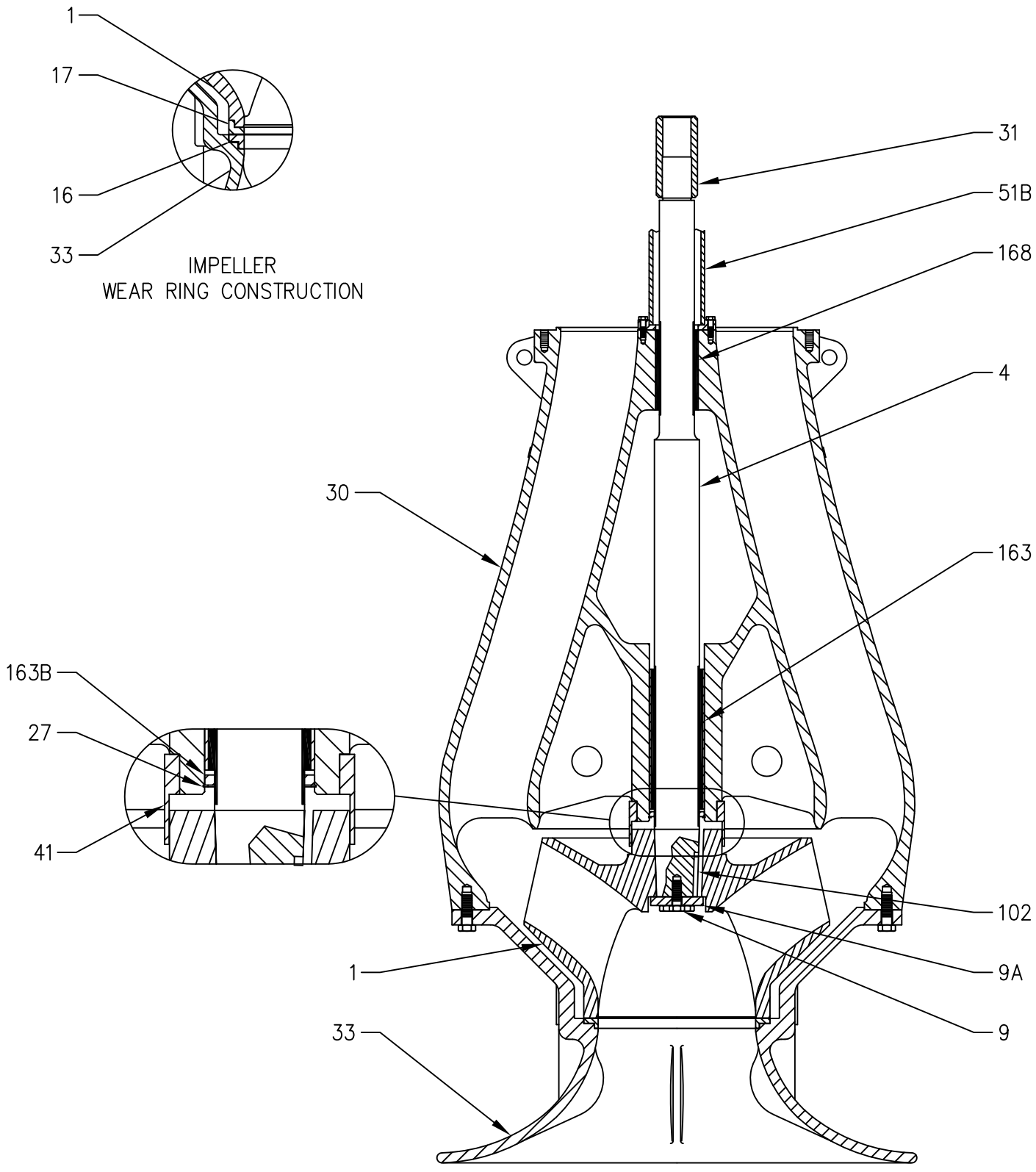
SETTING PLAN
VERTICAL TURBINE
SOLIDS HANDLING
BELOW GROUND DISCH

DWG NO 064585SP REV NO 1

Fairbanks Morse Pump
Material Specifications

Item	Description	Material	Specification[1]
1	Impeller	Cast Iron	A48 Class 30
4	Pump Shaft	Stainless Steel	AISI A582 S41600
8	Packing Box Gland	Bronze	B584 C83600
8A	Gland Bolt and Nut	Stainless Steel	18-8
9	Impeller Capscrew	Stainless Steel	A183 CL2 B8
9A	Impeller Washer	Stainless Steel	A582 S416
13	Top Shaft Sleeve	Stainless Steel	A743 CA-15 MOD (350-BHN) Min.
15	Packing	Synthetic, Graphite Impregnated	Commercial
15A	Washer, Packing Box	Stainless Steel	18-8
16	Bell Wearing Ring	Stainless Steel	A743 Gr CA40 (300-350 BHN)
17	Impeller Wear Ring	Stainless Steel	A743 Gr CA15 (190-241 BHN)
18	Soleplate	Steel	A36 & A53
19A	Drive Shaft	Steel	AISI 1045
19B	Top Shaft	Stainless Steel	A582 S41600
23	Lineshaft	Stainless Steel	A582 S41600
27	Ring, Retainer	Stainless Steel	AISI 302
28	Flanged Column Pipe	Steel	A36 & A53
28A	Head Gasket	Tag Board	D1170 Grade 3111
29	Shaft Sleeve	Stainless Steel	AISI 304
31	Shaft Coupling	Stainless Steel	A582 S41600
33	Suction Bell	Cast Iron	A48 Class 30
41	Throttle Ring, Bowl	Stainless Steel	A743 Gr CA40 (300-350 BHN)
50	Connector Bearing	Bronze	B505 C93200
51A	Top Enclosing Tube	Stainless Steel	AISI 316
51B	Enclosing Tube, Bottom	Stainless Steel	AISI 316
52	Underground Elbow	Steel	A36 & A120
62	Driver Pedestal	Steel	A36 & A120
63	Packing Box	Cast Iron	A48 Class 30
63A	Packing Box Gasket	Copper	B152 Alloy 110
63B	Packing Box Bearing	Bronze	B505 C93200
102	Impeller Key	Stainless Steel	A276 S304
126	Water Slinger	Rubber	Neoprene
163	Bearing, Lower Bowl	Bronze/Rubber	B505 C93200/Neoprene
163B	Restrictor	Teflon	Teflon
168	Bearing, Upper Bowl	Bronze/Rubber	B505 C93200/Neoprene
267	Guard, Shaft	Steel	Commercial
	Bowl Bolting	Stainless Steel	AISI 316
	Column Bolting	Stainless Steel	AISI 316
	Hydrocone	Stainless Steel	AISI 316

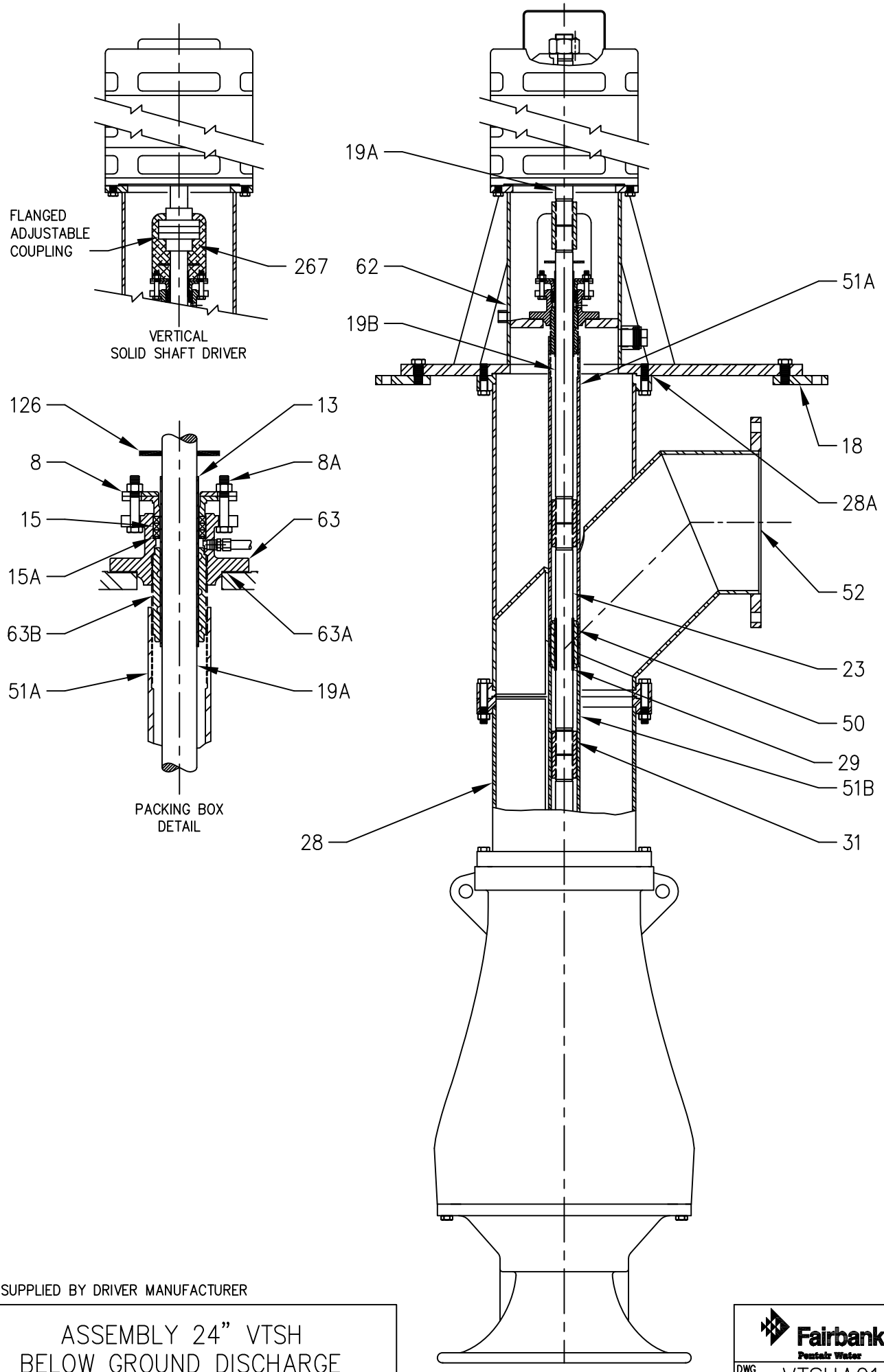
[1] Material specifications are ASTM unless otherwise noted and are for description of chemistry only.



ASSEMBLY
24" VTSH (BOWL ONLY)

Fairbanks Morse®
Pentair Water

DWG NO	VTSHA004	REV NO	2

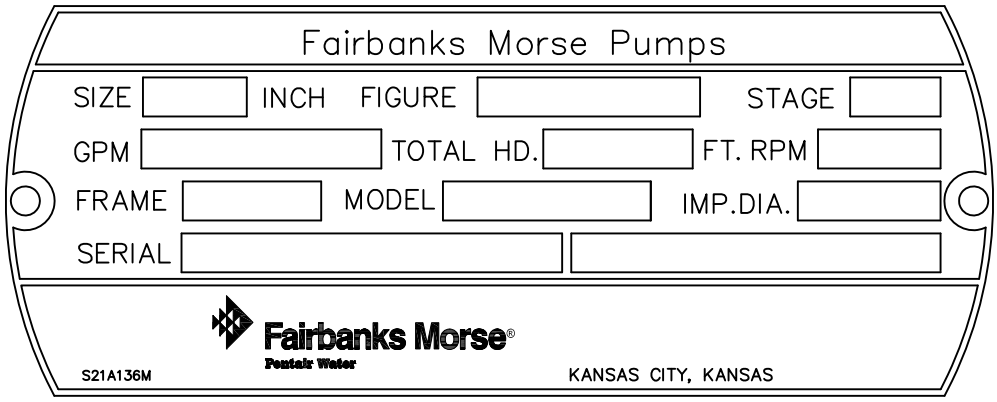


* SUPPLIED BY DRIVER MANUFACTURER

ASSEMBLY 24" VTSH
BELOW GROUND DISCHARGE

Fairbanks Morse®
Pentair Water

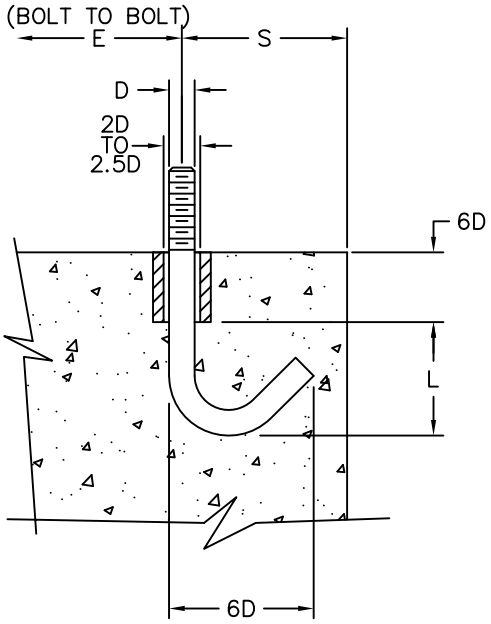
DWG NO	VTSHA013	REV NO	3



FULL DATA NAMEPLATE

Fairbanks Morse
Pentair Water

DWG NO	NAMEPLATE	REV NO



"J" TYPE

D = BOLT DIAMETER – INCHES
L = BOLT EMBEDDED LENGTH – INCHES
S = DISTANCE TO EDGE – INCHES
E = DISTANCE BETWEEN BOLTS – INCHES

* WHEN SHEAR AND TENSION ACT SIMULTANEOUSLY, THEN:

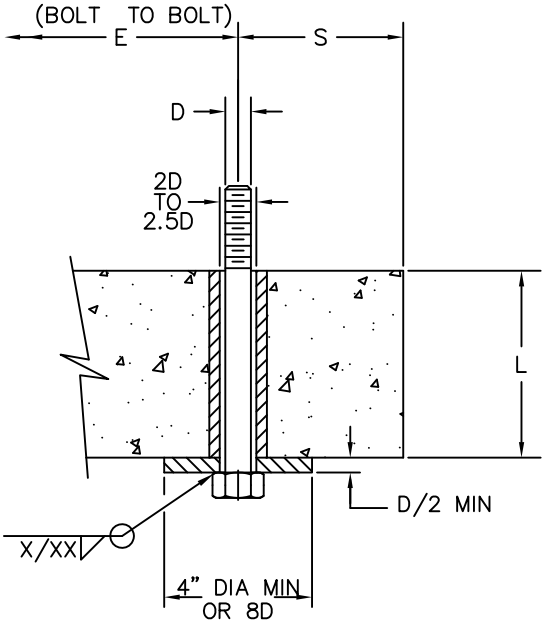
$$\left(\frac{\text{APPLIED SHEAR}}{\text{MAXIMUM SHEAR}}\right)^2 + \left(\frac{\text{APPLIED TENSION}}{\text{MAXIMUM TENSION}}\right)^2 \leq 1.0$$

THE ABOVE FORMULA MUST BE LESS THAN OR EQUAL TO 1.0.

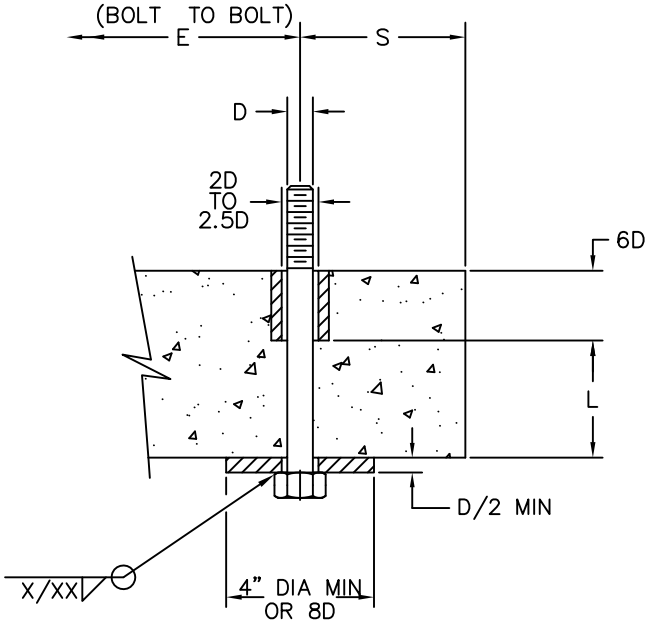
NOTES:
(1) THE DESIGN OF THE ANCHOR BOLT SHOWN IS A SUGGESTION ONLY. THE FINAL DESIGN AND INSTALLATION IS THE RESPONSIBILITY OF OTHERS.
(2) THE PUMP FOUNDATION MUST HAVE ADEQUATE STRENGTH AND MASS TO HOLD THE PUMP FIRMLY IN PLACE. THE CONTRACTOR IS RESPONSIBLE FOR THE ADEQUACY OF THE FOUNDATION.
(3) WHENEVER POSSIBLE, ALL ANCHOR BOLTS ARE TO BE SECURED TO THE REBAR.
(4) ALL VALUES ARE BASED ON 4,000 P.S.I. CONCRETE AND 60,000 P.S.I. TENSILE STRENGTH STEEL.
(5) CODE REFERENCE: UBC 1994 EDITION, SECTION 1925.1 AND TABLE 19–E
(6) LOAD VALUES MAY BE INCREASED AS NOTED AT THE BOTTOM OF THE CHART.
(7) ADD 1.2 TIMES D PLUS BASE THICKNESS AND GROUT.
(8) FOR SMALLER THAN ½" USE EPOXIED STUDS ACCORDING TO EPOXIED MFG. INST. (IE., HILTI OR RAMSET)

D NC THRD.	* MAX. ALLOWABLE LOAD PER BOLT (LBS)		MINIMUM VALUES (Inches)		
	TENSION	SHEAR	L	S	E
½"	950	1250	4.0	3.0	6.0
½"	1550	1750	4.0	5.0	6.0
⅝"	1500	2750	4.5	3.75	7.5
⅝"	2400	3050	4.5	6.25	7.5
¾"	2250	3560	5.0	4.5	9.0
¾"	3200	4400	5.0	7.5	9.0
⅞"	2550	4050	6.0	5.25	10.5
1"	3650	5300	7.0	6.0	12
1⅛"	3400	4750	8.0	6.75	13.5
1¼"	4000	5800	9.0	7.5	15
1⅜"	9150	14553	10.0	8.5	
1½"	15050	18070	11.0	9.0	
1¾"	20350	24420	13.0	10.5	
2"	26760	33100	16.0	12.0	

PER SECTION 1603.5 VALUES MAY BE INCREASED BY 1/3 WHEN ONLY SEISMIC FORCES. WITH SPECIAL INSPECTION VALUES MAY BE INCREASED 100% (SECTION 1701.5 [2]).



BOX TYPE 1



BOX TYPE 2

ANCHORING ILLUSTRATION

Fairbanks Morse® Pentair Water

DWG NO ABOLT–099 REV NO 2

Fairbanks Morse Pump
Technical Data [1]

Column	
Size	24
Column O.D.	24
Wall Thickness	0.379
Flange O.D.	28
Pipe Weight per Ft (Lbs)	120
Enclosing Tube	
Size	5
Schedule No.	80
Outside Diameter	5-9/16
Tube Weight / Ft. (Lbs)	20.78
Connector Bearing Spacing; Normal	60
Flush Water Requirements	
Flow (GPM)	1.2
Pressure (PSI)	50
Lineshaft	
Line Shaft Diameter	2-15/16
Weight (Lbs /Ft)	23.06
Line Shaft Sleeve Thickness	0.125
Bowl Assembly	
Weight (Lbs)	7600
KT (Thrust Factor), (Lbs/Ft)	58.8
KA (Rotor Weight) (Lbs)	1005
Wear Ring Nominal Clearance	0.030
Nominal Bowl Assembly End Play	1-1/4
Nominal Bowl Wall Thickness	1
Bowl Shaft Diameter at Lower Bearing	4-1/2
Driver Pedestal	
Weight (Lbs)	300
Discharge Flange Size (150lb ANSI)	24
Elbow Section Weight	1571
Sealing Box	
Packing Size	1/2
Rings per Box	3
Sleeve O.D.	3-3/16
Box I. D.	4-3/16
Box Depth	1.87
Box Inlet Tap Size (NPT)	1/4
Box Drain Tap Size (NPT)	3/4
Impeller Data	
Impeller Diameter	21-1/2
Clearance	0.033/0.041
Inlet Area In2	184.5
Maximum Sphere Size	6
Wr2 (Lb-Ft2)	332.8
Impeller Fastener	
Size (3 Bolts)	7/8-9
Tightening Torque (Ft-Lbs)	200

[1] Values shown are in inches unless otherwise noted.

64585LC

LATERAL CRITICAL SPEED ANALYSIS

FOR

PUMP

AT

ANDERSON WPC WET WEATHER PUMP
ANDERSON, IN

PROJECT NUMBER 064585
PENTAIR PUMP GROUP

24 " VTSH-UWF PUMP

License Expires 12-31-12

PREPARED BY

Virgil J. Beaty

VIRGIL J. BEATY, PE
CONSULTING ENGINEER
MAY 3, 2012

BEATY ENGINEERING
233 NE 104 ROAD
CLINTON, MO 64735
REGISTERED PROFESSIONAL ENGINEER IN
CALIFORNIA, MASSACHUSETTS, AND MISSOURI
PHONE: 660 885 8706

LATERAL CRITICAL SPEED ANALYSIS

THIS REPORT IS PREPARED FOR EVALUATION OF THE LATERAL NATURAL FREQUENCY AGAINST THE OPERATING FREQUENCIES OF THE PUMPING EQUIPMENT IN ACCORDANCE WITH THE REQUIRED LIMITS OF THE SPECIFICATIONS.

INPUT CONSISTS OF THE PHYSICAL CHARACTERISTICS OF THE PUMP AND MOTOR ONLY, THEREFORE THE CALCULATED NATURAL FREQUENCY IS BASED ON AN INFINITELY RIGID BASE FOUNDATION AND A DISCHARGE PIPE CONNECTION THAT ADDS NO SUPPORT OR STRAIN TO THE PUMP. THE CALCULATION METHOD IS BASED ON THE UNIT AS A CANTILEVER BEAM WITH THE BASE BEING THE SOLE SUPPORT.

OPERATING SPEED	MINIMUM	Np1 = 476	RPM
	MAXIMUM	Np2 = 710	RPM

VANE FREQUENCY		
AT MINIMUM SPEED	Z1 = 2854	CPM
AT MAXIMUM SPEED	Z2 = 4260	CPM

IN THIS CASE THE CALCULATED LATERAL NATURAL FREQUENCY FOR THE MOTOR/BASE ASSEMBLY AND PUMP IS:

MOTOR/BASE ASSEMBLY CRITICAL SPEED	Ncm = 1864	RPM
PERCENTAGE OF MINIMUM OPERATING SPEED	Pm1 = 392	%
PERCENTAGE OF MAXIMUM OPERATING SPEED	Pm2 = 262	%

PUMP COLUMN ASSEMBLY CRITICAL SPEED	Ncp = 153	RPM
PERCENTAGE OF MINIMUM OPERATING SPEED	Pp1 = 32	%
PERCENTAGE OF MAXIMUM OPERATING SPEED	Pp2 = 22	%
PERCENTAGE OF MINIMUM VANE FREQUENCY	Ppz1 = 5	%
PERCENTAGE OF MAXIMUM VANE FREQUENCY	Ppz2 = 4	%

IN EITHER CASE THE OPERATING FREQUENCIES OR MULTIPLES FREQUENCIES ARE NOT IN RESONANCE WITH THE CALCULATED VALUES.

IT IS CONCLUDED THAT DURING OPERATION OF THE PUMP NO EXCESSIVE VIBRATION SHOULD OCCUR WHEN THE PUMP IS PROPERLY INSTALLED AND OPERATED WITHIN PROPER GUIDELINES FOR THIS TYPE OF PUMP.

LATERAL CRITICAL SPEED SUMMARY

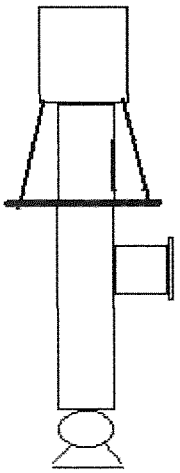
THE CALCULATIONS OF THE LATERAL NATURAL FREQUENCY HAS BEEN DONE USING A METHOD THAT TAKES INTO ACCOUNT BOTH THE BENDING AND DEFLECTION. THE PUMP/MOTOR SYSTEM IS DIVIDED INTO TWO COMPONENTS, THE MOTOR/BASE ASSEMBLY AND THE PUMP COLUMN ASSEMBLY. THE NATURAL LATERAL FREQUENCY IS CALCULATED FROM
THE DEFLECTION OF THE BEAM.

MOTOR:

MFGR		
SIZE	HP = 200	HORSEPOWER
SPEED	Np2 = 710	RPM
REED FREQ	Nr = 1980	CPM
WEIGHT	Wm = 5500	LBS
CENTER OF GRAVITY	Lm = 30	INCHES

BASE/DISCHARGE HEAD:

WEIGHT	Wh = 3100	LBS
CENTER OF GRAVITY	Lh = 4.3	INCHES



MOTOR/BASE:

CALCULATED DEFLECTION	Yt = 0.01	INCHES
CALCULATED FREQUENCY	Ncm = 1864	CPM
	Ncmz = 31.1	HZ

PUMP

SIZE	S = 24	
MODEL	VTSH	
BOWL WEIGHT	Wb = 7600	LBS
COLUMN WEIGHT	Wc = 4444	LBS
OPERATING SPEED, MIN	Np1 = 476	RPM
OPERATING SPEED, MAX	Np2 = 710	RPM
VANES, IMPELLER & BOWL	Zi = 2	Zv = 3
CALCULATED DEFLECTION	Y = 1.509	INCHES
CALCULATED FREQUENCY	Ncp = 153	CPM
	Nczp = 2.5	HZ

VANE FREQUENCY

MIN SPEED	$Z1 := Zi \cdot Zv \cdot Np1$	Z1 = 2854	CPM
MAX SPEED	$Z2 := Zi \cdot Zv \cdot Np2$	Z2 = 4260	CPM

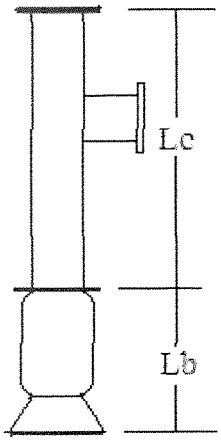
PERCENTAGE OF VANE FREQUENCY

$$Ppz1 := \frac{Ncp \cdot 100}{Z1} \quad Ppz1 = 5 \quad \%$$

$$Ppz2 := \frac{Ncp \cdot 100}{Z2} \quad Ppz2 = 4 \quad \%$$

PUMP COLUMN CRITICAL SPEED CALCULATIONS

BOWL WEIGHT	Wb = 7600	LBS
BOWL LENGTH	Lb = 83.25	INCHES
COLUMN O. D.	C = 24	INCHES
COLUMN I. D.	D = 23.25	INCHES
COLUMN LENGTH	Lc = 329.5	INCHES
COLUMN WT/FT	Cw = 94.62	LBS
COL FLG WT/PAIR	Wfl = 91	LBS
COL NO. OF PAIRS	Nfl = 3	
LINESHAFT WT/FT	Lw = 23.06	LBS
ENCLOSING WT/FT	Ew = 20.78	LBS
IMPELLER. VANES	Zi = 2	
BOWL VANES	Zv = 3	
COLUMN/SHAFTING WEIGHT	Wc = 4444	LBS
COLUMN MOMENT OF INERTIA	Ip = 2402	$INCHES^4$
MODULUS OF *ELASTICITY*	$Es := 29 \cdot 10^6$	PSI



COLUMN DEFLECTION

$$Y := \frac{\left[(Wb) + .236 \cdot \left[Lc \cdot \left(\frac{Cw + Lw + Ew}{12}\right)\right] + Wfl \cdot Nfl\right] \cdot (Lc)^3}{3 \cdot Es \cdot Ip} + Wb \cdot \frac{Lb^3}{8 \cdot Es \cdot Ip}$$

To determine the natural *frequency, calculate the* deflection of the column in the horizontal position.

Y = 1.509 INCHES

NATURAL FREQUENCY

$$Ncp := \frac{187.7}{\sqrt{Y}} \qquad Ncp = 153 \quad CPM$$

$$Nczp := \frac{Ncp}{60} \qquad Nczp = 2.5 \quad HZ$$

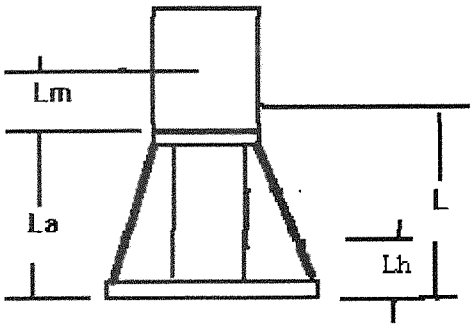
PUMP PERCENT OF OPERATING SPEED

MIN SPEED $Pp1 := \frac{Ncp \cdot 100}{Np1}$ Pp1 = 32 %

MAX SPEED $Pp2 := \frac{Ncp \cdot 100}{Np2}$ Pp2 = 22 %

MOTOR/BASE CRITICAL SPEED CALCULATIONS

MOTOR SIZE	HP = 200	HORSEPOWER
MOTOR SPEED MIN	Np1 = 476	RPM
MOTOR SPEED MAX	Np2 = 710	RPM
MOTOR WEIGHT	Wm = 5500	POUNDS
MOTOR CENTER GRAVITY	Lm = 30	INCHES
MOTOR REED FREQUENCY	Nr = 1980	CPM
MOTOR DEFLECTION	Yr = 0.009	INCHES
DISCHARGE HEAD WT	Wh = 3100	POUNDS
DISCHARGE HEAD C. G.	Lh = 4.3	INCHES
DISCHARGE HEAD HEIGHT	La = 30	INCHES
HEAD MOMENT OF INERTIA	Ih = 8162	$INCHES^4$



MOTOR/HEAD C. G $L := \frac{Wm \cdot (La + Lm) + Wh \cdot Lh}{Wm + Wh}$ L = 39.93 INCHES

DISCHARGE HEAD MODULUS OF ELASTICITY $E = 2.9 \cdot 10^7$ PSI

.MOTOR/HEAD DEFLECTION $Yh := \frac{(Wm + Wh) \cdot L^3}{3 \cdot E \cdot Ih}$ Yh = 0.0008 INCHES

TOTAL DEFLECTION $Yt := \frac{(Lm + La) \cdot Yh}{L} + Yr$ Yt = 0.0101 INCHES

NATURAL FREQUENCY $Ncm := \frac{187.7}{\sqrt{Yt}}$ Ncm = 1864 CPM

$Ncmz := \frac{Ncm}{60}$ Ncmz = 31.06 HZ

PERCENTAGE OF OPERATING SPEED

MIN SPEED $Pm1 := \frac{Ncm \cdot 100}{Np1}$ Pm1 = 392 %

MAX SPEED $Pm2 := \frac{Ncm \cdot 100}{Np2}$ Pm2 = 262 %

64585TC

TORSIONAL CRITICAL SPEED ANALYSIS

FOR

PUMP

AT

ANDERSON WPC WET WEATHER PUMP
ANDERSON, IN

PROJECT NUMBER 064585
PENTAIR PUMP GROUP

24 " VTSH-UWF PUMP

License Expires 12-31-12

PREPARED BY

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TORSIONAL CRITICAL SPEED ANALYSIS

THIS REPORT IS PREPARED FOR EVALUATION OF THE TORSIONAL NATURAL FREQUENCY AGAINST THE OPERATING FREQUENCIES OF THE PUMPING EQUIPMENT IN ACCORDANCE WITH REQUIRED LIMITS OF THE SPECIFICATIONS.
INPUT CONSISTS OF THE PHYSICAL CHARACTERISTICS OF THE ROTATING SYSTEM,
THE MASS MOMENT OF INERTIA OF THE MOTOR AND THE PUMP IMPELLERS ARE VERY LARGE IN COMPARISON TO THE SHAFTING AND COUPLINGS THEREFORE IT IS CONSIDERED TO BE A MULTIPLE MASS SYSTEM CONNECTED WITH SPRINGS. THE MASS OF THE LINESHAFT IS EQUALLY ADDED TO *THE MOTOR AND FIRST IMPELLER RESPECTIVELY. THE COMBINED SPRING CONSTANTS OF THE* LINESHAFT AND PUMPSHAFT HAS BEEN USED TO CALCULATE THE SYSTEM SPRING CONSTANTS THAT CONNECTS THE MASS OF THE MOTOR AND THE IMPELLERS

OPERATING SPEED	MINIMUM	Np1 = 476	RPM
	MAXIMUM	Np2 = *710*	*RPM*
VANE FREQUENCY			
AT MINIMUM SPEED		V1 = 2854.2	CPM
AT MAXIMUM SPEED		V2 = 4260	CPM

IN THIS CASE THE TORSIONAL CRITICAL SPEED IS: Nc = 475 RPM Ncz = 7.9 HZ

THE PERCENTAGE OF OPERATING SPEED IS:

FOR MINIMUM SPEED	Pp1 = 100	%
FOR MAXIMUM SPEED	Pp2 = 67	%

THE SHAFT TORSIONAL STRESS AT CRITICAL SPEED IS: Ss = 1400 PSI

IN THIS CASE THE TORSIONAL CRITICAL SPEED IS AT THE MINIMUM OPERATING SPEED. FURTHER CALCULATIONS ARE REQUIRED TO DETERMINE IF THE SHAFT TORSIONAL STRESS IS WITHIN THE ALLOWABLE TORSIONAL STRESS AT A CRITICAL SPEED.

THE TORSIONAL EXCITATION IS 1 % OF THE STEADY-STATE TORQUE. FOR THIS DYNAMIC TORQUE THERE IS AN AMPLIFICATION FACTOR ASSOCIATED WITH THE MODE SHAPE, A TYPICAL AMPLIFICATION FACTOR WOULD BE 30 OR 30 x 1 % (30 %).

THE TOTAL SHAFT STRESS INCLUDING THE TORSIONAL
EXCITATION WITH AMPIFICATION FACTOR IS: Stor := 1.30·Ss Stor = 1820 PSI

THE ALLOWABLE TORSIONAL STRESS IS DETERMINED FROM THE ENDURANCE LIMIT OF THE SHAFT MATERIAL AND THE ENDURANCE TORSIONAL LIMIT IS A DIRECT FUNCTION OF THE TENSILE STRENGTH OF THE SHAFT MATERIAL. AS A GUIDE "MIL STD 167" USES 4 % OF THE TENSILE STRENGTH AND "ASME" USES 8.125 % OF THE TENSILE STRENGTH.

TO AVOID SHAFT FATIGUE FAILURE A CONSERVATIVE PRACTICE IS TO LIMIT THE ALLOWABLE TORSIONAL STRESS TO 6 % OF THE SHAFT TENSILE STRENGTH WHEN THE CRITICAL SPEED IS AT THE OPERATING SPEED AND 4 % WHEN AT THE VANE FREQUENCY.

SHAFT TENSILE STRENGTH St := 100000 PSI

THE ALLOWABLE TORSIONAL STRESS IS: Sa := 0.06·St Sa = 6000 PSI

THE TORSIONAL STRESS AT CRITICAL SPEED IS: Stor = 1820 PSI

SINCE TORSIONAL SHAFT STRESS IS LESS THAN THE ALLOWABLE SHAFT STRESS, IT IS CONCLUDED THAT DURING OPERATION OF THE PUMP NO EXCESSIVE VIBRATION OR TORSIONAL SHAFT FAILURE SHOULD OCCUR WHEN THE PUMP IS PROPERLY INSTALLED AND OPERATED WITHIN PROPER GUIDELINES FOR THIS TYPE OF PUMP.

TORSIONAL CRITICAL SPEED SUMMARY

MOTOR MFG _____

HORSEPOWER Hpm = 200

SPEED *Np2 = 710 RPM*

MOMENT OF INTERIA WRm = 305 LB FT^2

PUMP MFG

SIZE _____ S = 24

MODEL _____ VTSH

SPEED _____ MIN Np1 = 476 RPM

MAX Np2 = 710 RPM

NUMBER OF IMPELLER VANES _____ Zi = 2

NUMBER OF BOWL VANES _____ Zv = 3

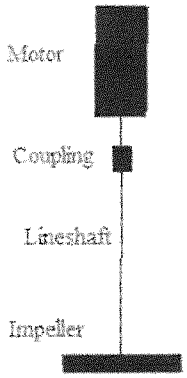
IMPELLER WR^2 WRi = 893.23 LB FT^2

CALCULATED NATURAL TORSIONAL FREQUENCY Nc = 475 CPM

Ncz = 7.91 HZ

CALCULATED SHAFT STRESS AT CRITICAL SPEED Ss = 1400 PSI

CALCULATIONS



ORDER NUMBER TC = 64585

MOTOR HORSEPOWER Hpm := 200 *HORSEPOWER*
MOTOR SPEED N := 710 RPM
MOTOR WR^2 WRm := 305 LB FT^2
MOTOR SHAFT STIFFNESS Sm := $1.52 \cdot 10^6$ IN LB/RAD

PUMP SIZE S := 24
PUMP MODEL VTSH
PUMP HORSEPOWER Hp1 := 175 HORSEPOWER
PUMP SPEED Np1 := .67·N RPM MIN Np1 = 476
Np2 := N RPM MAX

LINESHAFT DIAMETER Dl := 2.934 INCHES
PUMPSHAFT DIAMETER Dp := 4.5 INCHES

IMPELLER WR^2 WRi := 893.23 *LB* FT^2
IMPELLER VANES Zi := 2
BOWL OR VOL VANES Zv := 3

LINESHAFT LENGTH Ll := 341.6 INCHES
PUMPSHAFT LENGTH Lp := 68.88 INCHES

SHAFT COUPLING STIFFNESS Sc := $4.48 \cdot 10^7$

SHAFT COUPLING WR^2 $WRc := \frac{336.86}{144}$ *LB* FT^2 WRc = 2.34

LINESHAFT WR^2 $WRl := Dl^4 \cdot Ll \cdot \frac{\pi}{4 \cdot 576} \cdot .284 \cdot .5$ WRl = 4.901 LB FT^2

MASS #1 MOTOR $M1 := \frac{144}{386.4} \cdot (WRm)$ M1 = 113.66 INCH LB SEC^2

MASS #2 COUPLING $M2 := \frac{144}{386.4} \cdot \left(WRc + \frac{WRl}{2}\right)$ M2 = 1.79 INCH LB SEC^2

MASS #3 IMPELLER $M3 := \frac{144}{386.4} \cdot \left(WRi + \frac{WRl}{2}\right)$ M3 = 333.79 INCH LB SEC^2

LINESHAFT STIFFNESS $SL := 12 \cdot 10^6 \cdot .098 \cdot \frac{Dl^4}{Ll}$ SL = 255111 INCH LB / RAD

PUMPSHAFT STIFFNESS $SP := 12 \cdot 10^6 \cdot .098 \cdot \frac{Dp^4}{Lp}$ SP = 7001067 IN LB/RAD

MOTOR/CPLG STIFFNESS

$$S1 := \frac{1}{\left(\frac{1}{Sm} + \frac{1}{Sc}\right)}$$ S1 = 1470121 IN LB/RAD

LINESHAFT/PUMPSHAFT STIFFNESS

$$S2 := \frac{1}{\left(\frac{1}{SL} + \frac{1}{SP}\right)}$$ S2 = 246142 IN LB/RAD

SYSTEM STIFFNESS

$$SS := \frac{1}{\left(\frac{1}{Sm} + \frac{1}{Sc} + \frac{1}{SL} + \frac{1}{SP}\right)}$$ SS = 210841 IN LB/RAD

CRITICAL SPEED

INPUT DATA INTO PROGRAM FOR 3 OR MORE MASSES

RESTRAINT AT EACH END IS ZERO
REm := 0
REp := 0

M1 = 113.66

S1 = 1470121

M2 = 1.79

S2 = 246142

M3 = 333.79

OUTPUT DATA FROM PROGRAM

TORSIONAL NATURAL FREQUENCY FIRST CRITICAL Ncz := 7.91 HERTZ

Nc := 60·Ncz Nc = 475 CPM

SECOND CRITICAL Ncz2 := 157 HERTZ

Nc2 := 60·Ncz2 Nc2 = 9420 CPM

CALCULATION METHOD, USE ONLY AS CHECK ASSUME TWO MASS SYSTEM

$Ks := \frac{1}{\left(\frac{1}{SS}\right)}$ Ks = 210841 $NCK := \frac{60}{2 \cdot \pi} \cdot \sqrt{Ks \cdot \frac{M1 + M3}{M1 \cdot M3}}$ NCK = 476 CPM

PERCENTAGE OF OPERATING SPEED FOR THE PUMP

MIN SPD $Pp1 := \frac{Nc \cdot 100}{Np1}$ Pp1 = 100 %

MAX SPD $Pp2 := \frac{Nc \cdot 100}{Np2}$ *Pp2* = 67 %

VANE FREQUENCY

MIN SPD V1 := Np1·Zi·Zv V1 = 2854.2 CPM

MAX SPD V2 := Np2·Zi·Zv V2 = 4260 CPM

SHAFT STRESS

WHEN Nc IS BELOW FULL LOAD SPEED Hpm = 200

USE HORSEPOWER $Hpc := \left(\frac{Nc}{N}\right)^3 \cdot Hp1$ Hpc = 52.27

$Ss := Hpc \cdot \frac{321000}{(Nc \cdot Dl^3)}$ $Ss = Hpc \cdot \frac{321000}{(Nc \cdot Dl^3)} = 1400$ *PSI*

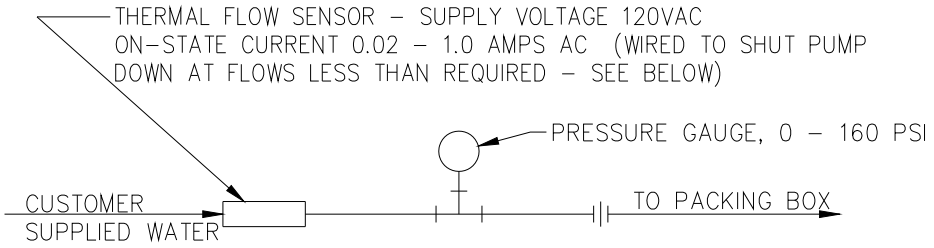
Fairbanks Morse Pump
Minimum Submergence

Use the following chart to determine the submergence required to prevent vortexing. Submergence is measured from the suction bell.

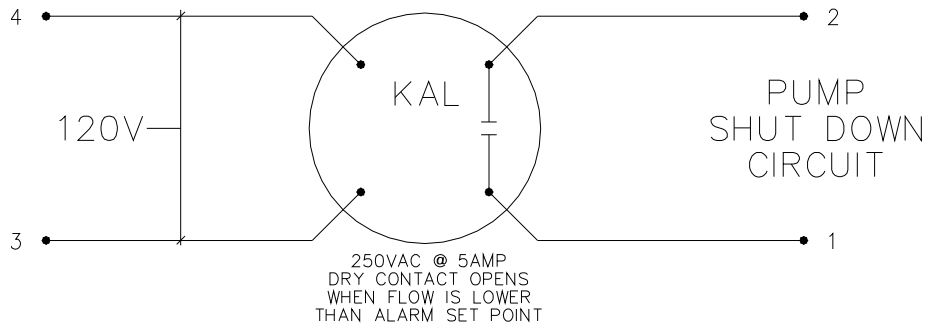
Minimum Submergence 24" VTSH	
GPM	Inches
7000	53
8000	57
10000	63
15000	70
20000	73
25000	80
30000	85

Fairbanks Morse Pump

Seal Water Schematic



Flow Meter Wiring Diagram[1]

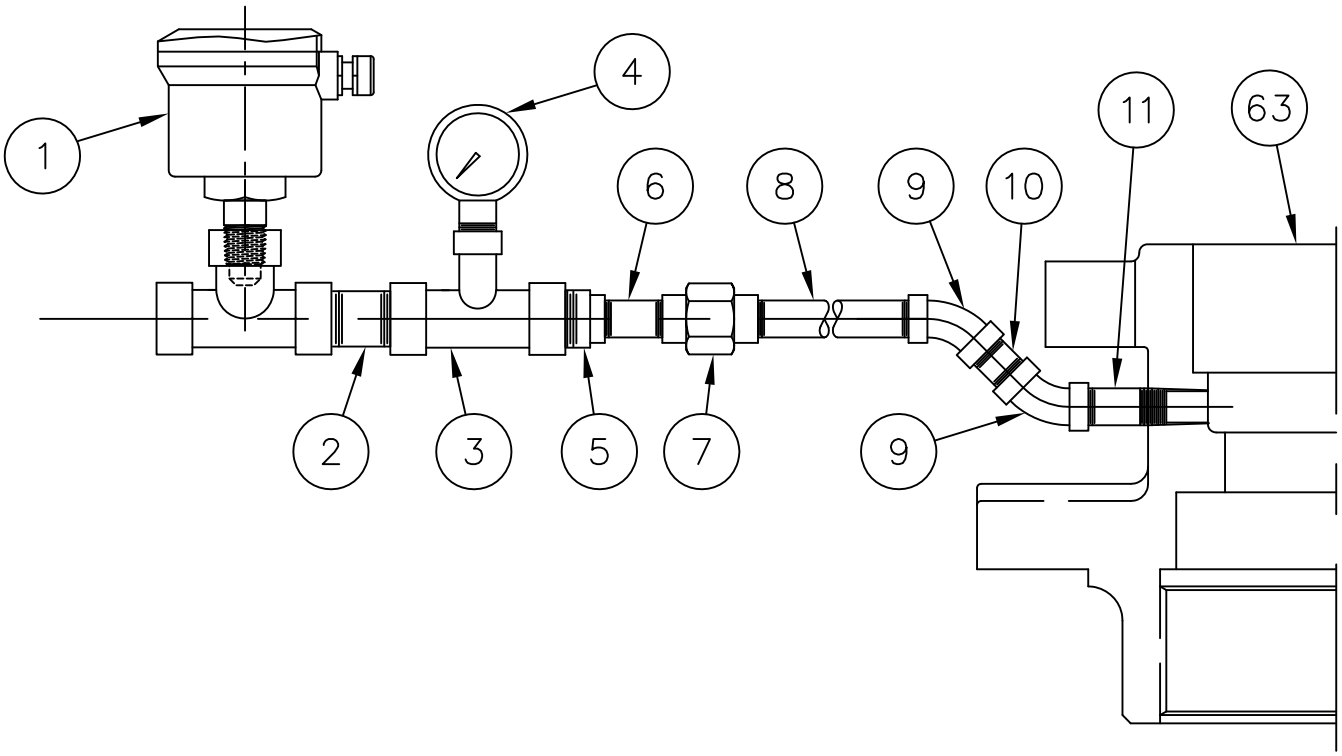


Specifications

1. The following water quality standard is recommended as a minimum for water used to flush the bearing system of this VTSH pump.
   - pH Value: 6.0-8.0
   - Solids Content:
     Dissolved: 500 PPM (MG/L)
     Suspended: 30 PPM (MG/L)
   - Maximum Particle Size: 60 Microns
   - Maximum Individual Dissolved Ions:
     Hardness: (Ca^{+}, Mg^{+}) 220 PPM (MG/L)
     Calcium Carbonate ($CaCO_3$): 10PPM (MG/L)
     Sulfate (SO_4): 50PPM (MG/L)
   - Temperature Range: 35°F - 100°F.
2. The flush water system is to be operated as follows:
   - Rubber Bowl Bearings
     1. For moderate service, the bearings must be flushed for a minimum of 5 minutes before starting the pump, continuously while in operation and at least 15 minutes after the pump is stopped.
     2. Continuous fresh water flushing is required for applications where the fluid may included an excessive amount of abrasive fines, sand or grit.
3. Flow Requirements

Pump Size	Nominal Flow (GPM)	Alarm Flow (GPM)	Minimum Pressure (PSI)
24”	1.2	0.5	50

[1] Wiring and hook up of flow switch not by Fairbanks Morse



ITEM	QTY	P/N or MATERIAL CODE	DESCRIPTION
63	1	H7x7037xx-0220-F	VTSH PACKING BOX
11	1	20FM6A0098-7380-F	3/8" PIPE NIPPLE X 2 1/4"LG
10	1	20FM6A0093-7380-F	3/8" CLOSE NIPPLE
9	2	20FM3B0003-0008-F	3/8" X 45° ELBOW
8	1	20FM6A0127-7380-F	3/8" PIPE NIPPLE X 9 1/2"LG
7	1	20FM8B0002-0008-F	3/8" UNION
6	1	20FM6A0096-7380-F	3/8" PIPE NIPPLE X 1 3/4"LG
5	1	20FM2A0004-0008-F	BUSHING 1/2" X 3/8"
4	1	HYD13S-9906-F	160# PSI PRESSURE GAUGE
3	1	20FM9A0014-0008-F	TEE 1/2" X 1/2" X 1/4"
2	1	20FM6A0141-7380-F	1/2" PIPE NIPPLE X 2"LG
1	1	HYD13V2-9906-F	* FLOWMETER

* KOBOLD KAL-K FLOW METER
MODEL NO. KAL-4215-P03R

24" VTSH SEAL WATER ASSEMBLY

Fairbanks Morse Pump Corporation

DWG. NO. VTSH-WTRFLUSH | REV NO 0

KAL-K ~~& KAL-A~~
COMPACT THERMAL FLOW SENSOR

Flow
Pressure
Level
Temperature
measurement
monitoring
control

- **Revolutionary Microprocessor-Based Drift Stabilization**
- **NPT and 3-A Compliant Sanitary Fittings**
- **Standard and Explosion Proof Housings**
- **No Moving Parts**
- **Extremely Low Pressure Loss**
- **Easy to Operate**
- **Insensitive to Dirt**
- **4-20 mA Flow Rate Signal with KAL-A**

S5

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Visit KOBOLD Online at
www.kobold.com

Model:
KAL-K ~~& KAL-A~~

The KAL-K thermal flow switch and ~~KAL-A~~ thermal flow sensor utilize KOBOLD's revolutionary, temperature compensating electronics. These compact, one-piece units provide reliable readings unaffected by temperature or physical characteristics of a wide variety of process liquids. This breakthrough is made possible through the use of state-of-the-art microprocessor technology. The microprocessor can be field calibrated to the users' liquid properties and operating range in a simple, five minute set-up procedure. This intelligence, coupled with a "no moving parts" design, make the KAL a superior performer in virtually all applications.

To further enhance the versatility of the KAL-K ~~and KAL-A~~, both are offered in a 3-A compliant and an explosion proof version.

The KAL-K incorporates an 8 segment bar-graph LED flow trend indicator and one flow alarm setpoint. The setpoint is fully configurable as NPN, PNP, normally-open or normally-closed.

~~The KAL-A applies the KAL's advanced microprocessor based technology to the problem of rate detection. It incorporates a 4-20 mA, flow rate proportional output, the same 8-segment LED display found in the KAL-K, and an optional PNP setpoint alarm relay.~~

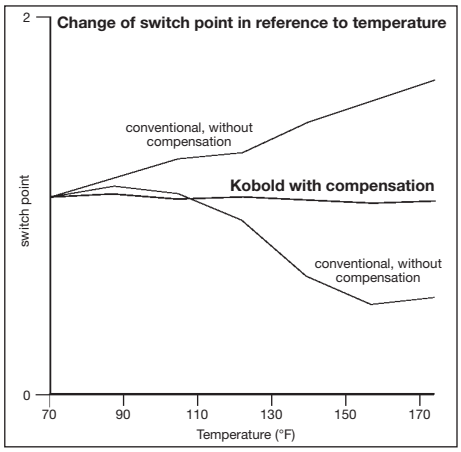
Operation

The KAL design is based on the time-proven calorimetric principle. The sensor is internally heated to a few degrees above the temperature of the medium. Flow of the medium causes removal of heat from the sensor, resulting in a cooling effect. The rate of cooling is a measure of the flow velocity.

The microprocessor based design of the KAL distinguishes it from the competition. Full temperature compensation of the flow rate is readily obtained through a simple, one-time, calibration procedure. This assures elimination of flow rate reading drift caused by temperature variations in the process liquid.

Note:
The flow ranges specified in the table on the right are extrapolated from values measured with water in a 1" pipe. Since flow characteristics vary with pipe dimensions, observed flow ranges may differ significantly from the values provided in the table.

KOBOLD KAL-K ~~and KAL-A~~ Flow Sensors



Temperature Compensation

The Kobold KAL flow products use a microprocessor to compensate for temperature changes through use of an internal look-up table. End-users can easily adapt the equipment to the requirements of their unique installations. Unlike conventional calorimetric flow switches, the technically advanced design of the KAL provides a flow reading which is unaffected by temperature.

Approximate Sensing Range at Various Pipe Diameters

Nominal ID inches	Range GPM Water
½	0.3 - 5.0
~~¾~~	~~0.5 - 8.9~~
1	0.8 - 14
1¼	1.1 - 20
1½	2.0 - 35
2	3.1 - 55
~~2½~~	4.4 - 80
3	7.9 - 140

Nominal ID inches	Range GPM Water
4	12 - 220
6	28 - 500
8	50 - 900
10	78 - 1400
12	110 - 2000
16	200 - 3600
20	310 - 5600

Subject to change without prior notice.

- Revolutionary Microprocessor-Based Switch-Point Stabilization
- NPT and 3-A Compliant Sanitary Fittings
- Compact Design
- No Moving Parts
- Extremely Low Pressure Loss
- Easy to Operate
- Insensitive to Dirt

The KAL-K thermal flow switch utilizes KOBOLD's advanced microprocessor-based technology to provide a stable setpoint regardless of changes in temperature. The KAL-K's solid-state switches can be configured as NPN or PNP and normally-open or normally closed.

Based on the calorimetric principle, the KAL-K can continuously monitor the flow of both viscous and non-viscous media. Unlike other designs, the KAL is unique in its use of a single element to both heat the probe tip and measure its temperature. This integrated heating-measuring approach allows the probe to be machined into a single, continuous, protrusion-free surface. The absence of protrusions prevents contaminant from building up on the probe tip. This improves the KAL's performance in two ways:

1. The KAL's sensing stability is increased because contaminant cannot thermally isolate the probe from the liquid.
2. System down-time associated with probe cleaning is dramatically decreased.

Stability and Reliability ... a KOBOLD KAL trademark!

KOBOLD KAL-K in Standard Housing

Specifications

Switching Range: 0.05 - 2 m/s
Media: water-based liquids
60 cSt Max.

Response Time
Typical: 5.6 seconds
~~**Optional F:** 1.2 seconds~~

Fittings
Standard: 1/2" or 3/4"NPT
~~**Sanitary:** 1½" Tri-Clamp®~~
~~**Explosion Proof:** ½" or ¾" NPT~~

Flow Trend Indicator: 8 Red LEDs

Temperature Rating
Operating: 32°F to 250°F
CIP: 280°F Max.

Maximum Pressure: 1450 PSIG

Wetted Parts
Standard: 304 SS
~~**Sanitary:** 316-Ti SS~~
~~**Explosion Proof:** 316-Ti SS~~

Housing
Standard: NEMA 4 (Nylon®)
~~**Sanitary:** NEMA 4 (Nylon®)~~
~~**Optional:** Explosion Proof (AI) Class I & II, Groups C & D~~

Power Requirements
Supply Voltage: ~~24 VDC ± 10%~~
Optional: 110 VAC
Current Draw: 300 mA max.

Switch Characteristics
Adjustment: by Potentiometer
Status Indicator: Bi-colored LED
~~**24 VDC Units:**~~
~~**Type:** N/O PNP or NPN open collector~~
~~**Switch Rating**~~
~~**DC only:** 400 mA @ 24V~~
110 VAC Units:
Type: N/O dry contact
Switch Rating
AC only: 5A @ 240 V
~~**DC only:** 0.2 A @ 110V~~

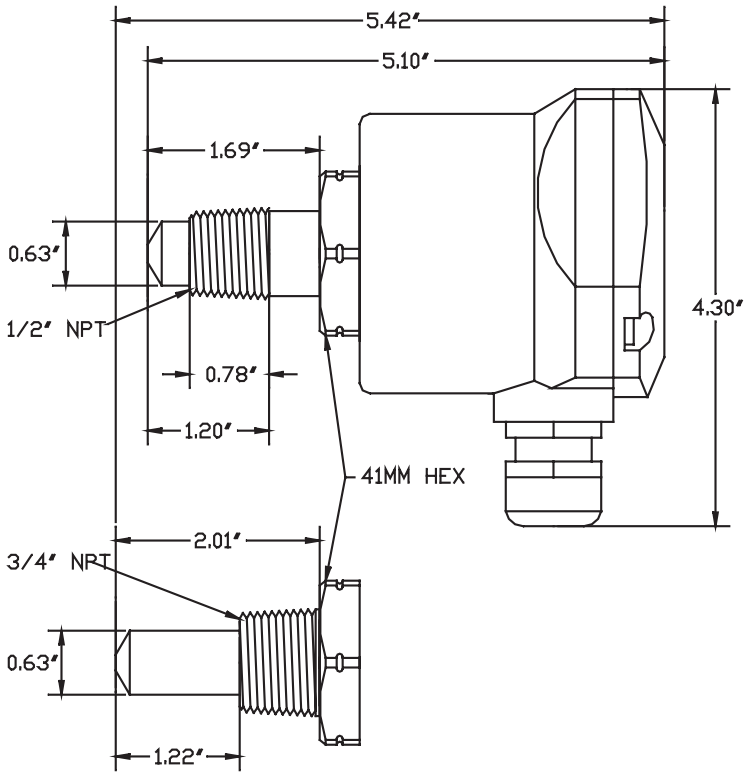
KAL-K Ordering Information

Model	Wetted Parts	1/2" Model	~~3/4" Model~~
Standard	304 SS	KAL-4215	-
~~Standard 316-Ti SS~~	~~316-Ti SS~~	~~KAL-4315~~	~~KAL-4320~~
~~Explosion Proof~~	~~316-Ti SS~~	~~KAL-4315~~	~~KAL-4320-EX~~
~~Sanitary~~	~~316-Ti SS~~	~~KAL-4340-S~~	
Plug Connector with 6 ft cable (not available in explosion proof)		Suffix: "M12"	
~~N/O Switch Logic~~		~~Suffix: "K"~~	
110 VAC version with dry contact		Suffix: "P03R"	
~~Fast Response Time~~		~~Suffix: "F"~~	

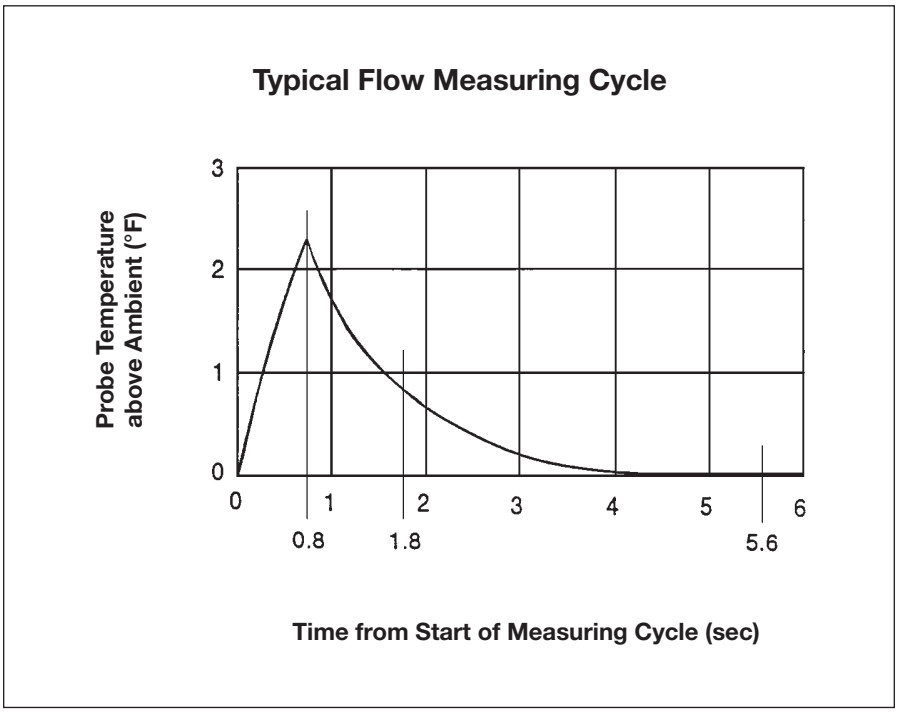
Subject to change without prior notice.

Standard Version

Dimensions



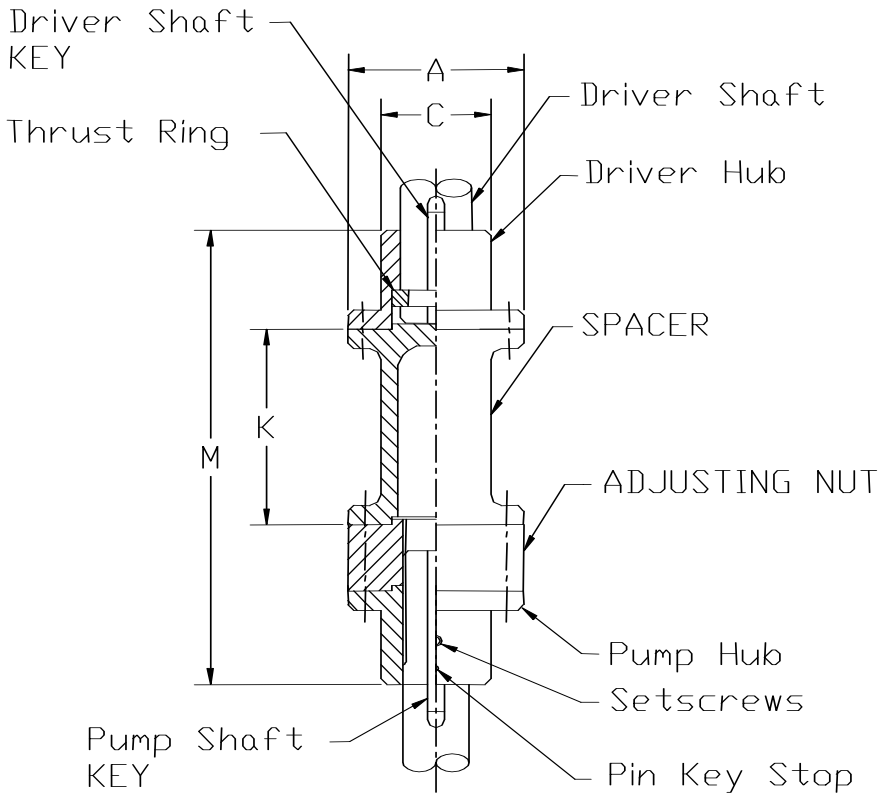
KAL Timing - Heating and Measuring Cycle



Operating Behavior

1. At t=0, the probe temperature is recorded. This reading represents the ambient liquid temperature.
2. Still at t=0, the KAL begins heating the probe.
3. At t=0.8 seconds, the heating cycle ends and the KAL begins monitoring the probe temperature.
4. At t=1.8 seconds, a temperature reading is taken and compared to the t=0.8 second temperature. The rate of cooling is calculated and compared to a Cooling Rate vs Flow Rate table specific to the ambient temperature recorded at t=0.
5. The probe is allowed to cool until t=5.6 seconds. A temperature reading is taken and compared to the initial t=0 reading. If the temperatures are equal (or nearly so), the flow reading is determined valid and passes through to the KAL output. If the temperatures are not equal, the KAL waits another 5.6 sec, and Step 5 repeats.

Fairbanks Morse Pump
Style IV Adjustable Coupling



Technical Data

Size	CPAT 3125
Horsepower per 100 Rpm	57.0
Thrust Capacity, Lbs.	38000
Bolts (No. & Size)	(8) 1/2
WR^2, Lbs-In^2	336.86
Maximum Bore	3-1/8
Weight, Lbs.	55.35

Dimensional Data

A	6-3/4
C	4-5/8
K	4-7/16
M	15-15/16

Type CPLR & CPAT

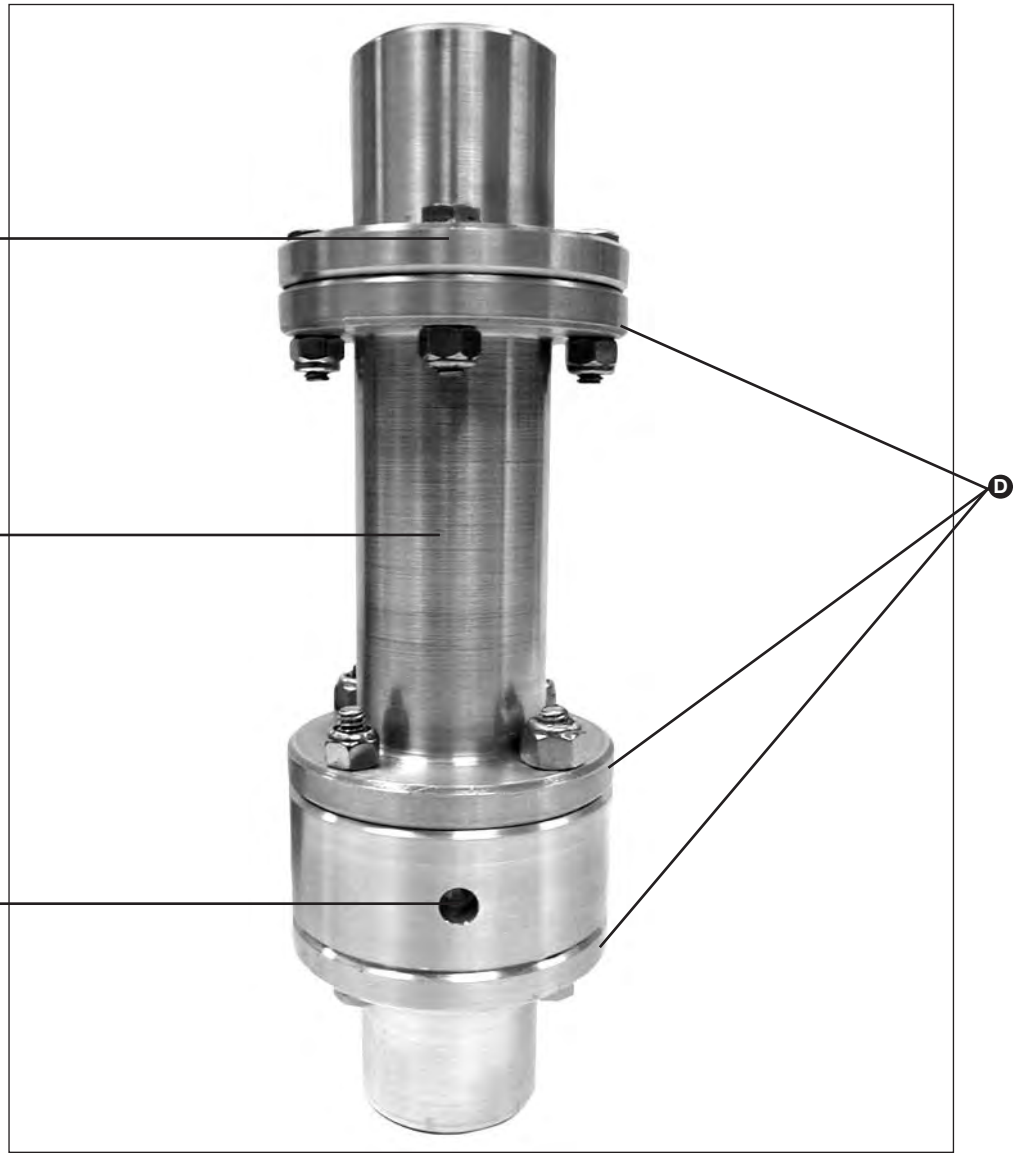
METASTREAM® C-Series Rigid Couplings

A – Motor hub and split ring to NEMA standard

B – Variable length spacer

C – Externally adjustable shaft nut

D – Pilot fits insure repeatable concentric installation



Product Description

Metastream® C-Series Couplings incorporate a segmented, piloted locating design. This eliminates the shaft distortion associated with conventional 'clam shell' coupling designs. The CPLR is for industrial applications and the CPAT is for higher speed applications:

- Easily adjustable for setting vertical clearance.
- Infinite life.
- Corrosion-resistant phosphate coating on AISI 1040 steel.
- Robust design.

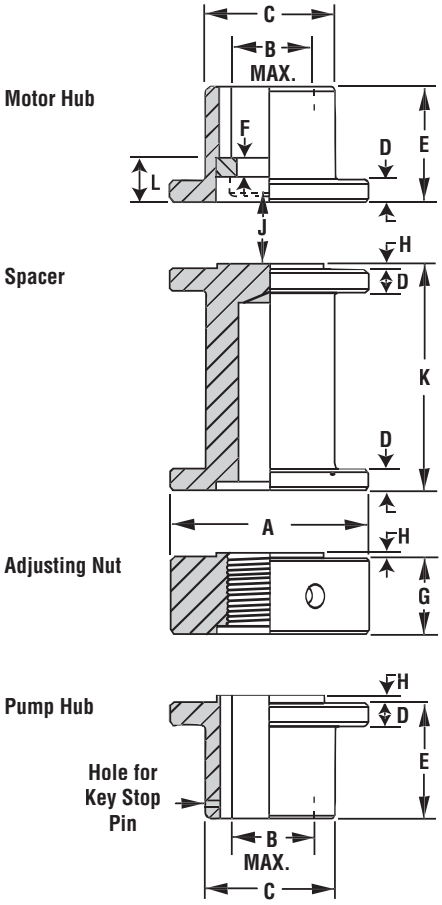
Design Features

- Designed to transmit torque between vertical mounted equipment including:
  - Vertical Pumps.
  - Vertical Turbines.
  - Vertical Mixers.
- CPAT meets requirements of API 610 8th Edition.
- Optional materials & coatings available.
- Electrically insulated design available.

Type CPLR & CPAT

METASTREAM® C-Series Rigid Couplings

Dimensions and Technical Data



Coupling Size	HP/100 RPM	Trust CAP.-LB	Fit NEMA Frame	Bolts Per FLG	Bolt DIA.	A	B	C	D	E	F	G	H	J	K STD	K MIN	L
1125	2.7	4500	182-215	4	1/4	3.00	1.125	1.75	0.38	2.00	0.375	1.25	0.125	0.016	4.44	1.63	0.89
1625	8.0	11000	254-326	6	5/16	4.00	1.625	2.50	0.44	2.25	0.375	1.50	0.125	0.016	4.44	1.75	0.89
2125	17.9	28500	364-445	6	1/2	5.13	2.125	3.13	0.63	2.69	0.375	1.75	0.125	0.016	4.44	2.63	0.89
2625	33.8	28500	No std	6	1/2	5.88	2.625	3.88	0.63	2.94	*	3.50	0.125	0.016	4.44	2.63	0.89
~~2875~~	~~44.4~~	~~28500~~	~~No std~~	~~6~~	~~1/2~~	~~6.38~~	~~2.875~~	~~4.38~~	~~0.75~~	~~3.44~~	~~*~~	~~3.50~~	~~0.125~~	~~0.016~~	~~4.44~~	~~2.88~~	~~0.89~~
3125	57.0	38000	No std	8	1/2	6.75	3.125	4.63	0.75	4.00	*	3.50	0.125	0.016	4.44	2.88	0.89
~~3875~~	~~109~~	~~66000~~	~~No std~~	~~6~~	~~3/4~~	~~8.94~~	~~3.875~~	~~5.88~~	~~0.81~~	~~4.38~~	~~*~~	~~4.00~~	~~0.125~~	~~0.016~~	~~4.44~~	~~3.13~~	~~0.89~~
5000	310	159000	No std	8	1	11.75	5,000	7.50	1.00	6.00	*	3.00	0.250	0.125	No std	4.50	1.38
6000	404	199000	No std	10	1	13.25	6,000	9.00	1.13	9.25	0.625	2.38	0.250	0.125	No std	4.75	1.63
7250	712	278000	No std	14	1	15.00	7.250	10.75	2.25	10.75	0.750	3.69	0.313	0.125	No std	7.06	1.94
8500	1148	294000	No std	12	1-1/8	17.25	8.500	12.50	2.25	15.00	0.750	3.56	0.313	0.125	No std	7.31	1.94
10500	2164	352000	No std	12	1-1/8	20.50	10.500	15.00	2.75	18.38	0.750	4.19	0.313	0.125	No std	8.31	1.94

Notes:

1. Driver hub bores are in 0.25" increments from 0.875" to and including 3.875" then any diameter up to 10.500". Standard bores are to AGMA 9002 Class 2 clearance and keyways to AGMA 9002 commercial tolerance for both driver and driven hubs.

2. John Crane Flexibox does not furnish the key stop pin.

3. 3/8 or 1/2 inch thick split rings are standard options on sizes 2625 thru 3875 and 1/2 or 3/4 inch on size 5000.

4. Adjusting nuts can be supplied blank or threaded. Standard threads are ANSI UN Class 2B, left or right hand.

5. NEMA frame sizes apply to VP and HP series.

Table refers to Standard Range. Modified designs to meet specific customer requirements are available.

Type CPLR & CPAT

METASTREAM® C-Series Rigid Couplings

Configurations

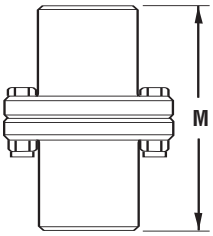
Style 1
Non-spacer style provides easy assembly on driver and rotating driven equipment shafts. Usually used on equipment where there is a minimum of distance between shaft ends.

Style 2
Non-spacer style with an adjusting nut so that vertical clearances in the driven equipment may be attained. Usually used on equipment where there is a minimum of distance between shaft ends.

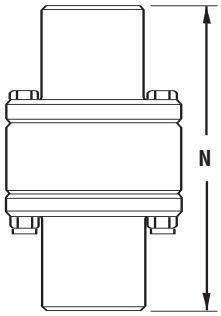
Style 3
Spacer Coupling style offers a spacer whereby the driven equipment may be worked on without the disassembly or removal of the driver.

Style 4
Spacer Type Rigid Coupling offers a removable spacer for easy maintenance of driven equipment and an adjusting nut assembly, whereby the vertical clearance in the driven equipment may be attained.

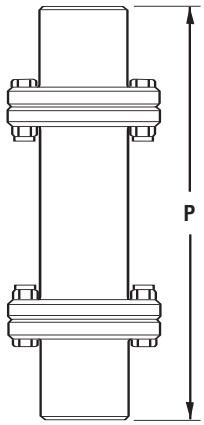
Style 1



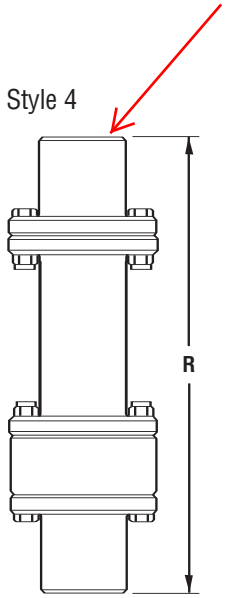
Style 2



Style 3



Style 4



Coupling Size	M	N	P		R	
			STD	MIN	STD	MIN
1125	4.00	5.25	8.31	5.50	9.56	6.75
1625	4.50	6.00	8.81	6.13	10.31	7.63
2125	5.38	7.13	9.69	7.88	11.44	9.63
2625	5.88	9.38	10.19	8.38	13.69	11.88
2875	6.88	10.38	11.19	9.63	14.69	13.13
3125	8.00	11.50	12.31	10.75	15.81	14.25
3875	8.76	12.75	13.07	11.76	17.06	15.75
5000	12.00	15.00	No std	16.50	No std	19.50
6000	18.50	20.88	No std	23.00	No std	25.38
7250	21.50	25.19	No std	28.25	No std	31.94
8500	30.00	33.56	No std	37.00	No std	37.00
10500	36.76	40.94	No std	44.76	No std	48.94

Type CPLR & CPAT

METASTREAM® C-Series Rigid Couplings

Selection Procedure

Step 1
Determine the shaft diameter of the driver and compare to the maximum sized hub bore in column B of the dimensions shown on page 2. If the driver is a standard Nema HP or VP series motor, use the column marked 'Fit Nema Frame' to determine the coupling size required.

Step 2
Determine the shaft diameter of the driven equipment and compare to the maximum sized hub bore in column B of the dimensions shown on page 2. The shaft size of the driven equipment should not exceed the maximum bore size to determine the coupling size.

Step 3
The largest size shaft of either the driver or driven equipment will determine the ultimate coupling size.

Step 4
Specify the coupling configuration and type, bore size for the driver and driven equipment hubs, type of fit, and adjusting nut thread details.

Step 5
Select type CPLR for standard coupling tolerances or type CPAT for API 610 8th edition tolerances.

Balance Recommendations

As supplied, standard CPLR and CPAT couplings meet AGMA Balance Class 8 with clearance fit bores. The standard CPAT coupling meets AGMA Balance Class 9 with transition/interference fit bores. While dynamic balancing is not normally required, if specified, John Crane Flexibox recommends component balancing. Any potential benefits of assembly balancing are negated by the installation fits and adjustable nature of the application. Contact John Crane Flexibox if your application warrants balancing consideration.

Europe
Slough, UK
Tel: 44-1753-224000
Fax: 44-1753-224224

North America
Houston
Tel: 1-713-944-6690
Fax: 1-713-946-8252

Latin America
São Paulo, Brazil
Tel: 55-11-3371-2500
Fax: 55-11-3371-2599

Middle East & Africa
Dubai, United Arab Emirates
Tel: 971-4-3438940
Fax: 971-4-3438970

Asia
Singapore
Tel: 65-6512-5200
Fax: 65-6512-5233

For your nearest John Crane facility, please contact one of the locations above.

If the products featured will be used in a potentially dangerous and/or hazardous process, your John Crane representative should be consulted prior to their selection and use.
In the interest of continuous development, John Crane Companies reserve the right to alter designs and specifications without prior notice.

www.johncrane.com ISO 9001, ISO 14001, ISO/TS 16949 Certified. Details available on request. S-**CPLR/CPAT/Eng**

smiths

Fairbanks Morse Pump
Furnished Spare Parts

Ref. No.	Description	Quantity
163, 168	Bowl Bearings	1 Set
50	Lineshaft Bearings	1 Set
15	Packing	2 Sets
--	Gaskets and O-Rings	1 Set
13	Sleeve	1
17	Impeller Wear Ring	1
16	Bowl Wear Ring	1
4	Bowl Shaft	1
--	Flow Meter/Flow Switch	1

Nidec (USEM)
Furnished Spare Parts

Ref. No.	Description	Quantity
--	Motor Bearings	1 Set

Above Ground Coating

- **Coating Manufacturer** Tnemec
- **Surface Preparation** SSPC-SP10, Near White Blast Cleaning
- **Prime Coat** Series N140 Pota-Pox Plus
  Number of Coats One
  Dry Film Thickness 4 to 6 mils
  Color 1211 Red
  Surfaces to be coated High Ring Base
  Top, unmachined portion of foundation plate

  Finish Coat Applied in Field by Contractor

Below Ground Coating Specifications

- **Coating Manufacturer** Tnemec
- **Surface Preparation** SSPC-SP10, Near White Blast Cleaning
- **Prime Coat** Series N140 Pota-Pox Plus
  Number of Coats One
  Dry Film Thickness 4 to 6 mils
  Color 1211 Red
  Surfaces to be coated Interior and Exterior of Bowl Assembly
  Interior and Exterior of Column
  Interior of Discharge Head including packing box exposed surfaces

  Finish Coat Applied in Field by Contractor

TNEMEC

PRODUCT DATA SHEET

POTA-POX® PLUS N140 or V140

PRODUCT PROFILE

GENERIC DESCRIPTION Polyamidoamine Epoxy

COMMON USAGE Innovative potable water coating which offers high-build edge protection and allows for application at a wide range of temperatures (down to 35°F or 2°C with 44-700 Accelerator). For use on the interior and exterior of steel or concrete tanks, reservoirs, pipes, valves, pumps and equipment in potable water service. **Note:** Series V140 conforms with air pollution regulations limiting Volatile Organic Compounds (VOC) to a maximum of 250 grams/litre (2.08 lbs/gal). In areas requiring less than 100 grams/litre VOC, please refer to the Series L140 data sheet.

COLORS 1211 Red, 1255 Beige, 00WH Tnemec White, 15BL Tank White, 35GR Black and 39BL Delft Blue. **Note:** Epoxies chalk with extended exposure to sunlight. Lack of ventilation, incomplete mixing, miscatalyzation or the use of heaters that emit carbon dioxide and carbon monoxide during application and initial stages of curing may cause yellowing to occur.

SPECIAL QUALIFICATIONS Certified by **NSF International** in accordance with **ANSI/NSF Std. 61.** Ambient air cured Series N140 (with or without 44-700 Epoxy Accelerator) is qualified for use on tanks and reservoirs of 1,000 gallons (3,785L) capacity or greater, pipes 14 inches (30 cm) in diameter or greater, valves four (4) inches (10 cm) in diameter or greater and fittings four (4) inches (10 cm) in diameter or greater. Series V140 is qualified for use on tanks of 20,000 gallons (75,708L) capacity or greater, valves two (2) inches (5 cm) in diameter or greater and fittings 1/2 inch (1 cm) in diameter or greater. **Note:** NSF certification for Series V140 applies to colors 1255 Beige, 1211 Red, 00WH Tnemec White and 15BL Tank White only. Conforms to **AWWA D 102 Inside Systems No. 1 and No. 2** (with or without 44-700). Conforms to **AWWA C 210** (without 44-700). Contact your Tnemec representative for systems and additional information. A two-coat system at 4.0-6.0 dry mils (100-150 dry microns) per coat passes the performance requirements of MIL-PRF-4556F for fuel storage. Reference the "Search Listings" section of the NSF website at www.nsf.org for details on the maximum allowable DFT.

PERFORMANCE CRITERIA Extensive test data available. Contact your Tnemec representative for specific test results.

COATING SYSTEM

PRIMERS Self-priming, 22, 91-H_2O, H91-H_2O, 94-H_2O, L140, L140F, N140F, V140F, 141

TOPCOATS **Interior:** Series 22, FC22, L140, L140F, N140, N140F, V140, V140F, 141.
Exterior: Series 27, 66, L69, L69F, N69, N69F, V69, V69F, 72, 73, L140, L140F, N140, N140F, V140, V140F, 156, 157, 161, 175, 180, 181, 446, 740, 750, 1028, 1029, 1074, 1074U, 1075, 1075U, 1077, 1078, 1080, 1081. Refer to COLORS on applicable topcoat data sheets for additional information. **Note:** The following recoat times apply for Series N140: Immersion Service—Surface must be scarified after 60 days. Atmospheric Service—After 60 days, scarification or an epoxy tie-coat is required. When topcoating with Series 740 or 750, recoat time for N140/V140 is 30 days. Contact your Tnemec representative for specific recommendations.

SURFACE PREPARATION

PRIMED STEEL **Immersion Service:** Scarify the Series N140, 20 or FC20 prime coat surface by blasting with fine abrasive before topcoating if it has been exterior exposed for 60 days or longer and N140 is the specified topcoat.

STEEL **Immersion Service:** SSPC-SP10/NACE 2 Near-White Blast Cleaning with a minimum angular anchor profile of 1.5 mils.
Non-Immersion Service: SSPC-SP6/NACE 3 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils.

CAST/DUCTILE IRON Contact your Tnemec representative or Tnemec Technical Services.

CONCRETE Allow new concrete to cure 28 days. For optimum results and/or immersion service, abrasive blast referencing SSPC-SP13/NACE 6, ICRI-CSP 2-4 Surface Preparation of Concrete and Tnemec's Surface Preparation and Application Guide. Fill all holes, pits, voids and cracks with 215 or 218.

ALL SURFACES Must be clean, dry and free of oil, grease and other contaminants.

TECHNICAL DATA

VOLUME SOLIDS 67.0 ± 2.0% (mixed—A, B & 44-700 Epoxy Accelerator) †

RECOMMENDED DFT 2.0 to 10.0 mils (50 to 225 microns) per coat. **Note:** MIL-PRF-4556F applications require two coats at 4.0-6.0 mils (100-150 microns) per coat. Otherwise, the number of coats and thickness requirements will vary with substrate, application method and exposure. Contact your Tnemec representative.

CURING TIME AT 5 MILS DFT Without 44-700 Accelerator:

Temperature	To Handle	To Recoat	Immersion
75°F (24°C)	6 hours	9 hours	7 days

With 44-700 Accelerator:

Temperature	To Handle	To Recoat	Immersion
75°F (24°C)	4 hours	5 hours	7 days
65°F (18°C)	7-8 hours	9-11 hours	8 days
55°F (13°C)	12-14 hours	16-20 hours	9-10 days
45°F (7°C)	18-22 hours	28-32 hours	12-13 days
35°F (2°C)	28-32 hours	46-50 hours	16-18 days

Curing time varies with surface temperature, air movement, humidity and film thickness. **Note:** For valve applications allow 14 days cure at 75°F (24°C) prior to immersion. For pipe applications allow 30 days cure at 75°F (24°C) prior to immersion. **Ventilation:** When used in enclosed areas, provide adequate ventilation during application and cure.

VOLATILE ORGANIC COMPOUNDS
N140: Unthinned: 2.4 lbs/gallon (285 grams/litre)
Thinned 5% (#60): 2.6 lbs/gallon (311 grams/litre)
Thinned 10% (#4): 2.8 lbs/gallon (334 grams/litre) †
V140: Unthinned: 1.95 lbs/gallon (234 grams/litre)
Thinned 2.5% (#4): 2.08 lbs/gallon (250 grams/litre)

HAPS
N140: Unthinned: 2.4 lbs/gal solids
Thinned 5% (#60): 2.4 lbs/gal solids
Thinned 10% (#4): 3.3 lbs/gal solids
V140: Unthinned: 2.1 lbs/gal solids
Thinned 2.5% (#4): 2.3 lbs/gal solids

POTA-POX® PLUS | N140 or V140

THEORETICAL COVERAGE 1,070 mil sq ft/gal (27.2 m²/L at 25 microns). See APPLICATION for coverage rates. †

NUMBER OF COMPONENTS Two: Part A (amine) and Part B (epoxy) — One (Part A) to one (Part B) by volume.

PACKAGING 5 gallon (18.9L) pails and 1 gallon (3.79L) cans - Order in multiples of 2.
Reference 44-700 Epoxy Accelerator product data sheet for its packaging information.

NET WEIGHT PER GALLON N140: 12.66 ± 0.25 lbs (5.82 ± .11 kg) (mixed) V140: 13.00 ± 0.25 lbs (5.90 ± .11 kg) (mixed) †

STORAGE TEMPERATURE Minimum 20°F (-7°C) Maximum 110°F (43°C)

TEMPERATURE RESISTANCE (Dry) Continuous 250°F (121°C) Intermittent 275°F (135°C)

SHELF LIFE 24 months at recommended storage temperature.

FLASH POINT - SETA N140 & V140 Part A: 82°F (28°C) N140 Part B: 80°F (27°C) V140 Part B: 86°F (30°C) 44-700: None

HEALTH & SAFETY Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product.
Keep out of reach of children.

APPLICATION

COVERAGE RATES

	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m²/Gal)
Suggested	6.0 (150)	9.0 (230)	179 (16.6)
Minimum	2.0 (50)	3.0 (75)	537 (49.9)
Maximum	10.0 (225)	15.0 (375)	107 (10.0)

Note: Roller or brush application requires two or more coats to obtain recommended film thickness. Allow for overspray and surface irregularities. Wet film thickness is rounded to the nearest 0.5 mil or 5 microns. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance. Reference the "Search Listings" section of the NSF website at www.nsf.org for details on the maximum allowable DFT. †

MIXING

1. Start with equal amounts of both Parts A & B.
2. Using a power mixer, separately stir Parts A & B.
3. (For accelerated version. If not using 44-700, skip to No. 4.)
Add four (4) fluid ounces of 44-700 per gallon of Part A while Part A is under agitation.
4. Add Part A to Part B under agitation, stir until thoroughly mixed.
5. Both components must be above 50°F (10°C) prior to mixing. For application of the unaccelerated version to surfaces between 50°F to 60°F (10°C to 16°C) or the accelerated version to surfaces between 35°F to 50°F (2°C to 10°C), allow mixed material to stand 30 minutes and restir before using.
6. For optimum application properties, the material temperature should be above 60°F (16°C).

Note: The use of more than the recommended amount of 44-700 will adversely affect performance.

THINNING Use No. 4 or No. 60 Thinner for N140. Use No. 4 Thinner for V140. For air spray, thin up to 10% or 3/4 pint (380 mL) per gallon with No. 4 Thinner or thin up to 5% or 1/4 pint (190 mL) per gallon with No. 60 Thinner. For airless spray, roller or brush, thin up to 5% or 1/4 pint (190 mL) per gallon. **Caution: Series N140 NSF certification is based on thinning with No. 4 or No. 60 Thinner for tanks and only No. 60 Thinner for pipe, valves and fittings. Series V140 NSF certification is based on thinning with No. 4 Thinner only.** Use of any other thinner voids ANSI/NSF Std. 61 certification. **Note:** When using Series V140, a maximum of 2.5% of No. 4 Thinner may be used to comply with VOC regulations.

POT LIFE Without 44-700 15 hours at 50°F (10°C) 4 hours at 75°F (24°C) 3 hours at 100°F (38°C)
With 44-700 4 hours at 50°F (10°C) 2 hours at 75°F (24°C) 1 hour at 100°F (38°C)

SPRAY LIFE Without 44-700: 1 hour at 75°F (24°C) With 44-700: 30 minutes at 75°F (24°C)
Note: Spray application after listed times will adversely affect ability to achieve recommended dry film thickness.

APPLICATION EQUIPMENT

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss JGA	E	765 or 704	5/16" or 3/8" (7.9 or 9.5 mm)	3/8" or 1/2" (9.5 or 12.7 mm)	75-100 psi (5.2-6.9 bar)	10-20 psi (0.7-1.4 bar)

Airless Spray

Tip Orifice	Atomizing Pressure	Mat'l Hose ID	Manifold Filter
0.015"-0.019" (380-485 microns)	3000-4800 psi (207-330 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Low temperatures or longer hoses require higher pot pressure. Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.
Roller: Use 3/8" or 1/2" (9.5 mm to 12.7 mm) synthetic woven nap roller cover. Use longer nap to obtain penetration on rough or porous surfaces.
Brush: Recommended for small areas only. Use high quality natural or synthetic bristle brushes.

SURFACE TEMPERATURE Without 44-700: Min. 50°F (10°C), Max. 135°F (57°C) With 44-700: Min. 35°F (2°C), Max. 135°F (57°C)
The surface should be dry and at least 5°F (3°C) above the dew point. Coating will not cure below minimum surface temperature.

CLEANUP Flush and clean all equipment immediately after use with the recommended thinner or MEK.
† Values may vary with color.

Section 8 Vendor Submittal

Approved Submittal

Motor – U S Electrical Motors

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James Slaughter
Territory Manager

June 5, 2012

Fairbanks Morse Pump
Attn: Rikki Simmons
Division of Pentair Water
3601 Fairbanks Avenue
Kansas City, Kansas 66110

Subject: Purchase order 2706144, Job 064585A02
City of Anderson
US Motors Factory Order #20113356

Dear Rikki:

The intent of this letter is to address project engineer's comment specific to shaft grounding provisions.

Attached are Product Data sheets on our proposed MGS Inpro Seals on the above subject order.
Product management has indicated that we cannot offer the specified AEGIS shaft ground due to the IEEE841 requirement, which calls for a seal.
US Motors took exception to the AEGIS when we submitted our proposal on this project.
We have no test experience to demonstrate the equivalence to the AEGIS but feel the attached demonstrates the solution to shaft currents.
Please review and /or submit the attached to the project engineer for acceptance.

If you should have any other questions, or if I can help in any other way, please do not hesitate to contact me.

Best regards.

James Slaughter
Territory Manager
U.S. Electrical Motor

NIDEC MOTOR CORPORATION
U.S. ELECTRICAL MOTORS: 5000 West 66th Street, P.V., KS 66208
PHONE: (913) 236-5000 FAX: (913) 236-5501 EMAIL: james.slaughter@nidec-motor.com

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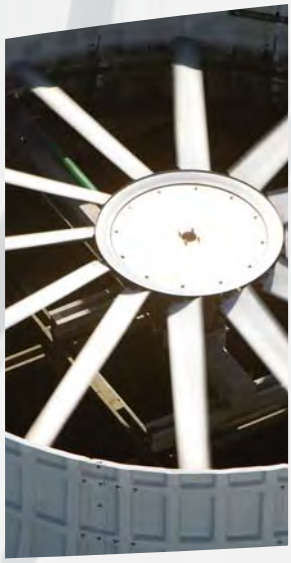


COMPLETE SHAFT GROUNDING SOLUTIONS

Current Diverter Ring™
and Motor Grounding Seal™

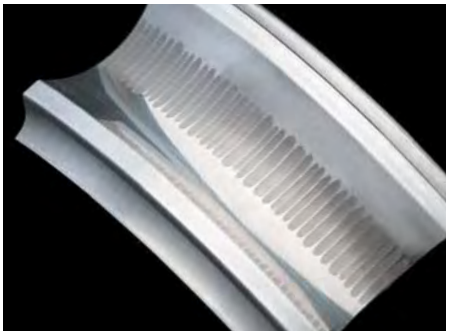
INPRO/SEAL®
A DOVER COMPANY

SAFEGUARD YOUR INVESTMENT FROM BEARING DAMAGE

The VFD Challenge

Variable frequency drives (VFDs) are becoming the system of choice across a variety of industries because of their ability to reduce energy consumption – generating significant cost savings. However, these systems may also contribute to unplanned downtime.

VFDs induce high frequency voltages on the shaft that seek a path to ground through the motor's bearings or the bearings of the coupled equipment. When these voltages exceed the insulation breakdown of the lubricant, they discharge through the bearings to ground.



Stray shaft currents discharging through the bearings on rotating equipment can cause fluting on the bearing race, resulting in premature bearing failure.

The Cost of Electrical Damage

This discharge, called electrical discharge machining (EDM), causes fusion craters, pitting, frosting, and fluting. These effects make EDM a leading cause of premature bearing failure in VFD-driven motors.

Even if the motor itself has insulated bearings, shaft currents can travel to the coupled equipment, such as pumps, pillow blocks and gearboxes, and damage those bearings. The results are costly and include reduced equipment reliability, increased maintenance costs, unscheduled downtime and lost revenue.

SHAFT GROUNDING OPTIONS						
	CDR®	CERAMIC BEARING	COPPER METAL BRUSH	CARBON BRUSH	CONDUCTIVE GREASE	FILTERS ON VFD
EASY MOUNTING	✓				✓	✓
MAINTENANCE FREE	✓	✓				
HIGH ROI	✓					
LOW INITIAL COST	✓			✓	✓	
LONG LIFE	✓					
NO RPM LIMIT	✓	✓				✓

Reducing Electrical Damage

Diverting shaft currents and controlling EDM needs to be a priority for your business. Various methods have been used over the years to mitigate shaft currents, but they have all had limitations...**until now.**

The Inpro/Seal® Current Diverter Ring™ and Motor Grounding Seal™ protect bearings from harmful stray shaft currents.

SAME-DAY
SHIPPING AVAILABLE

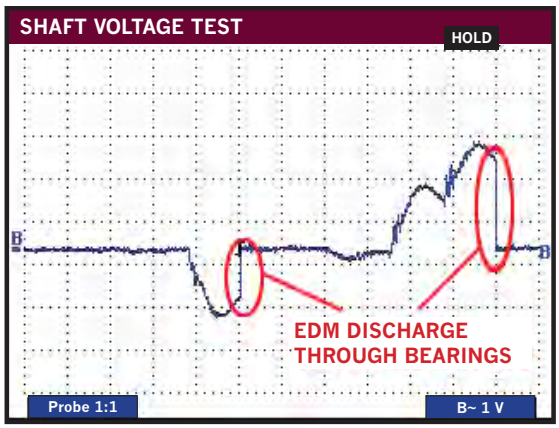
The Inpro/Seal® Solution

The Inpro/Seal Current Diverter Ring™ (CDR®) uses proprietary conductive filaments to protect bearings from stray shaft currents by providing a low impedance path to ground – drawing the currents safely away from the bearings.

For severe duty applications, the Inpro/Seal Motor Grounding Seal™ (MGS®) combines proven shaft-grounding technology with the patented VBXX® Bearing Isolator to provide complete bearing protection against stray shaft currents and contamination ingress.

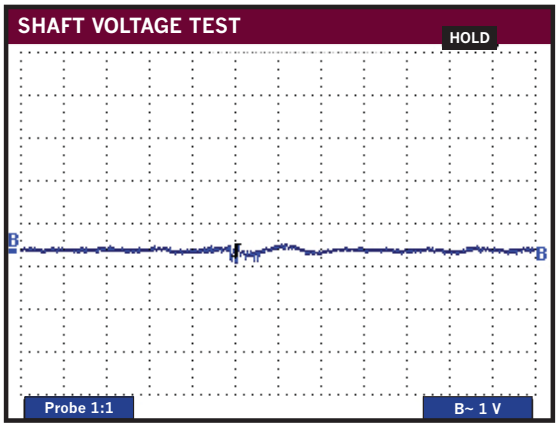
Benefits:

- Split designs available for easy installation
- Can be installed by OEMs or retrofitted on site
- Maintenance free at all RPMs
- Modular design allows for use with any size motor
- Multi-stage product can handle high shaft currents found in larger rotating equipment
- Can accommodate shaft sizes of 0.625 – 48.0 in. (1.59 – 121.92 cm)
- Manufactured in bronze, stainless steel and aluminum



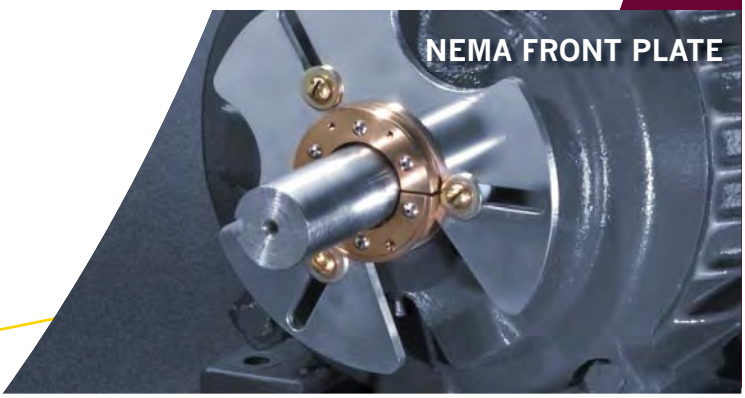
5HP 3PH MOTOR VFD DRIVEN
SHAFT VOLTAGE 1200 RPM

Stray shaft currents discharging through the motor's bearings.



SHAFT VOLTAGE WITH CDR® INSTALLED

No discharges with the Inpro/Seal® CDR® installed.



GUARANTEED PERFORMANCE

The Inpro/Seal® CDR® and MGS® are backed by a performance guarantee. See our website for complete details.

Experience You Can Trust

Reducing EDM damage requires a custom engineered solution that takes into account all these factors:

- Motor size
- Bearing type
- Bearing insulation
- Existing circulating currents
- Existing system grounding configuration
- Operating equipment
- Coupled equipment

Unmatched Customer Service

Inpro/Seal's responsive global sales network is committed to making sure you have the right technology for your application, right when you need it. We know that time means money for you. That's why we offer same-day shipping on most products, even new designs. No matter what your application, we can deliver a custom engineered solution designed to meet your specific needs.

Technology you can rely on, supported by customer service you'll appreciate.

You don't need to be an expert; our knowledgeable team will help. You can count on Inpro/Seal®, the leader in bearing and system protection, to maximize the uptime of your rotating equipment. We've been the trusted source for bearing isolator technology for more than 30 years, and now we're expanding our product offerings to deliver protection from electrical damage. Inpro/Seal's line of complete shaft grounding solutions is ideal for HVAC, industrial, and wind energy applications.

The Inpro/Seal Advantage

Inpro/Seal is committed to delivering innovative technology and superior customer support...standard with every solution. When you work with Inpro/Seal, you can expect:

- Same-day shipments available on most products, including new designs
- Custom engineered solutions for your application and operating environment
- Knowledgeable sales network providing localized support
- Performance guarantee– see website for complete details

Engineering Specifications

To ensure that your equipment is protected by Inpro/Seal's shaft grounding technology, simply include the following with your specifications:

"All motors driven by variable frequency drives (VFD) shall include bearing protection in the form of a device to divert shaft currents to ground. The device shall be maintenance free and constructed of highly conductive bronze. Recommended device: Inpro/Seal Current Diverter Ring™ (CDR®)."

"All VFD driven motors operating in harsh environments shall employ complete bearing protection through the use of a non-contact or non-contacting-while-rotating type seal to obtain an IP55 degree of protection as well as an integrated device to divert shaft currents to ground. Recommended device: Inpro/Seal Motor Grounding Seal™ (MGS®)."

Inpro/Seal® Multi-Stage CDR® for high voltage systems.

READY TO GET STARTED?

Visit www.inpro-seal.com to contact your local Inpro/Seal representative or request a quote.

INPRO/SEAL® A DOVER COMPANY

www.inpro-seal.com | info@inpro-seal.com | +1 309-787-4971

Pentair Pump Group

3601 Fairbanks Avenue
Kansas City, KS 66110
913-371-5000 FAX 913-748-4025

CERTIFIED MOTOR PERFORMANCE DATA

MOTOR MANUFACTURER: U.S. ELECTRICAL MOTORS **DATE:** 26-Apr-12

FM PURCHASE ORDER #: 2706144 **FM TAG#:** 064585A02

PERFORMANCE DATA BASED ON STANDARD RULES OF: X IEEE X ASA X NEMA

HP	SYNCHRONOUS SPEED (RPM)	FULL LOAD * SPEED (RPM)	FRAME NUMBER	TYPE	ENCLOSURE
200	720	710	5807P	JVCI4	TEFC

*Full Load Speed Tolerance Per NEMA MG1-12.46 is+/- 20% of slip (Slip=Synchronous RPM-Full Load RPM)

PHASE	HERTZ	VOLTS	AMPERES		INSULATION CLASS	MAX. TEMP. RISE	SERVICE FACTOR	NEMA KVA/HP CODE	NEMA DESIGN
			FULL LOAD	LOCKED ROTOR		X RESIS. / THERM.			
3	60	460	258.3	1422.0	F	80 DEG C AT 1.0 SF	1.15	G	B

MINIMUM GUAR EFFICIENCY			POWER FACTOR			TORQUE AT FULL VOLTAGE		
						FULL LOAD TORQUE AT FULL LOAD SPEED (LB.FT)	LOCKED STARTING	PULLOUT BREAKDOWN
FULL LOAD	3/4 LOAD	1/2 LOAD	FULL LOAD	3/4 LOAD	1/2 LOAD		PERCENT OF FULL LOAD	
93.0	94.0	93.7	81.0	77.1	67.5	1478.7	115	200

VSS [X] **VHS** [ ] **NRR** [X] **SRC** [ ] **HORIZ** [ ]

BEARINGS:

Drive End Lubrication:
[X] Oil [ ] Grease

Opposite End Lubrication:
[X] Oil [ ] Grease

PAINT: (Attach Technical Data Sheets)
[X] Factory Standard
[ ] Other _____

MOTOR NO.: 20113356

MOTOR WEIGHT: 5500 LBS.

ROTATION: [ ] BI-DIRECTIONAL [ ] CW [X] CCW

Certified by: _____ Date: 26-Apr-12 Revision # 4

FM013/0194

Pentair Pump Group

3601 Fairbanks Avenue
Kansas City, KS 66110
913-371-5000 FAX 913-748-4025

Accessory Data

Motor Manufacturer: U.S. ELECTRICAL MOTORS Date: 13-Jun-12

FM Purchase Order #: 2706144 FM Tag #: 064585A02

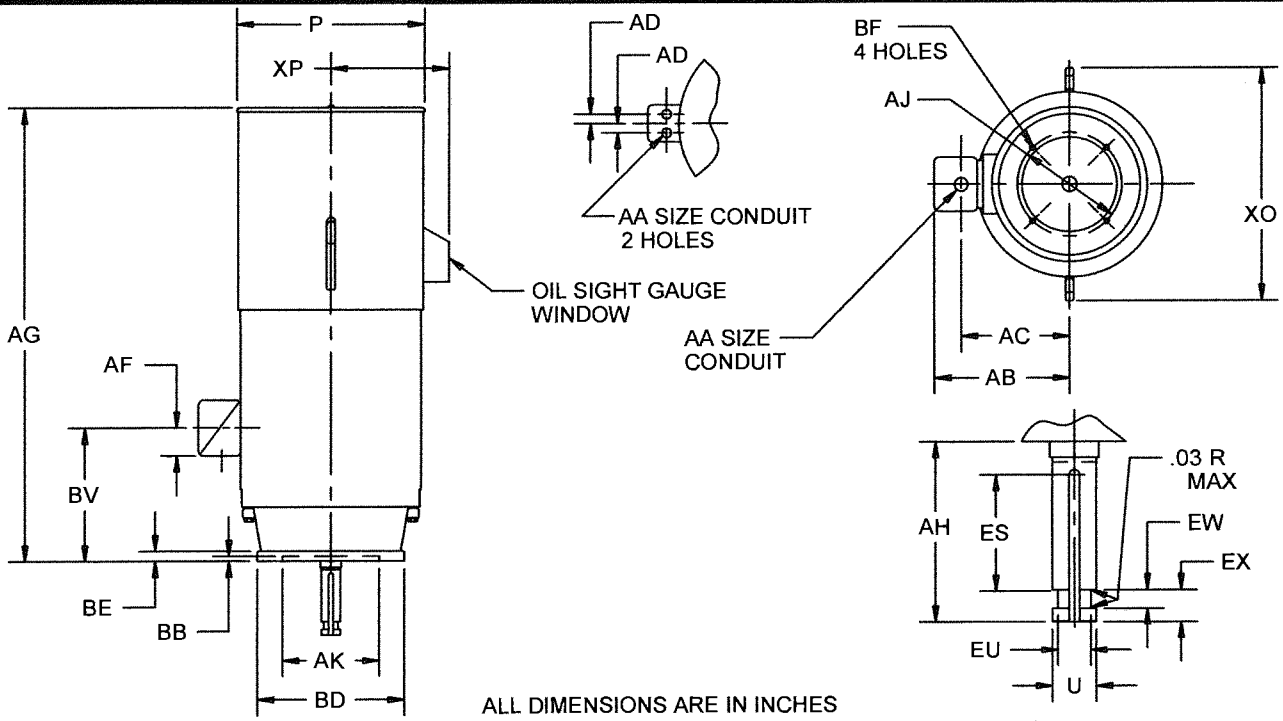
	Required	Not Required	Description
Space Heaters:	[X]	[ ]	Watts: 384 Voltage: 115
Thermostats:	[X]	[ ]	Type: [ ] N.O. [X] N.C.
Thermistors:	[ ]	[X]	Make & Model: Trip Range: Quantity Per Motor: [ ] relay not Supplied [ ] relay supplied: Type: [ ] factory set [ ] field adjustable [ ] wiring diagram/cut sheet attached. Ref.:
Winding RTD's:	[ ]	[X]	Make & Model: Construction/OHM Rating: Quantity Per Motor: [ ] relay not Supplied [ ] relay supplied: Type: [ ] factory set [ ] field adjustable [ ] wiring diagram/cut sheet attached. Ref.:
Bearing RTD's:	[ ]	[X]	Make & Model: Construction/OHM Rating: Quantity [ ] relay not Supplied [ ] relay supplied: Type: [ ] factory set [ ] field adjustable [ ] wiring diagram/cut sheet attached. Ref.:
Vibration Sensor:	[ ]	[X]	Make & Model: Quantity [ ] relay not Supplied [ ] relay supplied: Type: [ ] factory set [ ] field adjustable [ ] wiring diagram/cut sheet attached. Ref.:
Tests:	[X]	[ ]	[ ] Short commercial, unwitnessed [ ] Short commercial, witnessed [ ] Complete Initial Test, unwitnessed [ ] Complete Initial Test, witnessed [ ] Sound Test, unwitnessed [ ] Sound Test, witnessed [ ] Vibration Test, unwitnessed [X] IEEE 841 + No Load Test

Other Features: TEFC, VERTICAL SOLID SHAFT, HIGH THRUST, PREMIUM EFFICIENT, INVERTER DUTY 1.15 SERVICE FACTOR (1.0 ON VFD POWER), CLASS F INSULATION W/ CLASS B RISE @ 1.0 SF, 3300 FT ALT 40 DEGREE C AMBIENT, DESIGN B, IEEE 841 CORRODUTY, Q3 N.C. THERMOSTATS, CODE G, GROUND LUG GROUND PAD ON FRAME, NON-REVERSE RATCHET, INPRO MGS GROUND SEAL, 50,000 HR L-10 BEARING LIFE INSULATED BEARING - UPPER BEARING, CCW ROTATION, SPECIAL BALANCE, CAST IRON CONDUIT BOX

Exceptions & Clarifications: **FEATURES CONT. -** VPI-2000 TREATMENT, RANDOM WOUND, SS N/P, BD = 30.50 AH=5, U=2.625, 115V SP HTRS. **REVISION #1, 1/3/2012:** CHANGED BX (COUPLING) DIMENSION TO 2 11/16. **REVISION #2, 2/2/2012:** CHANGED MOTOR DESIGN FROM VHS TO VSS. REVISED PERF DATA AND DIMENSIONAL DRAWING. **REVISION #3, 3/15/2012:** REVISED MOTOR PERF DATA AND DRAWING. **REVISION #4, 4/26/2012:** CHANGED AND ADDED 100,000 HR BEARING LIFE. **REVISION #5, 6/13/2012:** ADDED 115V SPACE HEATERS.

Certified by: Date: 13-Jun-12 Revision #: 5

EFFECTIVE: 20-JUL-11	VERTICAL MOTORS TEFC/EXPLOSION PROOF FRAME: 5800 BASIC TYPE: JV4, EV4	PRINT: 09-1875-46
SUPERSEDES: 06-AUG-04		SHEET: 1 OF 2



ALL DIMENSIONS ARE IN INCHES

FRAME	HP	TYPE	VOLTS	AB	AC	AD	AF
5800	THRU 500	JV-4	460	26.13	20.63	-	8.06
	ALL	JV-4	2300				
	OVER 500	JV-4	460	32.38	23.75	3.00	10.94
	ALL	JV-4	4000	27.13	21.63	-	10.00
	THRU 500	EV-4	460	26.13	19.44	-	5.63
	ALL	EV-4	2300	32.00	21.63	3.00	8.63
	OVER 500	EV-4	460				
	ALL	EV-4	4000				

AA
2 1/2 NPT
3 NPT
3 1/2 NPT
4 NPT

FRAME	AG
5807	73.69
5809	80.69
5811	88.69

FRAME	P [3]	AJ	AK +.005	BB MIN	BD MAX	BE	BF	BV	XO	XP
5800P	31.13	26.000	22.000	.25	30.50	1.25	.81	16.75	38.50	17.63
5800PH		14.750	13.500		24.50		.69			
		22.000					.94			

	POLES(RPM)				U -.001	AH ±.062	ES MIN	EU -.005	EW +.002	EX -.005	SQ KEY
	2(3600)	4(1800)	6(1200)	8(900)							
HP	ALL THRU 600	ALL THRU 300	ALL THRU 200	ALL THRU 150	2.125	4.500	3.000	1.750	.375	.750	.500
	—	350 THRU 450	250 THRU 300	200	2.375	5.000	3.500	2.000	.375	.750	.625
	—	500 THRU 600	350 THRU 400	250 THRU 300	2.625	5.000	3.500	2.250	.375	.750	.625
	—	700 THRU 800	450 THRU 500	350 THRU 400	2.875	7.000	5.000	2.375	.500	1.000	.750
	—	—	600	450 THRU 500	3.125	7.000	5.000	2.625	.500	1.000	.750

	POLES(RPM)				U -.001	AH ±.062	ES MIN	EU -.005	EW +.002	EX -.005	SQ KEY
	10(720)	12(600)	14(514)	16(450)							
HP	ALL THRU 125	ALL THRU 100	ALL THRU 75	ALL THRU 75	2.125	4.500	3.000	1.750	.375	.750	.500
	150	125 THRU 150	100 THRU 125	100	2.375	5.000	3.500	2.000	.375	.750	.625
	200	200	150	125 THRU 150	2.625	5.000	3.500	2.250	.375	.750	.625
	250 THRU 300	250	200	200	2.875	7.000	5.000	2.375	.500	1.000	.750
	350 THRU 400	300	250	250	3.125	7.000	5.000	2.625	.500	1.000	.750

1: ROUGH DIMENSIONS MAY VARY BY ±.25" DUE TO CASTING AND/OR FABRICATION VARIATIONS.
2: CONDUIT OPENINGS MAY BE LOCATED IN STEPS OF 90°. STANDARD IS AS SHOWN WITH CONDUIT OPENING DOWN.
3: LARGEST MOTOR WIDTH.

TOLERANCES	
FACE RUNOUT	.007 T.I.R.
PERMISSIBLE ECCENTRICITY OF MOUNTING RABBET	.007 T.I.R.
PERMISSIBLE SHAFT RUNOUT	.0015 T.I.R.
SHAFT END PLAY	.010 MAX.

09-1875/B

Nidec Motor Corporation
St. Louis, Missouri

ISSUED BY	R. KING
APPROVED BY	K. POTTER

IHP_DP_NMCA (MAR-2011) SOLIDEDGE

TYPICAL REED CRITICAL FREQUENCY DATA

USEM MODEL NO: NA
USEM CATALOG NO: NA

Frame: 5807VP Type: JVCI4

REED CRITICAL FREQUENCY:	33	HZ
CENTER OF GRAVITY:	30	IN
DEFLECTION @ CENTER OF GRAVITY:	0.0090	IN
UNIT WEIGHT:	5000	LBS.
BASE DIAMETER:	30.5	IN.
MAXIMUM MOTOR DIAMETER:	31.875	IN.
DATE:	3/15/2012	

IX. LUBRICATION

Motor must be at rest and electrical controls should be locked open to prevent energizing while being serviced. If motor is being taken out of storage refer to **Section III "STORAGE", item 4** for instructions.

1. Oil Lubricated Bearings.

Motors are tested with oil at our manufacturing facility then drained prior to shipment. A small amount of residual oil and rust inhibitor will remain in the oil sump. This residual oil and rust inhibitor is compatible with Turbine Type Mineral Oils and Synthetic, PAO (Poly Alpha Olefin) based oils listed in this manual. It is not necessary to drain this residual oil when adding new oil for operation.

Change oil once per year with normal service conditions. Frequent starting and stopping, damp or dusty environment, extreme temperature, or any other severe service conditions will warrant more frequent oil changes. If there is any question, consult Emerson Motor Co. Product Service Department for recommended oil change intervals regarding your particular situation.

Determine required oil ISO Viscosity Grade (VG) and base oil type from Table 3, then see Table 4 for approved oils. Add oil into oil fill hole at each bearing housing until the oil level reaches between minimum and maximum marks located on the sight gauge window. It is important to wipe excess oil from the threads of the drain hole and to coat the plug threads with Gasoila®† P/N SS08, manufactured by Federal Process Corporation or equivalent thread sealant before replacing the drain plug. Plug should be tightened to a minimum of 20 lb.-ft. using a torque wrench. See the motor nameplate or Table 5 for the approximate quantity of oil required.

2. Grease Lubricated Bearings.

A. Relubrication of Units in Service

Grease lubricated bearings are pre-lubricated at the factory and normally do not require initial lubrication. Relubricating interval depends upon speed, type of bearing and service. Refer to Table 1 or suggested regreasing intervals and quantities. Note that operating environment and application may dictate more frequent lubrication. To relubricate bearings, remove the drain plug. Inspect grease drain and remove any blockage (caked grease or foreign particles) with a mechanical probe, taking care not to damage bearing.

⚠ WARNING

Under NO circumstances should a mechanical probe be used while the motor is in operation.

Add new grease at the grease inlet. New grease must be compatible with the grease already in the motor (refer to table 2 for compatible greases).

⚠ CAUTION

Greases of different bases (lithium, polyurea, clay, etc.) may not be compatible when mixed. Mixing such greases can result in reduced lubricant life and premature bearing failure. Prevent such intermixing by disassembling motor, removing all old grease and repacking with new grease per item B of this section. Refer to Table 2 for recommended greases.

Run the motor for 15 to 30 minutes with the drain plug removed to allow purging of any excess grease. Shut off unit and replace the drain plug. Return motor to service.

⚠ CAUTION

Overgreasing can cause excessive bearing temperatures, premature lubricant breakdown and bearing failure. Care should be exercised against overgreasing.

B. Change of Lubricant

Motor must be disassembled as necessary to gain full access to bearing housing(s).

Remove all old grease from bearings and housings (including all grease fill and drain holes). Inspect and replace damaged bearings. Fill bearing housings both inboard and outboard of bearing approximately 30 percent full of new grease. Grease fill ports must be completely charged with new grease. Inject new grease into bearing between rolling elements to fill bearing. Remove excess grease extending beyond the edges of the bearing races and retainers.

Table 1
Recommended Grease Replenishment Quantities & Lubrication Intervals

Bearing Number		Grease Replenishment Quantity (Fl.Oz.)	Lubrication Interval		
62xx, 72xx	63xx, 73xx		1801 thru 3600 RPM	1201 thru 1800 RPM	1200 RPM and slower
03 thru 07	03 thru 06	0.2	1 Year	2 Years	2 Years
08 thru 12	07 thru 09	0.4	6 Months	1 Year	1 Year
13 thru 15	10 thru 11	0.6	6 Months	1 Year	1 Year
16 thru 20	12 thru 15	1.0	3 Months	6 Months	6 Months
21 thru 28	16 thru 20	1.8	3 Months	6 Months	6 Months

Refer to motor nameplate for bearings provided on a specific motor. For bearings not listed in Table 1, the amount of grease required may be calculated by the formula:

$G = 0.11 \times D \times B$

Where: G = Quantity of grease in fluid ounces.
D = Outside diameter of bearing in inches.
B = Width of bearing in inches.

Table 2
Recommended Greases

Motor Frame Size	Motor Enclosure	Grease Manufacturer	Grease (NLGI Grade 2)
All Thru 447	All	Chevron USA, Inc. Exxon Mobil	Grease No. 83343 SRI No. 2 Polyrex-EM
449 and Up	Open Dripproof		
449 and Up	TEFC and Explosionproof	Exxon Mobil	Grease No. 974420 Mobilith SHC-100

The above greases are interchangeable with the grease provided in units supplied from the factory (unless stated otherwise on motor lubrication nameplate).

Table 3
Emerson Motor Co. Recommended Oil Viscosities

Angular Contact Thrust Bearing (7XXX Series)					
Motor Enclosure	**Frame Size**	**Speed (RPM)**	**Ambient Temperature**	**ISO VG**	**Base Oil Type**
Open Dripproof or Weather Protected	324 and Larger	All	-15C thru 40C (5-104F)	32	Mineral or Synthetic
			41C thru 50C (105-122F)	68	Synthetic Only
Totally Enclosed or Explosion proof	404 thru 447		-15C thru 40C (5-104F)	32	Mineral or Synthetic
			41C thru 50C (105-122F)	68	Synthetic Only
	449 thru 5811	1801 - 3600	-15C thru 40C (104F)	32	Synthetic Only
		1800 & Below		68	Synthetic Only
		All	41C thru 50C (105-122F)	Refer to Office	
Spherical Roller Thrust Bearing (29XXX Series)					
Motor Enclosure	**Frame Size**	**Speed (RPM)**	**Ambient Temperature**	**ISO VG**	**Base Oil Type**
Open Dripproof or Weather Protected	444 and Larger	1800 and Below	-15C thru 25C (5-77F)	68	Mineral or Synthetic
			6C thru 40C (42-104F)	150	
			41C thru 50C (105-122F)		Synthetic Only
Totally Enclosed or Explosion proof	449 and Larger		-15C thru 25C (5-77F)	68	Mineral or Synthetic
			6C thru 40C (42-104F)	150	Synthetic Only
			41C thru 50C (105-122F)	Refer to Office	

Notes:
1. If lower guide bearing is oil lubricated, it should use the same oil as the thrust bearing.
2. If lower guide bearing is grease-lubricated, refer to TABLE 2 for recommended greases.
3. Refer to Emerson Motor Co. for ambient temperatures other than those listed.

Table 4
Emerson Motor Co. Approved Oil Specifications For Use With Anti-Friction Bearings

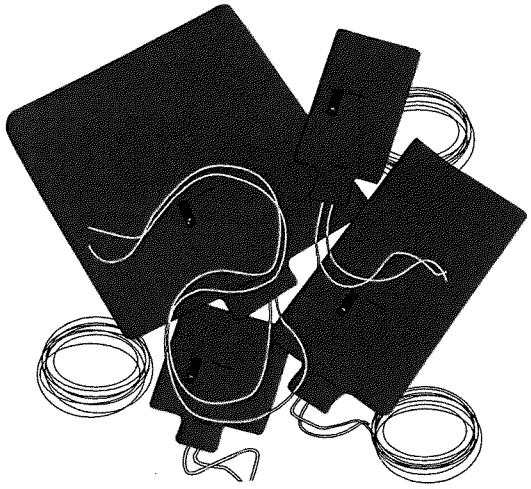
Oil Manufacturer	**ISO VG 32**		**ISO VG 68**		**ISO VG 150**	
	Viscocity: 130-165 SSU @ 100F		**Viscocity: 284-347 SSU @ 100F**		**Viscocity: 620-765 SSU @ 100F**	
	Mineral Base Oil	**Synthetic Base Oil**	**Mineral Base Oil**	**Synthetic Base Oil**	**Mineral Base Oil**	**Synthetic Base Oil**
Chevron USA, Inc	GST Turbine Oil 32	Tegra 32	GST Turbine Oil 68	Tegra 68	R & O Machine Oil 150	Tegra 150
Conoco Oil Co.	Hydroclear Turbine Oil 32	Syncon 32	Hydroclear Turbine Oil 68	Syncon 68	Hydroclear AW Hyd. Fluid 150	N/A
ExxonMobil	Teresstic 32	Synnestic 32	Teresstic 68	Synnestic 68	Teresstic 150	Synnestic 150
ExxonMobil	DTE Oil Light	SHC 624	DTE Oil Heavy Medium	SHC 626	DTE Oil Extra Heavy	SHC 629
Pennzoil Co., Inc	Pennzbell TO 32	Pennzbell SHD 32	Pennzbell TO 68	Pennzbell SHD 68	Pennzbell TO 150	Pennzbell SHD 150
Phillips Petroleum Co.	Magnus 32	Syndustrial "E" 32	Magnus 68	Syndustrial "E" 68	Magnus 150	N/A
Shell Oil Co.	Tellus 32	Tellus HD Oil AW SHF 32	Tellus 68	Tellus HD Oil AW SHF 68	Tellus 150	N/A
Texaco Lubricants Co.	Regal 32	Cetus PAO 32	Regal 68	Cetus PAO 68	Regal 150	N/A

Table 5
Approximate Oil Sump Capacities

Frame Size	Motor Type Designation (See Motor Nameplate)	Oil Capacity (Quarts)	
		Upper Bearing	Lower Bearing
180 - 280	AU, AV-4	Grease	Grease
180 - 280	AV		
320 - 440	RV		
320 - 360	RV-4, RU	3	
400	RV-4, RU	5	
440	RV-4 (2 pole)	17	
	RV-4, RU (4 pole & slower, w/ang contact thrust brg.)	6	
	(4 pole & slower, w/ spherical thrust brg.)	4	
180 - 440	TV-9, TV, LV-9, LV	Grease	
180 - 360	TV-4, TU, LV-4, LU		
400	TV-4, TU, LV-4, LU	6	
440	TV-4, TU, LV-4, LU	5	
449	JU, JV-4	22	
	HU, HV-4	12	
	JV-3, JV, HV	Grease	
5000	HV, EV, JV, RV	Grease	
	RU, RV-4	30	
	HU, HV-4 (4 pole & slower)	12	
	HV-4 (2 pole only)	20	
	EU, JU, EV-4, JV-4	22	5
5800	HU, HV-4	24	3
	EU, JU, EV-4, JV-4	37	4
6800	HU, HV-4	70	3
	HV (Bow Thruster)	Grease	Grease
	HV (Other Than Bow Thruster)	70	3
8000	RU, RV-4	70	6
	RV	Grease	Grease
9600	RU, RV-4	64	13
	RV	Grease	Grease

SILICONE RUBBER HEATERS

Rugged, Thin, Lightweight and Flexible...Limited Only By Your Imagination



Rugged, yet thin, lightweight, and flexible ... the use of Watlow silicone rubber heaters is limited only by your imagination. With these heaters, you can put the heat where it's needed and, in the process, improve heat transfer, speed warm-ups and decrease wattage requirements.

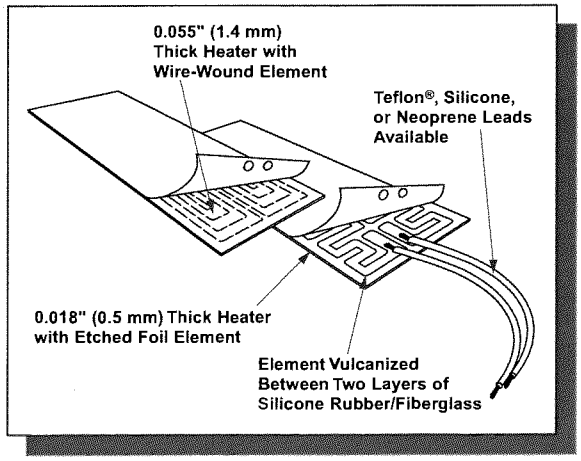
Fiberglass-reinforced silicone rubber gives your heater dimensional stability without sacrificing flexibility. Because very little material separates the element from the part, heat transfer is rapid and efficient.

Performance Capabilities

- Operating temperatures to 500°F (260°C)
- Watt densities to 80 W/in² (12.5 W/cm²) dependent upon application
- 0.055 inch (1.4 mm) thick with a wire-wound element; only 0.018 inch (0.5 mm) with an etched foil element

Applications

- Freeze protection and condensation prevention for many types of instrumentation and equipment
- Medical equipment such as blood analyzers, test tube heaters, etc.
- Computer peripherals such as laser printers
- Curing of plastic laminates
- Photo processing equipment



Features and Benefits

Designed in the exact shape and size you need

- Conforms to your equipment

More than 80 designs available immediately from stock

- Reduces down time

UR®, cUR®, and VDE recognitions

- Available on many designs

Moisture and chemical-resistant silicone rubber material

- Provides longer heater life

Vulcanizing adhesives or fasteners available

- Heaters bond easily to your part

WATLOW
2101 Pennsylvania Dr.
Columbia, Missouri 65202 USA
Phone: 573-474-9402
Fax: 573-474-5859
Internet: www.watlow.com
e-mail: www.watlow.com

SILICONE RUBBER HEATERS

Standard Silicone Rubber Specifications

Maximum width x maximum length:
- Wire-wound: 36 x 120 inches (915 mm x 3050 mm)
- Etched foil: 20 x 30 inches (510 mm x 760 mm)

Thickness (standard):
- Wire-wound: 0.055 inch (1.4 mm)
- Etched foil: 0.018 inch (0.5 mm)

Weight (standard):
- Wire-wound: 8 oz./ft² (0.24 g/cm²)
- Etched foil: 3 oz./ft² (0.09 g/cm²)

Maximum operating temperature:
- 500°F (260°C)

Maximum temperature for UL® Recognition:
- 428°F (220°C)

Minimum ambient temperature:
- -80°F (-62°C)

Maximum voltage:
- 600V~(ac)

Maximum wattage:
- Consult watt density graph on page 170 of the Watlow Heater's catalog.

Lead size:
- Sized to load

Lead length:
- 12 + 1½ - ½ inches (305 mm + 40 mm - 15 mm)

Wattage tolerance:
- Wire: ± 5 percent
- Foil: + 5 percent -10 percent

Dimensional tolerances:
- 0 to 6 inches (0 to 150 mm): ±1/16 inch (1.6 mm)
- 6 to 18 inches (150 to 455 mm): ±⅛ inch (3.2 mm)
- 18 to 36 inches (455 mm to 915 mm): ± 3/16 (4.8 mm)
- Over 36 inches (915 mm): ± 1 percent

How to Order

To order stock silicone rubber heaters, specify the Watlow code number (from the Watlow Heater's catalog) and the quantity. To order a heater with options, specify the code number, quantity and options desired (see page 165 in the Watlow Heater's catalog). Consult Watlow before combining options.

Made-to-Order: Consult factory

For made-to-order units, Watlow will need the following application information from you:
- Size (dimensions)
- Voltage
- Wattage/watt density
- Operating temperature
- Options (leads, thermostats, attachment techniques, etc.)
- Will heater be subject to flexing?
- Element type, if you have a preference
- Agency approvals
- Quantity

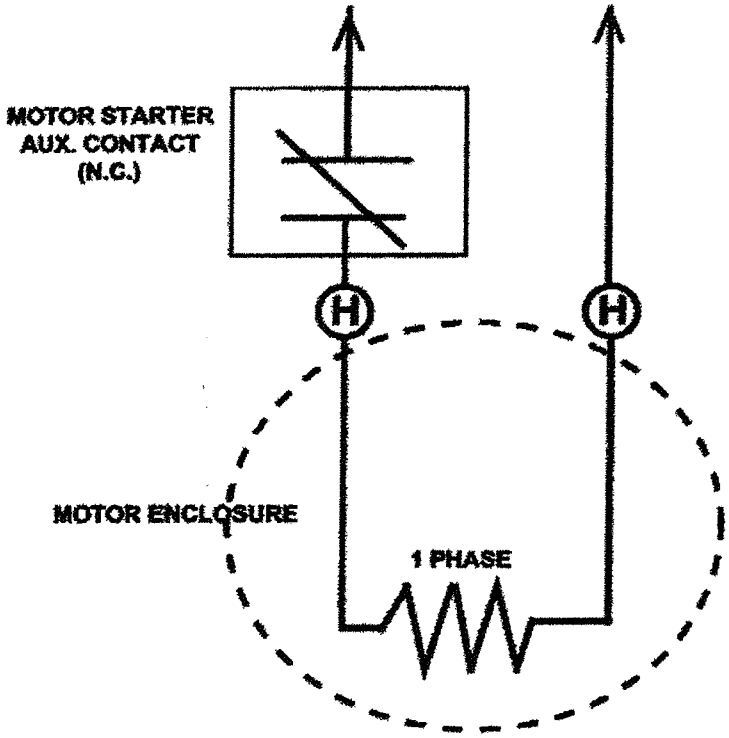
Availability

- Stock: Same day shipment of orders received by 11:00 a.m. CST.
- Stock with Options: Shipment in five working days or less. Not all options are available with stock heaters.

970798

SPACE HEATER CONNECTION DIAGRAM

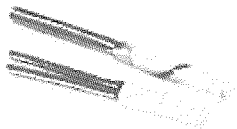
SPACE HEATER LEADS MAY BE LOCATED IN EITHER THE MAIN OUTLET BOX OR IF SO EQUIPPED, AN AUXILIARY BOX



THIS EQUIPMENT IS SUPPLIED WITH ANTI-CONDENSATION HEATERS. HEATERS SHOULD BE ENERGIZED WHEN EQUIPMENT IS NOT OPERATING TO PROTECT UNIT BY PREVENTING INTERNAL CONDENSATION. CONNECT THE "H" OR HEATER LEADS TO	
VOLTS	WATTS RATING

SPACE HEATER NAMEPLATE (ON MOTOR)

Sensata Technologies



9700

Thermal Protector for Motor/Fluorescent ballasts and Temperature Sensing Controls

KEY BENEFITS

Miniature size-compact design assures ease of installation

Precision Calibration-temperature calibrated and inspected in controlled ambients for dependable consistent performace

Snapaction-positive make and break assured with proven Klixon® strip disc...contact pressure at open temperature eliminates nuisance trips due to vibration

Sealed steel case-withstands impregnation and baking...maybe varnish dipped...prevents changes in calibration during installation

The Klixon® 9700 protector is a field proven miniature protector developed to protect shaded pole and permanent split capacitor motors, fluorescent ballasts, solenoids, transformers and other electrical equipment against overheating.

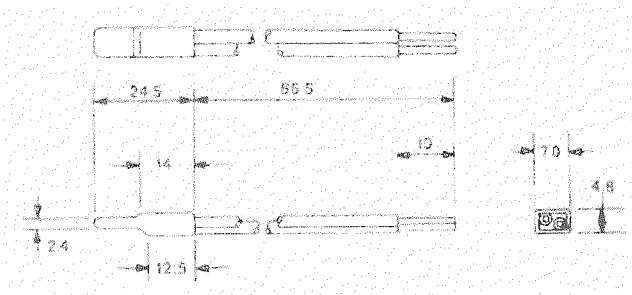
In addition to being small and lightweight, the unit is both temperature and current sensitive. Since the 9700 is sealed to withstand varnish dipping, it can be mounted directly in windings where it can best sense the true temperature of the electrical equipment. As a result, over-temperature protection is assured.

Since the case is not electrically insulated, the protector is furnished with a durable Mylar insulating sleeve. Shrinkable and non-shrinkable sleeves are available.

Technical Characteristics

Purpose of control:	thermal motor protector (TMP) thermal ballast protector (TBP) thermal cut-out (TCO)
Contact capacity:	250VAC 13A for TCO 250VAC 2A for TBP
Temperature range:	60°C to 150°C for TCO and TMP 60°C to 135°C for TBP
Tolerance on Open temp:	+/- 5K or +/- 8K
Automatic action:	Type 3C for TMP Type 2C for TBP and TCO
Operating time:	Continuous
Pollution situation:	Normal
Extent of sensing element:	Whole control
PTI of the insulation:	175
Enclosure protection degree:	IP00

KLIXON®



Sensata Technologies

9700 X X YY - ZZZZ

Z : Wire Lead and sleeve
Serial number is assigned for each lead and sleeve configuration, i.e. wire type, length, AWG#, stripped length, sleeve type, and length.

Y : Operating temperature and actuation disc material
Serial number is assigned for each desired temperature and resistance rating.

Nominal operating temperature	Resistance of actuation disc (ohms/cmf)				
	30	250	850	100	475
	Temperature code				
60	56	57	58	59	60
80	91	92	93	94	95
90	21	22	23	24	25
100	26	27	28	29	30
110	36	37	38	39	40
120	1	2	3	4	5
130	11	12	13	14	15
140	66	67	68	69	70
150	46	47	48	49	50

This is a typical temperature code. There is a temperature code at each 5℃ in a step from 60 to 150℃.

X : Open Temperature tolerance
: +/- 5K
2: +/- 8K

X : Contact material combination

Code	Stationaly contact	Movable contact
L	Steel + Fine silver	Steel + copper + Silver Cadmium oxide
K	Ag-Ni + Silver Cadmium oxide	Steel + copper + Silver Cadmium oxide
H	Brass + Fine silver	Steel + copper + Silver Cadmium oxide
P	Ag-Ni + Fine silver	Steel + Fine silver
S	Brass + Fine silver	Steel + Copper + Ag-Ni

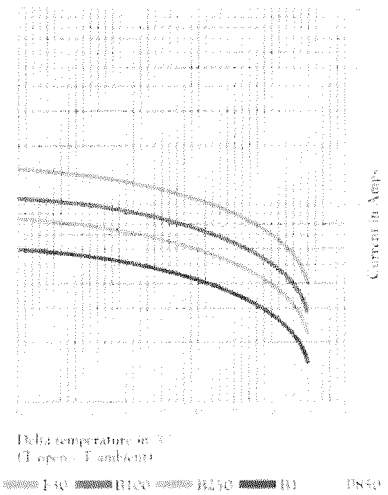
Type "S" is set up for Cadmium-free contact

9700 : Device Identification

Example :
9700K01-215
Bimetal of 30ohms/cmf,
120°C operating temperature,
+/-5K tolerance with
AWG#18(UL3343 125℃-600V)
66.7mm length leads,
thick 0.15mm, dia. 6.9mm,
length 34mm, Mylar sleeve.

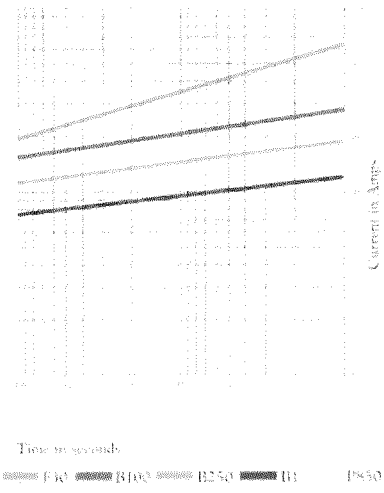
Ultimate trip current vs ambient temperature

Approx. to be used only for selecting samples for verification tests



Average first cycle tripping time vs current 25 C. ambient

Approx. to be used only for selecting samples for verification tests



Certifications

Agency	File number	Standard	Note
UL	E 15962	UL2111	Motor protector
ENEC	2014531.10	EN60730-2-9	Thermal cut-out
ENEC	2014531.10	EN60730-2-2	Thermal motor protector
ENEC	2014531.10	EN60730-2-3	Thermal ballast protector
CQC	CQC0200	2001344	

Sensata Technologies

TECHNICAL / SALES SUPPORT

Holland
Phone +31 546 879560 Fax +31 546 879204
Italy
Phone +39 039 6568310 Fax +39 039 6568316

Internet: www.sensata.com

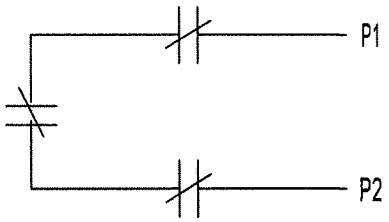
Email: info-cpe@list.sensata.com

THERMOSTATS

1. MOTOR IS EQUIPPED WITH QTY-3 (1 PER PHASE) NORMALLY CLOSED THERMOSTATS. THERMOSTATS ARE SET TO OPEN AT HIGH TEMPERATURE.

2. CONTACT RATINGS FOR THERMOSTATS: 120-600 VAC, 720 VA

N. C. THERMOSTATS



NOTE: THERMOSTATS LEADS MAY BE LOCATED IN EITHER THE MAIN OUTLET BOX OR IF SO EQUIPPED, AN AUXILIARY BOX.

ACCESSORY LISTING
QTY-3 N.C. THERMOSTATS

REVISION DESCRIPTION FOR: MISC STL0211 - UPDATED FORMAT .	SCALE: NONE	UNITS: IN	TITLE: CUSTOMER CONNECTION DIAGRAM		NIDEC MOTOR CORPORATION
MATERIAL: --- MUST BE COMPLIANT TO RoHS DIRECTIVE EU 2002/95/IEC AND REGULATION EC 1907/2006 (REACH) AS AMENDED	TOLERANCES ON DIMENSIONS (UNLESS OTHERWISE SPECIFIED) INCHES / mm ANGLES X°= ±1°		ISSUED BY: R. KING	APPROVED BY: C. CADE	REVISION DATE: 24-FEB-11
			CODE	DWG NO.: 0834066	REV: G / SHEET NUMBER: 1 OF 1 / DWG SIZE: A

EMERSON
Motor Technologies

Standard

Paint

Specification

For

EM Gray

DR#587-12765/MENA
REV. 9/23/94-BRB
REV.1/12/95-BRB
REV.4/4/96-RIH
REV.3/30/98-KWF
REV.4/21/98-RIH
REV.9/25/02-DH

EMERSON
Motor Technologies

CONTENTS

EMERSON
Motor Technologies

1.0 Scope

Commercial Industrial Motors (CIM) in Mena, Arkansas (formerly U.S. Electrical Motors) has selected the Hi-Solids enamel paint from "Valspar Corp." for its superior corrosion resistance and durability. The paint also has excellent resistance to various chemicals. This specification covers surface preparation and application of protective coating on motors built in the Mena, Arkansas facility.

2.0 Unpainted Surfaces

The following surfaces will not require protective coating:

Anodized Aluminum	Grounding Pads
Brass	Machined Surfaces
Bronze	Motor Leads
Chromium Plated Metals	Porcelain Enamel Finishes
Copper	Rubber
Galvanized Steel	Stainless Steel
Glass	Vacuum Pressure Impregnated Parts

3.0 Surface Preparation (Cast Iron & Steel)

A. The foundries are required to snag, remove all sand and slag from castings.

B. Prime paint all castings in-plant if they have not been primed by the foundry. Primer is to be "Valspar Corp." gray oxide primer Part No. 999-712 or water reduced gray oxide Primer Part No. 999-711. Film Thickness: 1 to 3 mils

C. All parts are to be cleaned prior to priming or finish painting as follows:

1. If parts are dirty – wash and rinse in parts washer.
2. If parts are oily or greasy – clean in a phosphate dip system and rinse in parts washer.
3. If parts are rusty – grit blast to commercial grade.
4. Welded fabricated assemblies – power wire brush, sand or grind all welds; then, degrease in the phosphate dip system and rinse in parts washer.
5. Thoroughly dry all parts prior to priming or finish painting. Primer must be applied immediately after cleaning and drying process.

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4.0 Cast Aluminum and Fiberglass Parts

Priming is not required on cast aluminum or fiberglass parts. Oxidation must be removed from aluminum parts with a solvent prior to finish painting. Fiberglass parts (canopy caps) are received with a white pigment in the fiberglass.

5.0 Motor Assembly

After assembling the motor, there may be surfaces that require priming or touch-up prior to final painting. These surfaces are bracket-to-frame register fits, outlet box pads, etc. Spray cans of primer are provided to allow motor assemblers to prime paint unfinished surfaces with two coats of primer. Sufficient drying time must be allowed between primer coats. If surfaces are oily, wash with clean paint thinner using a clean rag to prevent contamination of other surfaces.

6.0 General

A. Finished coating shall not be applied to wet or damp surfaces.
B. All coatings shall be applied in a conscientious manner and in accordance with the written application instructions of the coating manufacturer.
C. Re-application time between coats shall be in accordance with the coating manufacturer's recommendation corresponding to the conditions of temperature and humidity.
D. Hardware trim and other items not requiring coating may be removed as required for proper application of coatings. Such items shall be replaced after completion of work.
E. The dry film thickness of each coat, and of the entire system, shall follow the coating manufacturer's recommendation and this specification. The number of coats specified shall be a minimum number of coats to achieve the specified film thickness.
F. Coverage rates, as calculated by the coating manufacturer, shall be considered as the maximum allowable.
G. All spraying equipment shall be maintained in good working order, with daily inspection, and shall be in conformity with the coating manufacturer's most recent application specification.

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7.0 Finish Top Coating

All motor products must be clean and free of any dirt, oil or grease on the primed surface prior to finish painting. Except where otherwise specified, thinners shall not be used. Motors will be painted with one coat unless otherwise noted. Film thickness: 2 to 4 mils.

8.0 Final Finish Inspection

Visual inspection of completed work shall be performed on the finished motor by the Assembly End of Line Inspector. The final surface finish is to be in accordance with industry standards for comparable equipment. Any surfaces found in violation of this specification will be rejected and will require rework. The final finish top coat shall adhere to CIM Quality standards for appearance, adhesion and customer specifications.

9.0 Material Identification

A. Vendor Primer

USEM P/N 999712 GRAY OXIDE PRIMER
VALSPAR CORP.
#5410-E-10009
ALKYD-HI SOLIDS, FAST DRY

USEM P/N 999711 WATER REDUCED GRAY OXIDE PRIMER
VALSPAR CORP.
#5424-E-10035A
ALKYD-HI SOLIDS

B. Standard Finish Paint

USEM P/N 138538 EM GRAY 3.5 VOC H/S ENAMEL
VALSPAR CORP.
AAA1024 DURASPAR 430
ALKYD-HI SOLIDS, FAST DRY
COLOR: BLUE-GRAY, PANTONE PMS 433C

Valspar

TECHNICAL DATA

Product Line: Duraspar 430

Product Number: AAA1024

Product Description: EM Gray 3.5 VOC H/S Enamel

Physical Properties:

Viscosity (#2 EZ Zahn @ 77F):	30-35 seconds
Weight Per Gallon (Theoretical):	9.44 lbs./gallon
Solids by Weight (Theoretical):	58.59%
Solids by Volume (Theoretical):	44.33%
VOC:	3.25 lbs./gallon maximum
HAPs Content:	.0894 lbs./solid gallon

Application Recommendations:

Substrate/Pretreatment:	Steel / Iron Phosphate
Reduction:	As needed
Reduction Solvent:	Acetone
Application:	Spray
Clean-Up Solvent:	Ketones
Cure Cycle:	Air Dry

Film Properties:

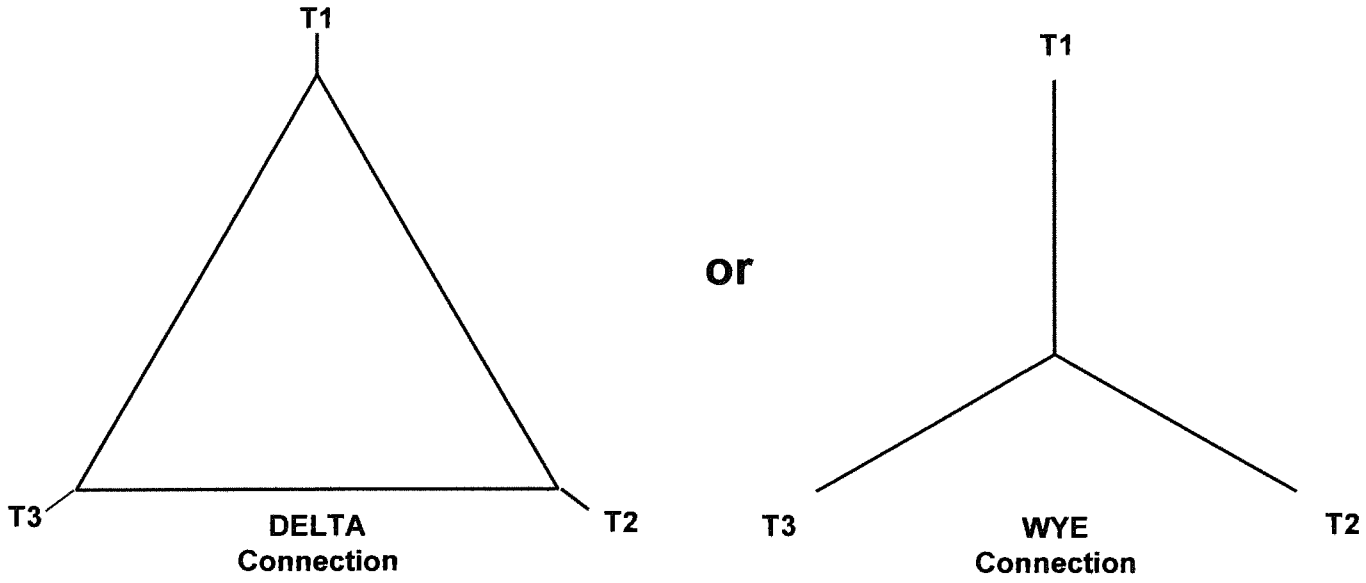
Dry Film Thickness:	0.8 – 1.2 mils
Gloss (60 degrees):	80 minimum
Coverage @ 1 mil DFT:	711 sq. ft./gallon

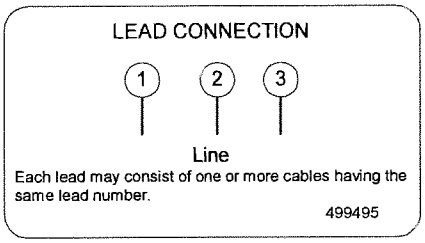
Issue Date: September 2002

The Valspar Corporation, Minneapolis, MN **1-800-328-8044**

499495

Motor Wiring Diagram





To reverse direction of rotation interchange connections L1 and L2.

Each lead may be comprised of one or more cables.
Each cable will be marked with the appropriate lead number.

EFFECTIVE: 2/27/96
SUPERCEDES: X736618, 96441, 179879, 284138
Connection Plate: 499495
Connection Decal: 912113

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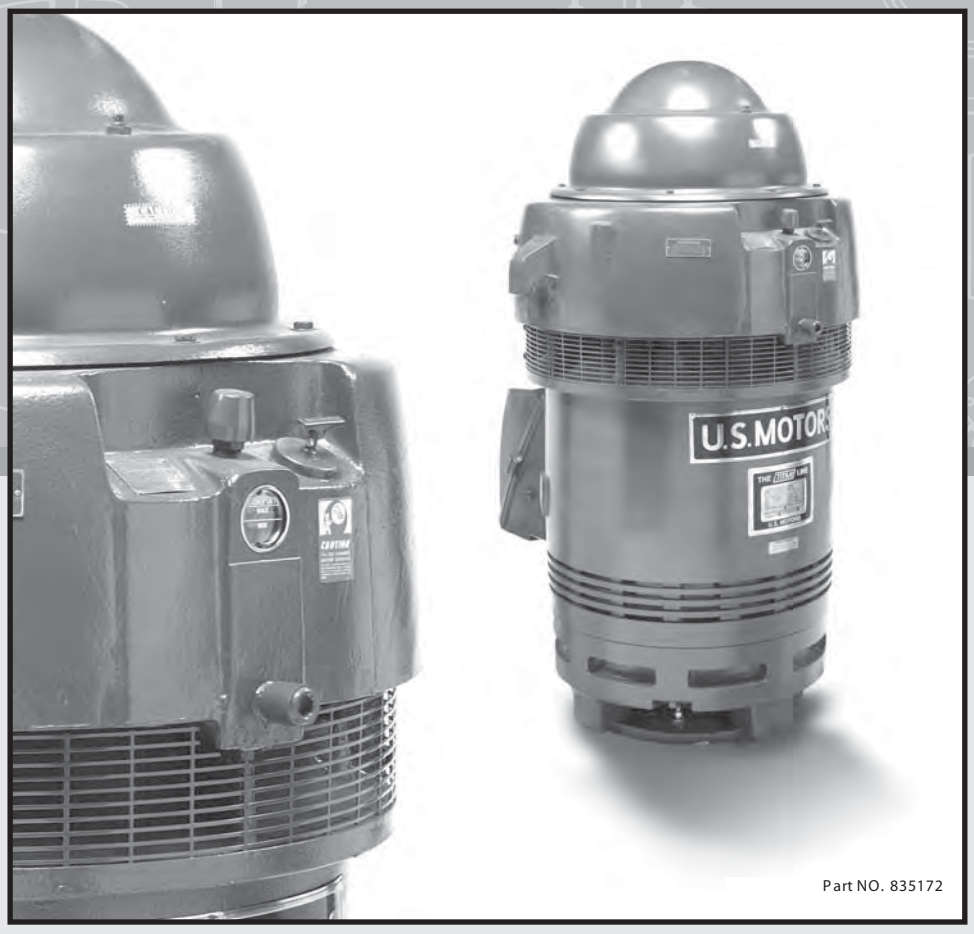
Vertical High Thrust Motors



Installation, Operation, and Maintenance

US MOTORS

EMERSON™
Motor Technologies

EMERSON. CONSIDER IT SOLVED.™

SAFETY FIRST!

High voltage and rotating parts can cause serious injury or loss of life. Installation, operation, and maintenance must be performed by qualified personnel. Familiarization with and adherence to NEMA MG2, the National Electrical Code, and local codes is recommended. It is important to observe safety precautions to protect personnel from possible injury. Personnel should be instructed to:

1. Disconnect all power to motor and accessories prior to initiating any installation, maintenance, or repairs. Also ensure that driven equipment connected to the motor shaft will not cause the motor to rotate (windmilling of fans, water flowing back through pump, etc.).

2. Avoid contact with rotating parts.

3. Act with care in accordance with this manual's prescribed procedures in handling and installing this equipment.

4. Be sure unit and accessories are electrically grounded and proper electrical installation wiring and controls are used in accordance with local and national electrical codes. Refer to "National Electrical Code Handbook" - NFPA No. 70. Employ qualified electricians.

5. Be sure equipment is properly enclosed to prevent access by children or other unauthorized personnel in order to prevent possible accidents.

6. Be sure shaft key is fully captive before unit is energized.

7. Provide proper safeguards for personnel against rotating parts and applications involving high inertia loads which can cause overspeed.

8. Avoid extended exposure to equipment with high noise levels.

9. Observe good safety habits at all times and use care to avoid injury to yourself or damage to equipment.

10. Be familiar with the equipment and read all instructions thoroughly before installing or working on equipment.

11. Observe all special instructions attached to the equipment. Remove shipping fixtures if so equipped before energizing unit.

12. Check motor and driven equipment for proper rotation and phase sequence prior to coupling. Also check if a unidirectional motor is supplied and note proper rotation.

13. Electric motors can retain a lethal charge even after being shut off. Certain accessories (space heaters, etc.) are normally energized when the motor is turned off. Other accessories such as power factor correction capacitors, surge capacitors, etc. can retain an electrical charge after being shut off and disconnected.

14. Do not apply power correction capacitors to motors rated for operation with variable frequency drives. Serious damage to the drive will result if capacitors are placed between the motor and drive. Consult drive supplier for further information.

Table of Contents

Shipment, Handling & Storage

I. SHIPMENT

Prior to shipment, all motors undergo extensive mechanical and electrical testing, and are thoroughly inspected. Upon receipt of the motor, carefully inspect the unit for any signs of damage that may have occurred during shipment. Should such damage be evident, unpack the motor at once in the presence of a claims adjuster and immediately report all damage and breakage to the transportation company.

When contacting Emerson Motor Co. concerning the motor, be sure to include the complete motor identification number, frame, and type which appear on the nameplate.

II. HANDLING

The equipment needed to handle the motor includes a hoist and spreader bar arrangement (see Figure 1) of sufficient strength to lift the motor safely. The spreader bar should have the lifting rings or hooks positioned to equal the span of the lifting lugs or eyebolts. The lifting lugs or eyebolts are intended to lift the motor weight only.

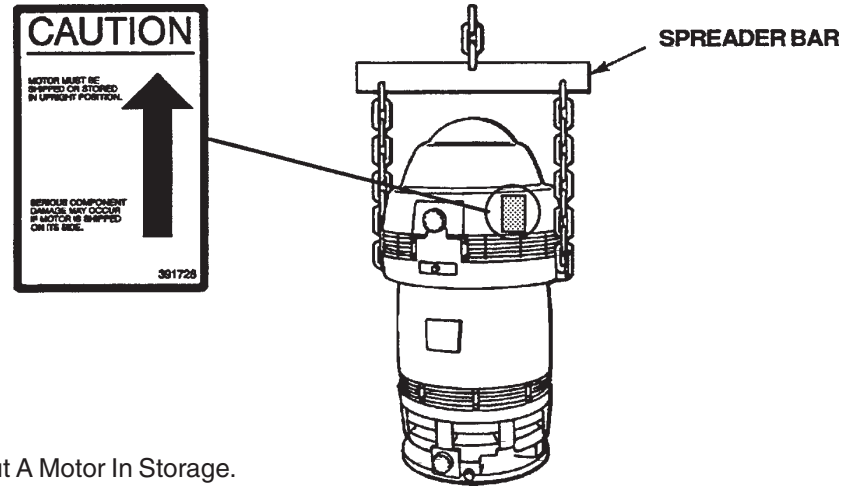
⚠ WARNING

Lifting the motor by other means may result In damage to the motor or injury to personnel.

⚠ CAUTION

Do not move motor with oil sumps filled. Sloshing action of oil in sumps can result in oil leaks and motor damage.

FIGURE 1



III. STORAGE

1. When To Put A Motor In Storage.

   If a motor is not put into immediate service (one month or less), or if it is taken out of service for a prolonged period, special storage precautions should be taken to prevent damage. The following schedule is recommended as a guide to determine storage needs.

A. Out of service or in storage less than one month - no special precautions except that space heaters, if supplied, must be energized at any time the motor is not running.

B. Out of service or in storage for more than one month but less than six months - store per items 2A, B, C, D, E, F(2), and G, items 3A, B, and C, and item 4.

C. Out of service or in storage for six months or more - all recommendations.

2. Storage Preparation.

A. Where possible, motors should be stored indoors in a clean, dry area.

B. When indoor storage is not possible, the motors must be covered with a tarpaulin. This cover should extend to the ground; however, it should not tightly wrap the motor. This will allow the captive air space to breathe, minimizing formation of condensation. Care must also be taken to protect the motor from flooding or from harmful chemical vapors.

> ⚠ ***CAUTION***
>
> ***Immediately remove any shrink wrap used during shipping. Never wrap any motor in plastic for storage. This can turn the motor into a moisture trap causing severe, non-warranty damage.***

C. Whether indoors or out, the area of storage should be free from excessive ambient vibration which can cause bearing damage.

D. Precautions should be taken to prevent rodents, snakes, birds, or other small animals from nesting inside the motors. In areas where they are prevalent, precautions must be taken to prevent insects, such as dauber wasps, from gaining access to the interior of the motor.

E. Inspect the rust preventative coating on all external machined surfaces, including shaft extensions. If necessary, re-coat the surfaces with a rust preventative material, such as Rust Veto No. 342 (manufactured by E.F. Houghton Co.) or an equivalent. The condition of the coating should be checked periodically and surfaces re-coated as needed.

F. Bearings:

(1) When storage time is 6 months or more, grease lubricated cavities must be completely filled with lubricant. Remove the drain plug and fill cavity with grease until grease begins to purge from drain opening. Refer to section **IX. "LUBRICATION"** and/or review motor's lubrication nameplate for correct lubricant.

> ⚠ ***CAUTION***
>
> ***Do not re-grease bearings with drain closed or with unit running.***

(2) Oil lubricated motors are shipped without oil. When storage time exceeds one (1) month, the oil sumps must be filled to the maximum capacity as indicated on the oil chamber sight gauge window. Refer to motor lubrication nameplate or Section **IX "Lubrication"** for proper oil.

NOTE: Motor must not be moved with oil in reservoir. Drain oil before moving to prevent sloshing and possible damage. With a clean cloth, wipe any excess oil from the threads of the drain plug and the inside of the drain hole. Apply Gasoila P/N SS08 or equivalent thread sealant to the threads of the drain plug and replace the plug in the oil drain hole. Refill oil when motor has been moved to the new location.

G. To prevent moisture accumulation, some form of heating must be utilized. This heating should maintain the winding temperature at a minimum of 5° above ambient. If space heaters are supplied, they should be energized. If none are available, single phase or "trickle" heating may be utilized by energizing one phase of the motor's winding with a low voltage. Request the required voltage and transformer capacity from Emerson Motor Co. A third option is to use an auxiliary heat source and keep the winding warm by either convection or blowing filtered warm air into the motor.

3. Periodic Maintenance.

A. Oil should be inspected monthly for evidence of moisture or oxidation. The oil must be replaced whenever contamination is noted or every twelve months; which ever occurs first. It is important to wipe excess oil from the threads of the drain plug and the drain hole and to coat the plug threads with Gasoila P/N SS08 or equivalent thread sealant before replacing the drain plug.

B. Grease lubricated bearings must be inspected once a month for moisture and oxidation by purging a small quantity of grease through the drain. If any contamination is present, the grease must be completely removed and replaced.

C. All motors must have the shaft rotated once a month to maintain a lubricant film on the bearing races and journals.

D. Insulation History:

The only accurate way to evaluate the condition of the winding insulation is to maintain a history of the insulation readings. Over a period of months or years these readings will tend to indicate a trend. If a downward trend develops, or if the resistance drops too low, thoroughly clean and dry the windings, retreating if necessary, by an authorized electrical apparatus service shop.

The recommended insulation resistance test is as follows:

(1) Using a megohm meter, with winding at ambient temperature, apply DC voltage (noted below) for sixty seconds and take reading.

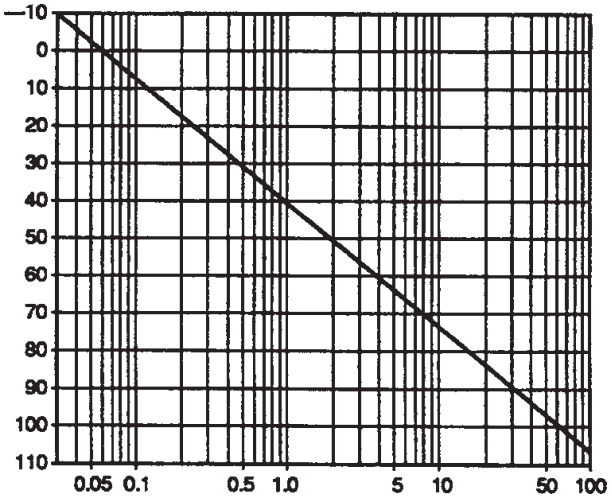
Rated Motor Voltage	Recommended DC Test Voltage
Up to 600 (inclusive)	500 VDC
601 to 1000 (inclusive)	500 to 1000 VDC
1001 and up	500 to 2500 VDC (2500 VDC optimum)

(2) For comparison, the reading should be corrected to a 40°C base temperature. This may be done by utilizing the following formula:

$$R_{40C} = K_t \times R_t$$

Where:
R_{40C} = insulation resistance (in megohms) corrected to 40°C
R_t = measured insulation resistance (in megohms)
K_t = temperature coefficient (from Graph 1)

GRAPH 1



(Adapted from IEEE 43)

INSULATION RESISTANCE TEMPERATURE COEFFICIENT (K_t)

(3) Insulation resistance readings must not drop below the value indicated by the following formula:

$$R_m = Kv + 1$$

Where:
R_m = minimum insulation (in megohms) at 40°C
Kv = rated motor voltage in kilovolts

(4) Dielectric absorption ratio:

In addition to the individual test reading, a dielectric absorption ratio may be required. The dielectric absorption ratio is obtained by taking megohm meter readings at a one minute and ten minute interval, or when hand powered megohm meters are used, at a thirty second and sixty second interval. The voltage should be the same as outlined in part 1 of this procedure.

The ratio is obtained by dividing the second reading by the first reading and is based on a good insulation system increasing its resistance when subjected to a test voltage for a period of time.

10 Minute: 1 Minute		60 Second: 30 Second	
Dangerous	= Less than 1.0	Poor	= Less than 1.1
Poor	= 1.0 to 1.4	Questionable	= 1.1 to 1.24
Questionable	= 1.5 to 1.9	Fair	= 1.25 to 1.3
Fair	= 2.0 to 2.9	Good	= 1.4 to 1.6
Good	= 3.0 to 4.0	Excellent	= Over 1.6
Excellent	= Over 4.0		

If a low insulation resistance reading is obtained in either the individual test or dielectric absorption ratio test, thoroughly clean and dry the windings. Recheck insulation resistance and dielectric absorption ratio.

NOTE: Slightly lower dielectric absorption ratios may be acceptable when high initial insulation resistance readings are obtained (1000 + megohms). Refer any questions to Emerson Motor Co. Product Service Department.

For additional information on insulation testing, refer to IEEE Transaction No. 43.

4. Start-up Preparations After Storage.

   A. Motor should be thoroughly inspected and cleaned to restore to an “As Shipped" condition.

   B. Motors which have been subjected to vibration must be disassembled and each bearing inspected for damage.

   C. When storage time has been six (6) months or more, oil and/or grease must be completely changed using lubricants and methods recommended on the motor’s lubrication plate, or in Section **IX - "LUBRICATION."**

   D. The winding must be tested to obtain insulation resistance and dielectric absorption ratio as described in Section **III., item 3**.

   E. Contact Emerson Motor Co. Product Service Department prior to start-up if storage time has exceeded one year.

IV. INSTALLATION LOCATION

When selecting a location for the motor and driven unit, keep the following items in mind:

1. The location should be clean, dry, well ventilated, properly drained, and provide accessibility for inspection, lubrication, and maintenance. Outdoor installations on open dripproof motors require protection from the elements.

2. The location should provide adequate space for motor removal without shifting the driven unit.

3. Temperature rise of a standard motor is based upon operation at an altitude not exceeding 3300 feet (1000 meters) above sea level unless specified otherwise on nameplate.

4. To avoid condensation inside the motor, it should not be stored or operated in areas subject to rapid temperature changes unless it is energized or protected by space heaters.

5. The motor should not be installed in close proximity to any combustible material or where flammable gases may be present, unless it is specifically built for that environment and is U.L. labeled accordingly.

6. Oil lubricated motors must be mounted within one degree of true vertical. Failure to do so will result in oil leakage and possibly bearing failure.

V. INITIAL INSTALLATION

1. General

   Reliable, trouble free operation of a motor and driven unit depends on a properly designed foundation and base plus good alignment. If the motor and driven unit are not installed properly, the following may result:

   * Noisy operation
   * Excessive vibration
   * Bearing damage or failure
   * Motor failure

2. Shaft Alignment

   On Holloshaft motors, the pump shaft and motor coupling must be aligned within .003" TIR. On Solidshaft motors, the motor and pump shafts must be aligned within .002" TIR.

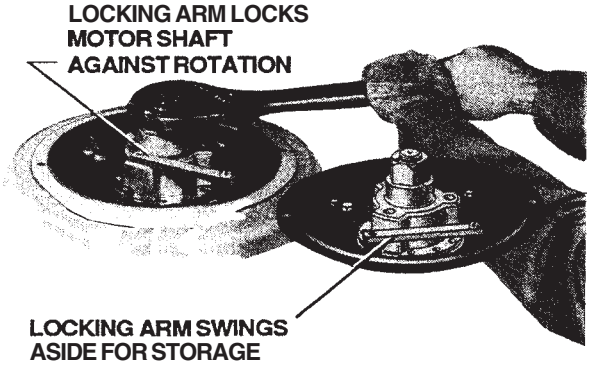
3. Pump Shaft Adjustment (Holloshaft motors only)

   To facilitate axial pump shaft adjustment, a locking feature is provided to lock the motor shaft against rotation. The two types of locking features are as follows:

   A. Locking arm (Figure 2) -The locking arm is bolted to a stationary part and is pinned (for best results use arm in tension) or interferes with a rotating part (when locking arm is not in use it should be moved out of the way and bolted in place). A non-reverse ratchet functions as a locking device. Motors supplied with non-reverse ratchets are not equipped with a locking arm.

   B. Pinning through mating holes-Holes are provided in both a stationary and rotating part which line up allowing insertion of a pin.

FIGURE 2



⚠ WARNING

Locking device must be disengaged prior to starting motor or motor damage and/or injury to personnel may result.

⚠ CAUTION

Care should be exercised when lowering the motor over the pump shaft so that the oil retaining tube in the lower bracket is not damaged (applies only to motors with oil lubricated lower bearing).

4. Drive Coupling (Holloshaft units only).

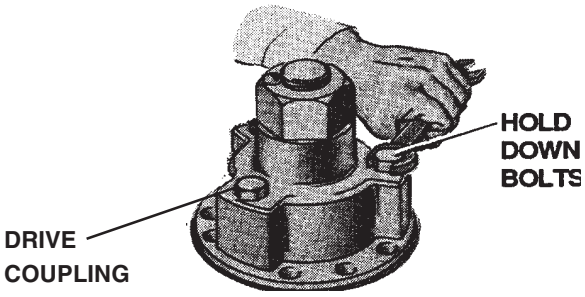
   The drive coupling may be utilized in one of two ways:

   A. Bolted type (Figure 3) - Hold down bolts are installed (some motors require removal of driving pins to allow installation of hold down bolts) in the drive coupling to prevent upward movement of the pump shaft. This will allow momentary upthrust from the pump to be taken by the motor's guide bearing.

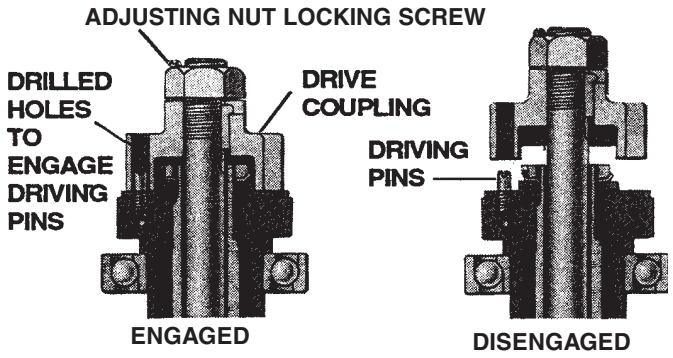
⚠ WARNING

Failure to tighten coupling and non-reverse ratchet bolts to required torque values may cause bolts to break, resulting in equipment damage or injury to personnel.

BOLTED COUPLING
FIGURE 3



SELF RELEASE COUPLING
FIGURE 4



   B. Self-release type (Figure 4) - Driving pins are used to engage the drive coupling with the rotor. A power reversal may unscrew the joints of the pump shafting, causing the shafting to lengthen and buckle or break if the shafting is restrained. The self-release coupling will lift out of engagement with partial unscrewing of the shafting, thus stopping further rotation of the pump. The following items must be followed for proper functioning of the self-release coupling:

   - The pump shaft adjusting nut must be properly secured to the drive coupling with a locking screw.
   - The drive coupling should not bind on the driving pins.
   - The drive coupling must not be bolted down.
   - The pump shaft must be concentric to the motor shaft to prevent rubbing of the pump shaft inside the motor shaft.
   - There must be no potential for upthrust in the application.
   - Do not use the self-release feature in conjunction with a lower steady bushing, as friction between the parts can damage the line shafting and/or bushing.
   - Due to the possibility of sparking as the parts separate, the self-release feature must not be used in an environment where explosive gases or dust may be present.

⚠ *WARNING*

Should a motor supplied with a self-release coupling become uncoupled, the motor and pump must be stationary and all power locked out before manually re-coupling.

5. Water Cooling For Bearing Oil Reservoir.

   If the motor is equipped with cooling coils in the oil reservoir, a minimum water supply of 4 GPM must be maintained at a maximum of 125 PSI with a 32°C (90°F) maximum inlet temperature. External water connections must be self draining to prevent cooling coil rupture at freezing temperatures. Use clean, noncorrosive water only. If corrosive conditions exist and are specified at time of motor order, special corrosion resistant fittings can be supplied.

6. Electrical Connection.

   Refer to the motor nameplate for power supply requirements and to the connection diagram on the motor. Be sure connections are tight. Check carefully and assure that they agree with the connection diagram, then carefully tape all connections with electrical tape to be sure that they will not short against each other or to ground. Be sure the motor is grounded to guard against possible electrical shock. Refer to the National Electrical Code Handbook (NFPA No. 70) and to local electrical codes for proper wiring, protection, and wire sizing. Be sure proper starting equipment and protective devices are used for every motor. For assistance contact the local sales office of the motor starter manufacturer for the particular brand of equipment you are using.

   Part Winding Starters: Part winding starters used with part winding start motors should have the timer set at a minimum time consistent with the power company requirements. The recommended maximum time on part winding is two seconds. Setting the timer for longer periods can cause permanent damage to the motor and may void the warranty. Note that motor may or may not start on part winding start connection.

7. Direction Of Rotation.

   As a standard, motors that are equipped with a non-reverse ratchet are designed to operate in a counter-clockwise direction as viewed from the top of the motor. Also, some high speed motors have unidirectional ventilating fans. When the motor has a unidirectional ventilating fan, the direction of rotation is indicated by an arrow mounted on the motor and by a warning plate mounted near the main nameplate.

⚠ *CAUTION*

Apply power momentarily to observe the direction of rotation for which the leads are connected. Motor damage may occur if power is applied for more than ten seconds while rotation is locked against the non-reverse ratchet. The motor should be uncoupled from the driven equipment during this procedure to assure driven equipment is not damaged by reverse rotation. Couplings (if installed) should be properly secured.

For a 3 phase motor, to reverse the direction of rotation (if the motor is not operating in the correct direction), interchange any two of the three power leads on the motor. For a 1 phase motor, if the motor is not operating in the correct direction, follow the instructions on the connection plate attached to the motor in order to reverse the direction of rotation. For both 1 and 3 phase motors, be sure that the power is off and steps are taken to prevent accidental starting of the motor before attempting to change electrical connection.

8. Spring-Preloaded Thrust Bearings.

   Motors built with spherical roller thrust bearings (bearing number 29xxx) at any speed or tandem angular contact thrust bearings (bearing number 7xxx) on large 3600 or 3000 RPM (2-pole) motors have preload springs which maintain a minimum thrust load at all times to prevent bearing skidding. These motors require a minimum external thrust load sufficient to compress the springs to properly seat the thrust bearing and to relieve the lower guide bearing of axial spring thrust. Refer to motor's minimum thrust nameplate for required thrust.

> ⚠ ***CAUTION***
>
> ***Do not run a motor which has bearing preload springs without thrust load for more than fifteen (15) minutes as bearing damage may result.***

9. Initial Start.

   After installation is completed, but before motor is put into regular service, make an initial start as follows:

   A. Ensure that motor and control device connections agree with wiring diagrams.

   B. Ensure that voltage, phase, and frequency of line circuit (power supply) agree with motor nameplate.

   C. Check insulation resistance according to Section **III "STORAGE"** item 3.

   D. Check all foundation, base, non-reverse ratchet (if applicable), and coupling bolts (if applicable) to ensure they are tight.

   E. If motor has been in storage, either before or after installation, refer to Section **III "STORAGE"** item 4 for preparations.

   F. Check oil lubricated units to be certain that bearing housings have been filled to between the "MAX" and "MIN" levels on the sight gauge windows with the correct lubricant. Refer to Section **IX "LUBRICATION"** for proper oils.

   G. Check for proper or desired rotation. See item 7 of this section for details.

   H. Ensure that all protective devices are connected and operating properly, and that all outlet accessory, and access covers have been returned to their original intended position.

   I. Start motor at lowest possible load and monitor to be sure that no unusual condition develops.

> ⚠ ***WARNING***
>
> ***All loosened or removed parts must be reassembled and tightened to original specifications. Keep all tools, chains, equipment, etc. clear of unit before energizing motor.***

   J. When checks are satisfactory to this point, increase load slowly up to rated load and monitor unit for satisfactory operation.

VI. NORMAL OPERATION

Start the motor in accordance with standard instructions for the starting equipment used.

1. General Maintenance.

   Regular, routine maintenance is the best assurance of trouble-free, long-life motor operation. It prevents costly shutdown and repairs. Major elements of a controlled maintenance program are:

   A. Trained personnel who have a working knowledge of rotational equipment and have read this manual.

   B. Systematic records which contain at least the following:

      1. Complete nameplate data.
      2. Prints (wiring diagrams, certified outline dimensions).
      3. Alignment data.
      4. Results of regular inspection, including vibration and bearing temperature data, as applicable.
      5. Documentation of any repairs.
      6. Lubrication data:
         - Method of application
         - Types of lubricants for wet, dry, hot, or adverse locations
         - Maintenance cycle by location (some require more frequent lubrication)

2. Inspection and Cleaning

   Stop the motor before cleaning. ***CAUTION: Assure against accidental starting of the motor.*** Clean the motor inside and out regularly. The frequency of cleaning depends upon actual conditions existing around the motor. Use the following procedures as they apply:

   A. Wipe off dirt, dust, oil, water, or other liquids from external surfaces of motor. These materials can work into or be carried into the motor windings and may cause overheating or insulation breakdown.

   B. Remove dirt, dust, or debris from ventilating air inlets. Never allow dirt to accumulate near air inlets. Never operate motor with air passages blocked.

   C. Clean motors internally by blowing with clean, dry, compressed air at 40 to 60 PSI. If conditions warrant, use a vacuum cleaner.

> ⚠ ***CAUTION***
>
> ***When using compressed air, always use proper eye protection to prevent accidental eye injury.***

   D. When dirt and dust are solidly packed, or windings are coated with oil or greasy grime, disassemble the motor and clean with solvent. Use only high-flash naphtha, mineral spirits, or Stoddard solvent. Wipe with solvent dampened cloth, or use suitable soft bristled brush. ***DO NOT SOAK***. Oven dry (150 – 175°F) solvent cleaned windings thoroughly before reassembly.

   E. After cleaning and drying the windings, check the insulation resistance per Section **III, Item 3**.

VII. NON-REVERSE RATCHET

Units featuring non-reverse ratchets are refine-balanced by attaching weights to the rotating ratchet. If the ratchet is removed it should be marked and reassembled in the same position to retain proper balance.

VIII. ENDPLAY ADJUSTMENT

The term *endplay* is defined as the total axial float of the rotor. Should the motor be disassembled for any reason, the rotor endplay must be adjusted. Care must be taken to ensure that end play is within the proper range. Use one of the following procedures, depending upon the type of thrust bearing to set end play:

> ⚠ ***CAUTION***
>
> ***Excessive endplay can allow the thrust bearing to separate when units are run with zero thrust or momentary up thrust, resulting in thrust bearing failure. Insufficient endplay may cause the bearings to load against each other, resulting in extreme heat and rapid failure of both the guide and thrust bearings.***

1. Spherical Roller Thrust Bearings and Angular Contact Bearings (With Springs).

   Setting the correct end play on units with spring-preloaded spherical roller or angular contact thrust bearings requires a controlled assembly method, due to various deflections internal to the motor and friction of locknut threads from spring force. An end play setting of .005 to .008 inches is required to allow the lower guide bearing to return to an unloaded position when external thrust is applied to the motor (see Figure 5). End play can be properly adjusted by the following recommended procedure:

   A. Place spring retainer (without springs) and lower thrust washer of bearing into upper bearing bore.

   B. Using a depth micrometer, measure the distance between the top of the lower thrust washer and the faced surface on top of the bearing housing (see Figure 5). Record dimension to three decimals.

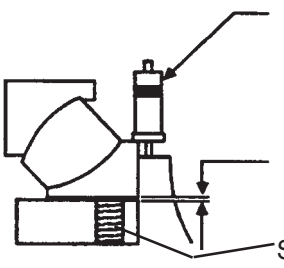
   C. Add .005 to .008 inches to the recorded dimension to obtain the correct endplay range for the unit.

   D. Reassemble bearing with springs. Motor is now ready to set end play. Several acceptable methods for setting endplay are following.

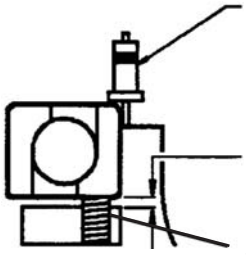
      NOTE: Certain motor builds require removal of the fabricated steel or cast aluminum oil baffle to provide access for depth micrometer measurements.

FIGURE 5

SPHERICAL ROLLER THRUST BEARING



ANGULAR CONTACT BEARING



2. Angular Contact Ball Bearings (Without Springs)

   A. No preliminary measurements are required to set end play. End play may be set by any of the following methods described in this section.

   B. To correctly adjust the endplay setting, a dial indicator should be positioned to read the shaft axial movement. (See figure 7 for location of dial indicator). The rotor adjusting lock nut should be turned until no further upward movement of the shaft is indicated. The locknut is then loosened until .005 to .008" endplay is obtained. Lock the locknut with lock washer.

> ⚠ ***CAUTION***
>
> ***Care should be taken to ensure that the locknut is not over-tightened, as this can lead to an erroneous end play setting (due to deflection of parts) and bearing damage may result.***

   C. Motors that have two opposed angular contact bearings that are locked for up and downthrust do not require endplay adjustment. The shaft, however, must be set to the original 'AH' (shaft extension length) to prevent the guide bearing from taking thrust.

ENDPLAY ADJUSTMENT METHODS

1. Method 1 (refer to Figures 6 & 7)

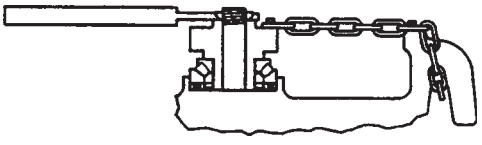
   This method requires the user to install a bolted chain from the bearing mount back to a lifting lug. Rotate the locknut with a spanner wrench (and bar extension) until dial indicator shows no movement on end of shaft. The locknut should then be loosened until proper endplay is obtained, lock the locknut with lock washer. (See figure 7 for location of dial indicator.)

   NOTE: This is the lowest cost of the three methods and requires the least amount of equipment. This method, however, may be less desirable than Method 2 as considerable locknut torque may be encountered on units with bearing preload springs.

Special equipment required:

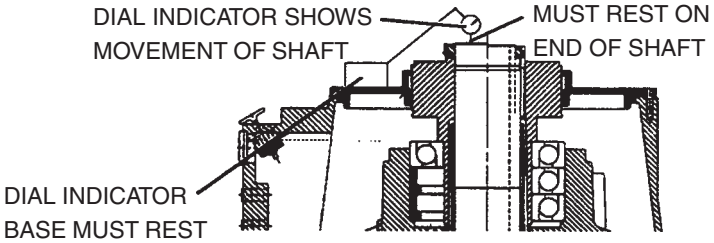
- Locking bolts
- 3/4" chain
- Spanner wrench with extension
- Dial indicator
- Depth micrometer

FIGURE 6 (METHOD 1)



MOUNTING SPRINGS ARE COMPRESSED AND ROTOR IS LIFTED BY LOCKNUT

FIGURE 7 (METHOD 1 & 3)



2. Method 2 (refer to Figure 8 - Utilized on Spring Loaded Bearings Only)

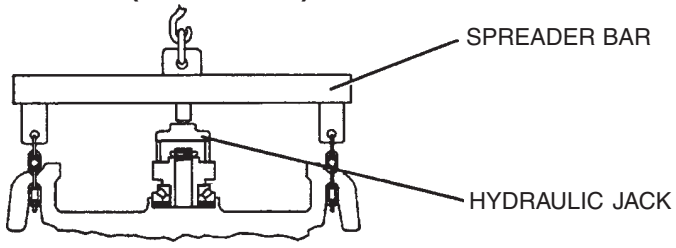
This method utilizes a spreader bar and chains to wrap around lifting lugs, a hydraulic jack (five ton), and crane to lift the spreader bar. The hydraulic jack is supported by two steel blocks of equal thickness on top of the bearing mounting with the jack pushing against the spreader bar. On large motors, the rotor can be lifted by placing a second jack below the motor shaft to allow the locknut to be turned easily.

NOTE: This method utilizes typical shop equipment and tools. Endplay settings can be checked quickly on larger vertical motor products. The locknut lifts rotor weight only.

Equipment required:
- Large spreader bar with chains and locking bolts
- Overhead crane
- Depth micrometer
- Spanner wrench
- Metal blocks
- 5-ton hydraulic jack
- Dial indicator

FIGURE 8 (METHOD 2)

MOUNTING SPRINGS ARE COMPRESSED – ONLY THE ROTOR IS LIFTED BY THE LOCKNUT.



3. Method 3 (refer to Figure 9)

This method uses a one inch thick steel disc with a center hole for the shaft end bolt and two threaded hydraulic jacks connected to a single pump. Apply load to hydraulic jacks until dial indicator shows no movement on end of shaft. (See figure 7 for location of dial indicator). The shaft locknut should be positioned and the pressure from hydraulic jack relieved until proper endplay is obtained.

⚠ CAUTION

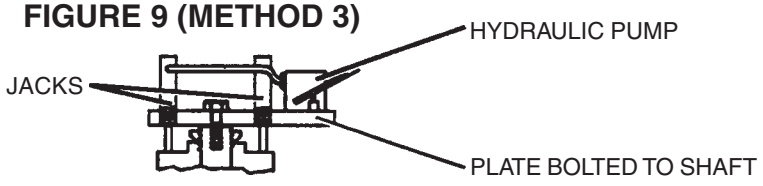
Use of excessive hydraulic pressure can damage bearings.

NOTE: This method is directly usable on solid shaft motors and can be used on most HOLLOSHAFT motors with the use of a long threaded rod and plate. It is easy to apply and settings can be checked quickly, especially in field service. The locknut does not see any force and can be turned easily.

Equipment required:
- Fixture with hydraulic jacks
- Dial indicator
- Spanner wrench

FIGURE 9 (METHOD 3)

MOUNTING SPRINGS ARE COMPRESSED AND ROTOR IS LIFTED BY THE FIXTURE. THE LOCKNUT IS TURNED FOR ADJUSTMENT.



⚠ CAUTION

After setting endplay, run unit for three to five minutes, then stop and verify the endplay setting. Readjust as necessary. All loosened or removed parts must be reassembled and tightened to original specifications. Keep all tools, chains, equipment, etc. clear of unit before energizing motor.

IX. LUBRICATION

Motor must be at rest and electrical controls should be locked open to prevent energizing while being serviced. If motor is being taken out of storage refer to Section **III "STORAGE"**, item 4 for instructions.

1. Oil Lubricated Bearings.

   Change oil once per year with normal service conditions. Frequent starting and stopping, damp or dusty environment, extreme temperature, or any other severe service conditions will warrant more frequent oil changes. If there is any question, consult Emerson Motor Co. Product Service Department for recommended oil change intervals regarding your particular situation.

   Determine required oil ISO Viscosity Grade (VG) and base oil type from Table 3, then see Table 4 for approved oils. Add oil into oil fill hole at each bearing housing until the oil level reaches between minimum and maximum marks located on the sight gauge window. It is important to wipe excess oil from the threads of the drain hole and to coat the plug threads with Gasoila P/N SS08, manufactured by Federal Process Corporation or equivalent thread sealant before replacing the drain plug. Plug should be tightened to a minimum of 20 lb.-ft. using a torque wrench. See the motor nameplate or Table 5 for the approximate quantity of oil required.

2. Grease Lubricated Bearings.

   A. Relubrication of Units in Service

      Grease lubricated bearings are pre-lubricated at the factory and normally do not require initial lubrication. Relubricating interval depends upon speed, type of bearing and service. Refer to Table 1 for suggested regreasing intervals and quantities. Note that operating environment and application may dictate more frequent lubrication.

      To relubricate bearings, remove the drain plug. Inspect grease drain and remove any blockage (caked grease or foreign particles) with a mechanical probe, taking care not to damage bearing.

⚠ *WARNING*

Under NO circumstances should a mechanical probe be used while the motor is in operation.

Add new grease at the grease inlet. New grease must be compatible with the grease already in the motor (refer to table 2 for compatible greases).

⚠ *CAUTION*

Greases of different bases (lithium, polyurea, clay, etc.) may not be compatible when mixed. Mixing such greases can result in reduced lubricant life and premature bearing failure. Prevent such intermixing by disassembling motor, removing all old grease and repacking with new grease per item B of this section. Refer to Table 2 for recommended greases.

Run the motor for 15 to 30 minutes with the drain plug removed to allow purging of any excess grease. Shut off unit and replace the drain plug. Return motor to service.

⚠ *CAUTION*

Overgreasing can cause excessive bearing temperatures, premature lubricant breakdown and bearing failure. Care should be exercised against overgreasing.

B. Change of Lubricant

Motor must be disassembled as necessary to gain full access to bearing housing(s).

Remove all old grease from bearings and housings (including all grease fill and drain holes). Inspect and replace damaged bearings. Fill bearing housings both inboard and outboard of bearing approximately 30 percent full of new grease. Grease fill ports must be completely charged with new grease. Inject new grease into bearing between rolling elements to fill bearing. Remove excess grease extending beyond the edges of the bearing races and retainers.

Table 1
Recommended Grease Replenishment Quantities & Lubrication Intervals

Bearing Number		Grease Replenishment Quantity (Fl. Oz.)	Lubrication Interval		
62xx, 72xx	63xx, 73xx		1801 thru 3600 RPM	1201 thru 1800 RPM	1200 RPM and slower
03 thru 07	03 thru 06	0.2	1 Year	2 Years	2 Years
08 thru 12	07 thru 09	0.4	6 Months	1 Year	1 Year
13 thru 15	10 thru 11	0.6	6 Months	1 Year	1 Year
16 thru 20	12 thru 15	1.0	3 Months	6 Months	6 Months
21 thru 28	16 thru 20	1.8	3 Months	6 Months	6 Months

Refer to motor nameplate for bearings provided on a specific motor.

For bearings not listed in Table 1, the amount of grease required may be calculated by the formula:

$$G = 0.11 \times D \times B$$

Where: G = Quantity of grease in fluid ounces.
D = Outside diameter of bearing in inches.
B = Width of bearing in inches.

Table 2
Recommended Greases

Motor Frame Size	Motor Enclosure	Grease Manufacturer	Grease (NLGI Grade 2)
All Thru 447	All	Chevron USA, Inc. Exxon Mobil	Grease No. 83343 SRI No. 2 Polyrex-EM
449 and Up	Open Dripproof		
449 and Up	TEFC and Explosionproof	Exxon Mobil	Grease No. 974420 Mobilith SHC-100

The above greases are interchangeable with the grease provided in units supplied from the factory (unless stated otherwise on motor lubrication nameplate).

Table 3
Emersom Motor Co. Recommended Oil Viscosities

Angular Contact Thrust Bearing (7XXX Series)					
Motor Enclosure	**Frame Size**	**Speed (RPM)**	**Ambient Temperature**	**ISO VG**	**Base Oil Type**
Open Dripproof or Weather Protected	324 and Larger	All	-15C thru 40C (5-104F)	32	Mineral or Synthetic
			41C thru 50C (105-122F)	68	Synthetic Only
Totally Enclosed or Explosionproof	404 thru 447		-15C thru 40C (5-104F)	32	Mineral or Synthetic
			41C thru 50C (105-122F)	68	Synthetic Only
	449 thru 5811	1801 - 3600	-15C thru 40C (104F)	32	Synthetic Only
		1800 & Below		68	Synthetic Only
		All	41C thru 50C (105-122F)	Refer to Office	

Spherical Roller Thrust Bearing (29XXX Series)					
Motor Enclosure	**Frame Size**	**Speed (RPM)**	**Ambient Temperature**	**ISO VG**	**Base Oil Type**
Open Dripproof or Weather Protected	444 and Larger	1800 and Below	-15C thru 25C (5-77F)	68	Mineral or Synthetic
			6C thru 40C (42-104F)	150	
			41C thru 50C (105-122F)		Synthetic Only
Totally Enclosed or Explosionproof	449 and Larger		-15C thru 25C (5-77F)	68	Mineral or Synthetic
			6C thru 40C (42-104F)	150	Synthetic Only
			41C thru 50C (105-122F)	Refer to Office	

Notes:
1. If lower guide bearing is oil lubricated, it should use the same oil as the thrust bearing.
2. If lower guide bearing is grease-lubricated, refer to TABLE 2 for recommended greases.
3. Refer to Emerson Motor Co. for ambient temperatures other than those listed.

Table 4
Emerson Motor Co. Approved Oil Specifications For Use With Anti-Friction Bearings

Oil Manufacturer	**ISO VG 32**		**ISO VG 68**		**ISO VG 150**	
	Viscosity: 130-165 SSU @ 100F		**Viscosity: 284-347 SSU @ 100F**		**Viscosity: 620-765 SSU @ 100F**	
	Mineral Base Oil	**Synthetic Base Oil**	**Mineral Base Oil**	**Synthetic Base Oil**	**Mineral Base Oil**	**Synthetic Base Oil**
Chevron USA, Inc	GST Turbine Oil 32	Tegra 32	GST Turbine Oil 68	Tegra 68	R&O Machine Oil 150	Tegra 150
Conoco Oil Co.	Hydroclear Turbine Oil 32	Syncon 32	Hydroclear Turbine Oil 68	Syncon 68	Hydroclear AW Hyd. Fluid 150	N/A
ExxonMobil	Teresstic 32	Synnestic 32	Teresstic 68	Synnestic 68	Teresstic 150	Synnestic 150
ExxonMobil	DTE Oil Light	SHC 624	DTE Oil Heavy Medium	SHC 626	DTE Oil Extra Heavy	SHC 629
Pennzoil Co., Inc	Pennzbell TO 32	Pennzbell SHD 32	Pennzbell TO 68	Pennzbell SHD 68	Pennzbell TO 150	Pennzbell SHD 150
Phillips Petroleum Co.	Magnus 32	Syndustrial "E" 32	Magnus 68	Syndustrial "E" 68	Magnus 150	N/A
Shell Oil Co.	Tellus 32	Tellus HD Oil AW SHF 32	Tellus 68	Tellus HD Oil AW SHF 68	Tellus 150	N/A
Texaco Lubricants Co.	Regal 32	Cetus PAO 32	Regal 68	Cetus PAO 68	Regal 150	N/A

Table 5
Approximate Oil Sump Capacities

Frame Size	Motor Type Designation (See Motor Nameplate)	Oil Capacity (Quarts)	
		Upper Bearing	Lower Bearing
180 - 280	AU, AV-4	Grease	Grease
180 - 280	AV		
320 - 440	RV		
320 - 360	RV-4, RU	3	
400	RV-4, RU	5	
440	RV-4 (2 pole)	17	
	RV-4, RU (4 pole & slower, w/ ang contact thrust brg.)	6	
	(4 pole & slower, w/ spherical thrust brg.)	4	
180 - 440	TV-9, TV, LV-9, LV	Grease	
180 -360	TV-4, TU, LV-4, LU		
400	TV-4, TU, LV-4, LU	6	
440	TV-4, TU, LV-4, LU	5	
449	JU, JV-4	22	
	HU, HV-4	12	
	JV-3, JV, HV	Grease	
5000	HV, EV, JV, RV	Grease	
	RU, RV-4	30	
	HU, HV-4 (4 pole & slower)	12	
	HV-4 (2 pole only)	20	
	EU, JU, EV-4, JV-4	22	5
5800	HU, HV-4	24	3
	EU, JU, EV-4, JV-4	37	4
6800	HU, HV-4	70	3
	HV (Bow Thruster)	Grease	Grease
	HV (Other Than Bow Thruster)	70	3
8000	RU, RV-4	70	6
	RV	Grease	Grease
9600	RU, RV-4	64	13
	RV	Grease	Grease

X. FUNDAMENTAL TROUBLESHOOTING - PROBLEM ANALYSIS

This chart can reduce work and time spent on motor analysis. Always check the chart first before starting motor disassembly, as what appears to be a motor problem may often be located elsewhere. For additional information, consult our website at www.usmotors.com.

SYMPTOM	PROBABLE CAUSE	ANALYSIS
Motor fails to start	Defective power supply	Check voltage across all phases above disconnect switch.
	Blown or defective primary fuses	
	Blown or defective secondary fuses	Check voltage below fuses (all phases) with disconnect closed.
	Open control circuit	Push reset button.
	Overload trips are open	
	Defective holding coil in magnetic switch	Push start button and allow sufficient time for operation of time delay, if used, then check voltage across magnetic holding coil. If correct voltage is measured, coil is defective. If no voltage is measured, control circuit is open.
	Loose or poor connections in control circuits.	Make visual inspection of all connections in control switch.
	Magnetic switch closes	Open manual disconnect switch, close magnetic by hand, and examine contractors and springs.
	Poor switch contact	
	Open circuit in control panel	Check voltage at Tl, T2, & T3
	Open circuit in leads to motor	Check voltage at leads in outlet box
	Leads improperly connected	Check lead numbers and connections.
Motor fails to come up to speed	Low or incorrect voltage	Check voltage at Tl, T2, & T3 in control panel and at motor leads in outlet box.
	Incorrect connection at motor	Check for proper lead connections at motor and compare with connection diagram on motor.
	Overload - mechanical	Check impeller setting. Check for a tight or locked shaft.
	Overload - hydraulic	Check impeller setting. Check GPM against pump capacity and head.
Motor Vibrates	Headshaft misaligned	Remove top drive coupling and check alignment of motor to pump.
	Worn line shaft bearings or bent line shaft	Disconnect motor from pump and run motor only to determine source of vibration.
	Hydraulic disturbance in discharge piping	Check isolation joint in discharge piping near pump head.
	Ambient Vibration	Check base vibration level with motor stopped.
	System Natural Frequency (Resonance)	Revise rigidity of support structure.
Motor noisy	Worn thrust bearing	Remove dust cover, rotate rotor by hand, and make visual examination of balls and races. Bearing noise is commonly accompanied by a high frequency vibration and/or increased temp.
	Electrical noise	Most motors are electrically noisy during the starting period. This noise should diminish as motor reaches full speed.

SYMPTOM	PROBABLE CAUSE	ANALYSIS
Motor overheating (Check with thermocouple or by resistance methods. Do not depend on hand.)	Overload	Measure load and compare to nameplate rating. Check for excessive friction in motor or in complete drive. Reduce load or replace motor with greater capacity motor. Refer to Appendix C.
	Motor intake or exhaust blocked or clogged.	Clean motor intake and exhaust areas. Clean filters or screens if motor is so equipped.
	Unbalanced voltage	Check voltage to all phases. Refer to Appendix A.
	Open stator windings	Disconnect motor from load. Check idle amps for balance in all three phases. Check stator resistance in all three phases.
	Over / Under Voltage	Check voltage and compare to nameplate voltage.
	Ground	Locate with test lamp or insulation tester and repair.
	Improper Connections.	Recheck connections.
Bearing Overheating Generally, bearing tempatures (as measured by a tipsensitive RTD or thermocouple touching the bearing outer race) should not exceed 90°C when using mineral-based lubricants or 120°C when using synthetic-based lubricants.	Misalignment	Check alignment.
	Incorrect oil, or oil level too high or too low.	Refill with proper oil. Verify oil level is correct.
	Excessive thrust.	Reduce thrust from driven machine.
	Bearing over-greased.	Relieve bearing cavity of grease to level specified in lubrication section.
	Motor overloaded	Measure load and compare to nameplate rating. Check for excessive friction in motor or in complete drive. Reduce load or replace motor with greater capacity motor. Refer to Appendix C.
	Motor intake or exhaust blocked or clogged.	Clean motor intake and exhaust areas. Clean filters or screens if motor is so equipped.
Bearing oil leaking around the drain plug.	Insufficient sealant applied to drain plug threads.	Remove drain plug and drain existing oil from sump. With a clean cloth, wipe excess oil from the plug threads and the threads in the drain hole. Apply Gasoila Thread Sealant P/N SS08 to the threads of the plug and replace. Fill sump with new oil to the proper level.

XI. SPARE PARTS

A parts list is available for your unit and will be furnished upon request. Parts may be obtained from local Emerson Motor Co. distributors and authorized service shops, or through Emerson Motor Co. distribution center.

Emerson Motor Co.
710 Venture Drive
Suite 100
Southaven, MS 38672
Phone (662) 342-6910
Fax (662) 342-7350

Drawings for many standard designs are supplied on the following pages. Most of the parts should be easy to identify. If however, there is some deviation from your machine, consult the factory for assistance.

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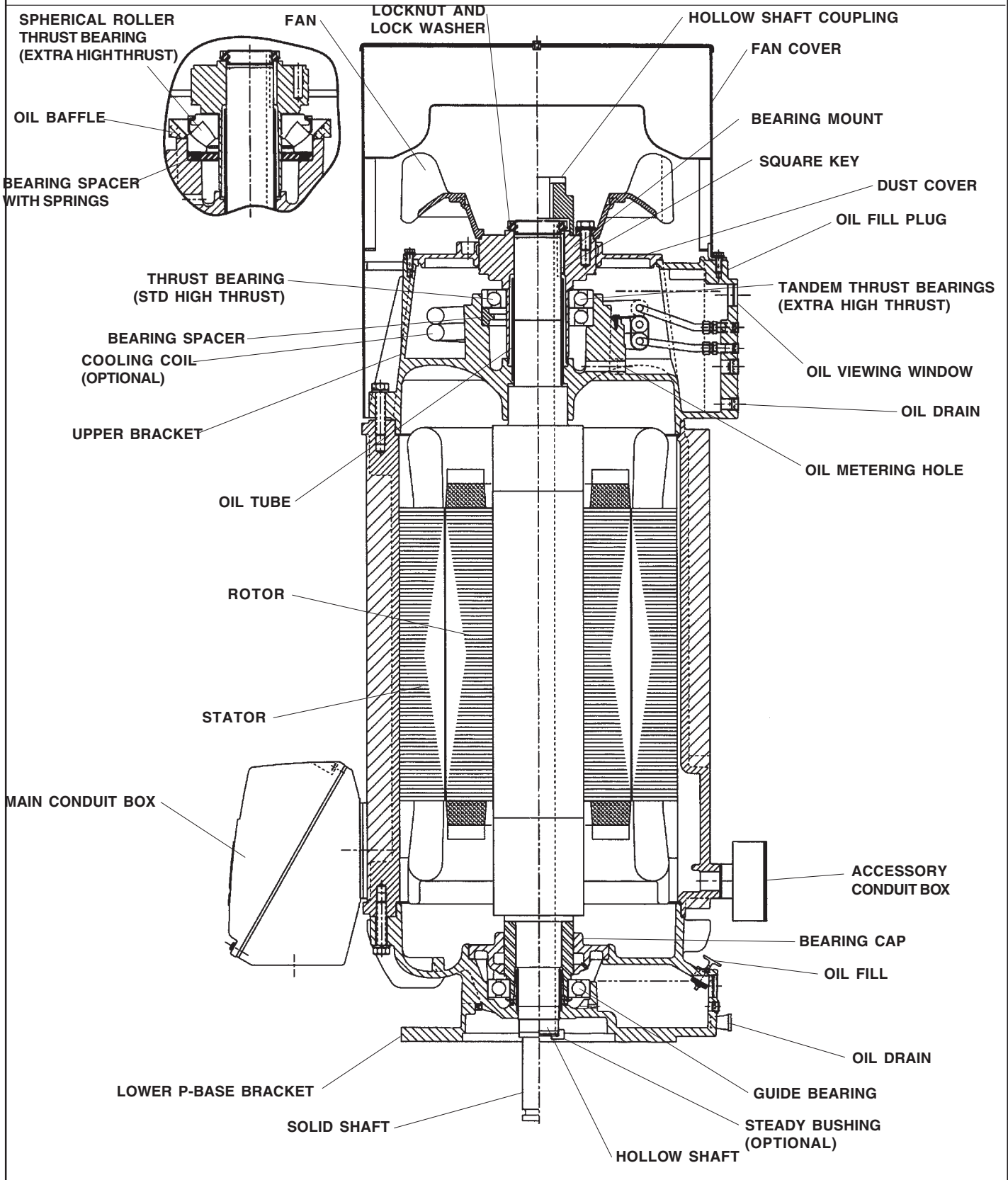

SPHERICAL ROLLER THRUST BEARING (EXTRA HIGH THRUST)
FAN
LOCKNUT AND LOCK WASHER
HOLLOW SHAFT COUPLING
FAN COVER
OIL BAFFLE
BEARING MOUNT
SQUARE KEY
BEARING SPACER WITH SPRINGS
DUST COVER
OIL FILL PLUG
THRUST BEARING (STD HIGH THRUST)
TANDEM THRUST BEARINGS (EXTRA HIGH THRUST)
BEARING SPACER
COOLING COIL (OPTIONAL)
OIL VIEWING WINDOW
OIL DRAIN
UPPER BRACKET
OIL METERING HOLE
OIL TUBE
ROTOR
STATOR
MAIN CONDUIT BOX
ACCESSORY CONDUIT BOX
BEARING CAP
OIL FILL
OIL DRAIN
LOWER P-BASE BRACKET
GUIDE BEARING
SOLID SHAFT
STEADY BUSHING (OPTIONAL)
HOLLOW SHAFT

Installation Record

NAMEPLATE AND INSTALLATION INFORMATION

SERIAL NUMBER OR MODEL NUMBER ..... _____
HORSEPOWER ..... _____
MOTOR RPM ..... _____
PHASE ..... _____
FREQUENCY ..... _____
AMPS ..... _____ AT _____ VOLTS
DESIGN ..... _____
FRAME ..... _____
TYPE ..... _____
DATE PURCHASED ..... _____ P.O. NUMBER _____
DATE INSTALLED ..... _____
LOCATION OF JOB SITE ..... _____
MACHINE OR INSTALLATION NUMBER ..... _____
PURCHASED FROM ..... _____
MOTOR RESISTANCE LINE TO LINE AT TIME OF INSTALLATION ..... _____

INSULATION TO GROUND READING AT TIME OF INSTALLATION ..... _____

RECORD OF MAINTENANCE

GRADE AND TYPE OF LUBRICANT USED ..... _____

DATE OF LAST RELUBRICATION	INSULATION RESISTANCE		OVERHAUL OR REPAIR	
	DATE	MEGOHMS	DATE	ACTION

Table 6
Threaded Fastener Torque Requirements

All threaded fasteners used for rigid joints (cast iron and low carbon steel) in products of Emerson Motor Co., are to be tightened to the torque values listed in the following tabulation. Values are based upon dry assembly.

Diameter of Fastener	Number of Threads Per Inch	Grade5 Fasteners	Grade 2 Fasteners
#6	32	16 lb.-in.	10 lb.-in
	40	18	12
#8	32	30	19
	36	31	20
#10	24	43	27
	32	49	31
#12	24	66	37
	28	72	40
1/4"	20	96	66
	28	120	76
5/16"	18	16 lb.-ft.	11 lb.-ft.
	24	18	12
3/8"	16	29	20
	24	34	23
7/16"	14	46	30
	20	52	35
1/2"	13	70	50
	20	71	55
9/16"	12	102	
	18	117	
5/8"	11	140	
	18	165	
3/4"	10	249	
	16	284	
7/8"	9	401	
	14	446	
1"	8	601	
	14	666	
1-1/8"	7	742	
	12	860	
1-1/4"	7	1046	
	12	1196	
1-3/8"	6	1371	
	12	1611	
1-1/2	6	1820	
	12	2110	

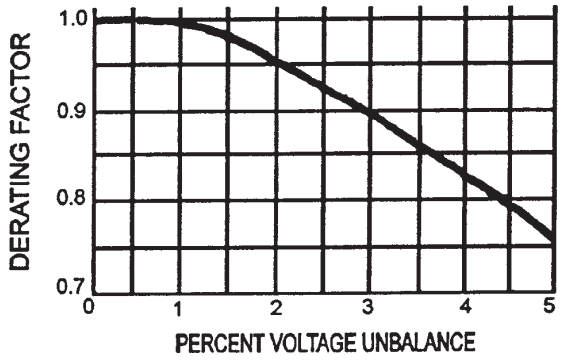
The above torque limits are not to be used when a drawing or specification lists a specific torque.

Effects of Unbalanced Line Voltage.

A potential cause of premature motor failure is unbalanced line (supply) voltage. Three phase motors produce useful work when they efficiently convert electrical energy into mechanical energy. This is accomplished when each phase of the supply voltage is of equal strength and works in harmony to produce a rotating magnetic field within the motor.

When the value of supply voltage leg to leg is not equal (e.g. 460-460-460), the risk of unbalanced line voltage is present. If this voltage unbalance exceeds about 1%, excessive temperature rise will result. Unless the motor HP capacity is derated to compensate, the motor will run hot resulting in degradation of the insulation system and bearing lubricant.

From NEMA MG-1, 14.36: Derating factors due to unbalanced line voltage



Example: Field ratings of Phase A - 480 v, Phase B = 460 v, Phase C = 450 v

As a rule of thumb, the percentage increase in temperature rise will be about two times the square of the percentage voltage unbalance. In this case the average voltage (480 + 460 + 450) is equal to 463 volts. The maximum deviation between legs is 17 volts (480 - 463 volts).

The Percentage voltage unbalance is determined as follows: 17 / 463 x 100 = 3.7%. The temperature rise will then increase $(3.7)^2$ x 2 = 27%. This condition will reduce the typical life of your motor to less than 25% of its design life. Should this condition be present, call your electric utility and resolve your unbalanced supply condition.

Other areas of motor performance will also be effected - e.g., loss of torque capacity, change in full load RPM, greatly unbalanced current draw at normal operating speed. Refer to NEMA MG-1 section 14.36 for details.

Motors Applied to Variable Frequency Drives (VFD's).

Electric motors can be detrimentally affected when applied with variable frequency drives (VFD's). The non-sinusoidal waveforms of VFD's have harmonic content which causes additional motor heating; and high voltage peaks and short rise times, which result in increased insulation stress, especially when long power cable lengths are used. Other affects of VFD's on motor performance include reduced efficiency, increased load current, vibration and noise. Standard motors utilized with VFD's must be limited to those application considerations defined in NEMA MG-1 Part 30.

NEMA MG-1 Part 31 defines performance and application considerations for Definite-Purpose Inverter Fed motors. To insure satisfactory performance and reliability, Emerson Motor Co. offers and recommends nameplated inverter duty motor products which meet the requirements of NEMA MG-1 Part 31. The use of non-inverter duty motors may result in unsatisfactory performance or premature failure, which may not be warrantable under the Terms and Conditions of Sale. Contact your Emerson Motor Co. Field Sales Engineer for technical assistance in motor selection, application and warranty details.

ELECTRIC MOTOR LOAD TEST USING THE WATT HOUR METER

In the analysis of electric motors it is sometimes desirable to conduct an accurate load check on a particular installation to determine whether the motor is operating within the rating and horsepower for which it was designed. Since most pump installations have their own watt hour power meters, accurate readings will permit a load check via the following formula:

K = Disc constant (watts per revolution of disc per hour). This is typically found on the meter face.

R = Revolutions of disc in watt meter within the time of the test.

T = Time of test, in seconds.

Transformer ratio = Stated on meter face. Must be included where current transformers are used with watt meters.

To obtain input kilowatts:

$$\text{Input KW} = \frac{K \times R \times 3.6}{T}$$

To obtain input horsepower:

$$\text{Input HP} = \frac{K \times R \times 4.83 \times \text{Transformer Ratio}}{T}$$

The watt hour meter measures power consumed over a period of time. It is necessary to establish the rate at which power is being consumed by the work being done. We establish this rate by counting the revolutions of the disc in a given time. Here is a typical example of a load check:

GIVEN

- Pump motor to be load checked is rated 100 HP, 1800 RPM, 3-phase, 60 Hz, 1.15 service factor, 91.0 Percent Efficiency.
- Disc constant (K) found on face of meter = 40.
- Transformer ratio found on face of meter = 3.

DATA FOUND FROM TESTS
With stop watch, disc was observed to revolve 10 times in exactly 49 seconds. Therefore, R = 10; T = 49.

THUS

$$\text{Input HP} = \frac{40 \times 10 \times 4.83 \times 3}{49} = 118.29$$

Output HP = Input HP x Motor Efficiency
Output HP = 118.29 x 91% = 107.54

CONCLUSION
The output HP (107.54) is greater than output HP shown on nameplate (100 HP), but is well within the 1.15 service factor which applies to this motor.

Associate Member

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CITY OF ANDERSON, INDIANA

WATER QUALITY CONTROL PROJECT

HONORABLE ROBERT L. ROCK, MAYOR

BOARD OF PUBLIC WORKS

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RAYMOND NUCE - MEMBER
LLOYD MELLENTHIN - MEMBER

DIVISION II

WASTEWATER FORCE MAIN

HENRY B. STEEG & ASSOCIATES

A DIVISION OF

HOWARD NEEDLES TAMMEN & BERGENDOFF

ENGINEERS

INDIANAPOLIS, INDIANA

CERTIFIED
HENRY B. STEEG & ASSOCIATES
A DIVISION OF HOWARD NEEDLES TAMMEN & BERGENDOFF
BY:

GEORGE K. ERGANIAN, PARTNER
REGISTERED ENGINEER NO. 4439
STATE OF INDIANA

GEORGE K. ERGANIAN — REGISTERED — No. 4439 — STATE OF INDIANA — PROFESSIONAL ENGINEER

APPROVED July 22, 1974
BOARD OF PUBLIC WORKS
ANDERSON, INDIANA
ROBERT L. ROCK - MAYOR

BY _____
CHESTER T. LAWRENCE - CHAIRMAN

BY _____
RAYMOND H. NUCE

BY _____
LLOYD R. MELLENTHIN

BY _____
LLOYD LINE - ACTING CITY ENGINEER

BY _____
A.E. HOLLENBECK - SUPERINTENDENT

SET NO. [redacted]

MARBAUGH (Borders Only)

MOSS ISLAND ROAD PLANT

N

WHITE RIVER

WHITE RIVER

New Clean-Out

Existing 30" Force Main Approx. Cover 4'-6"

Concrete Pavement Rd.

Existing 6" C.I.

Slope To Drain

Digester Control Building

Air Relief

New Clean-Out

Water Level 833.8

Waste Pond

Tank

Existing 36" Force Main Approx. Cover 7'-0"

New Clean-Out

Pavement Repair

Air Relief

Repair Lawns & Dones

Replace Fences

New Clean-Out

P.R. Crossing Air Relief

Existing 30" Force Main Approx. Cover 6'-0"

New Clean-Out

Proposed 36" D.I. Force Main

Existing 6" C.I.

Proposed 36" D.I. Force Main

Water Level 829.8

Raible Ave.

8th St.

St. Rd.

488,000 E

488,500 E

487,000 E

486,500 E

486,000 E

DEWEY STREET PLANT

CITY OF ANDERSON, INDIANA
WATER QUALITY CONTROL PROJECT

WASTEWATER FORCE MAIN

LOCATION PLAN

JOB NO. 109900

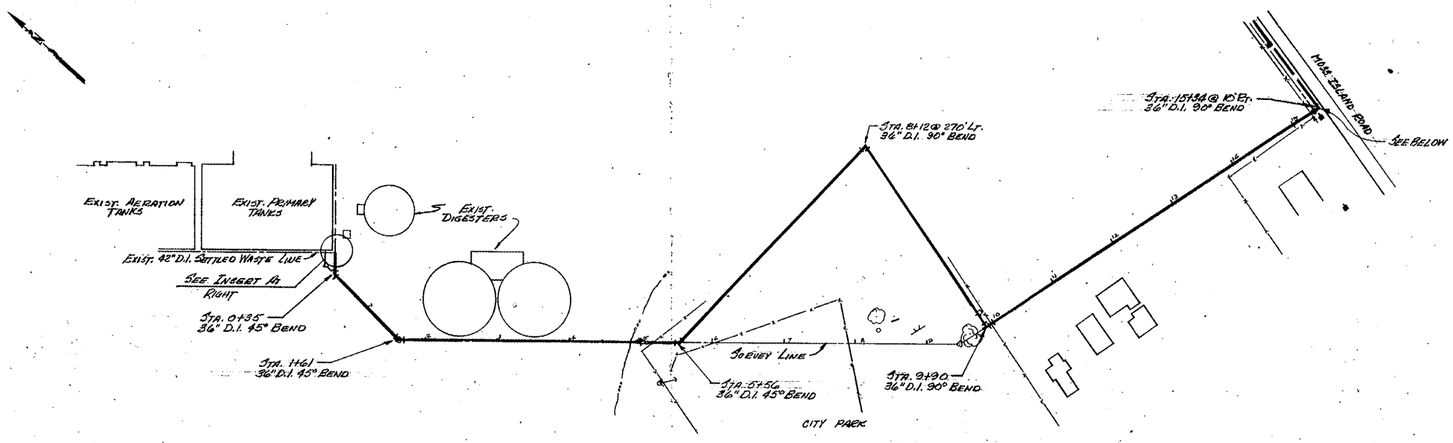
DIV. II

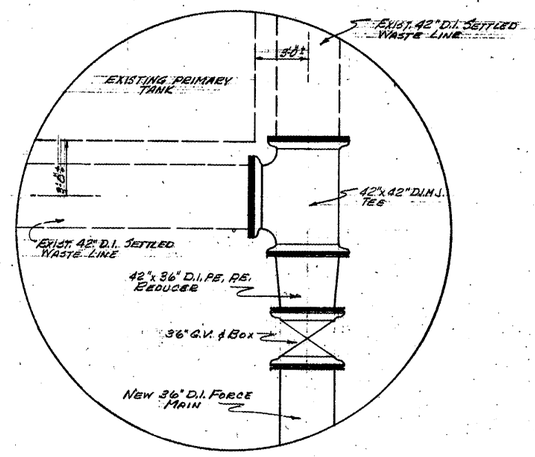
DATE 6-3-77

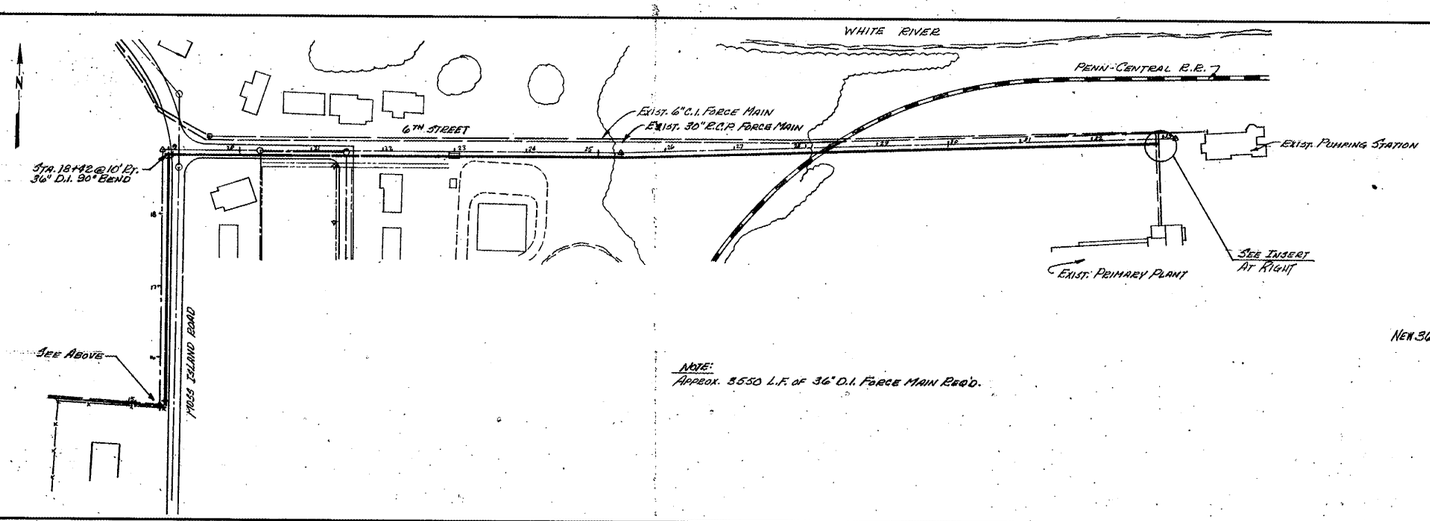
HENRY B. STEEG & ASSOCIATES, INC.
ENGINEERS
4650 NORTH PENNSYLVANIA STREET
INDIANAPOLIS, INDIANA

SHEET NO. 1

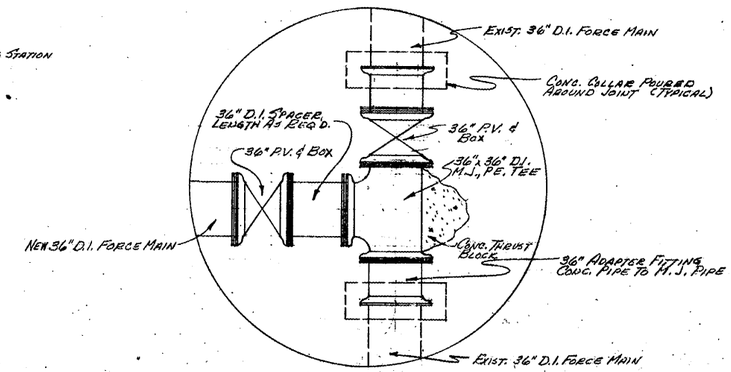
SCALE 1"=100'

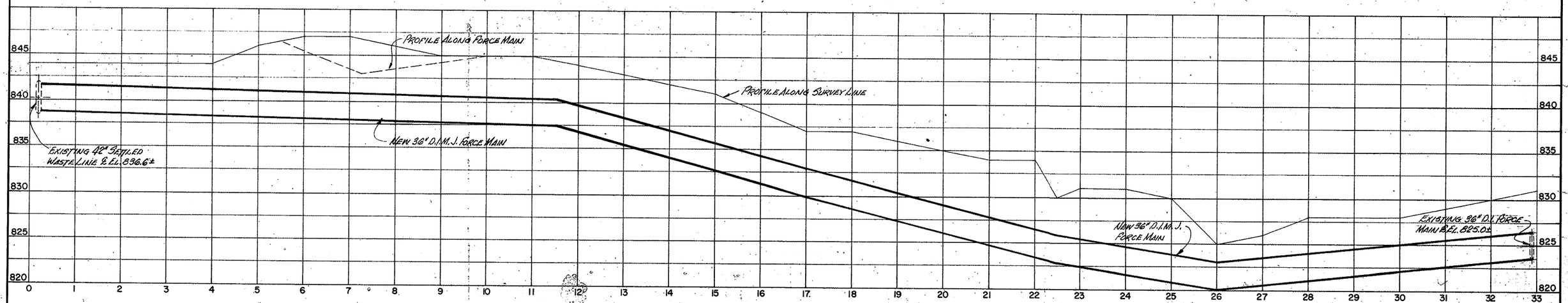






NOTE:
APPROX. 3550 L.F. OF 36" D.I. FORCE MAIN REQ'D.





SYMBOL	REVISIONS	BY	DATE	APPROVED

DESIGNED	
DRAWN	
TRACED	
CHECKED	
CERTIFIED	DATE
BY	

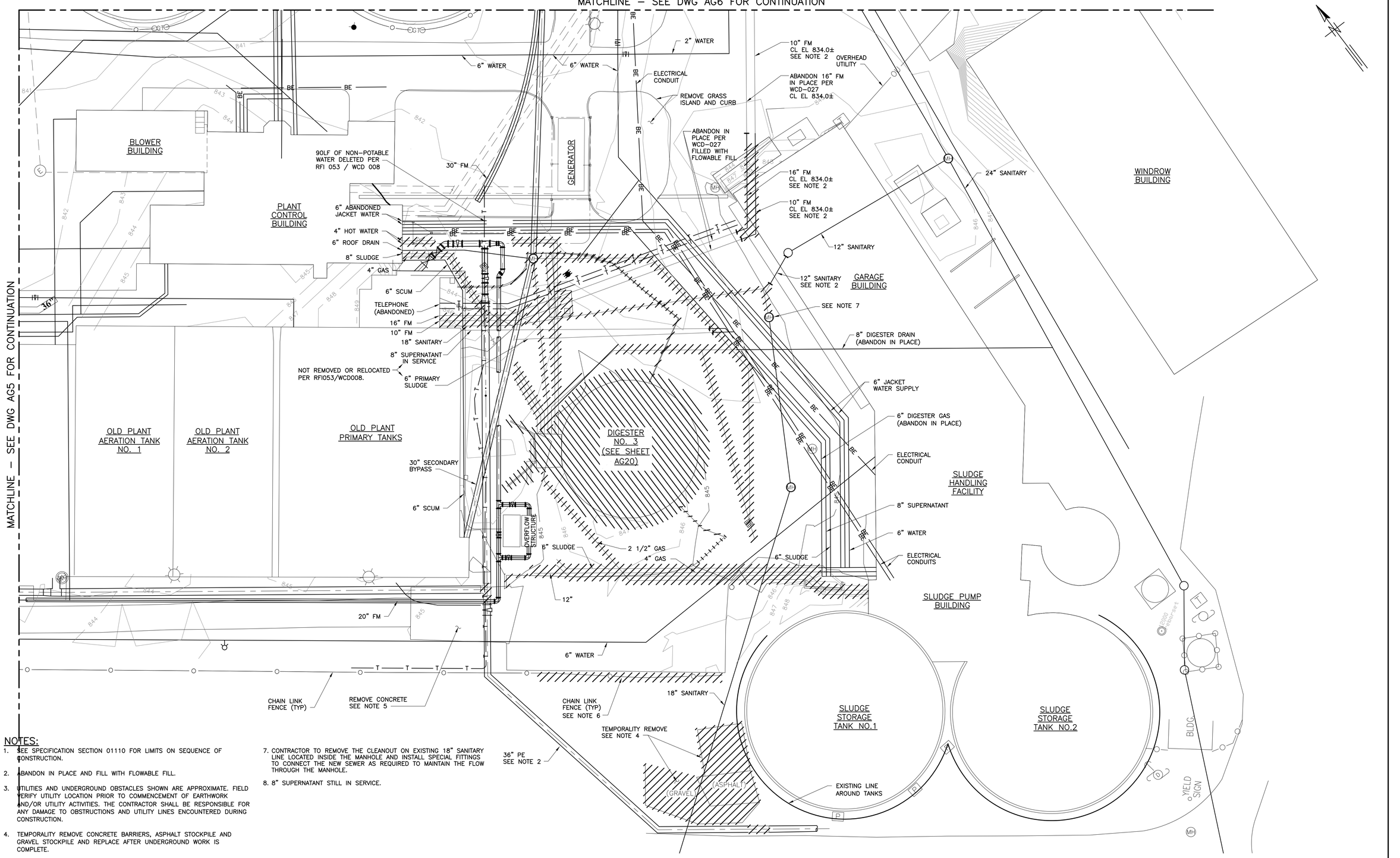
Henry B. Steeg & Associates, inc.
Engineers
4930 NORTH PENNSYLVANIA STREET
INDIANAPOLIS, INDIANA 46205

JOB NO. 109900
DIV. II
DATE 6-21-73

CITY OF ANDERSON, INDIANA
WATER QUALITY CONTROL PROJECT
WASTEWATER FORCE MAIN
FORCE MAIN
PLAN & DETAILS

SHEET NO. 2
SCALE 1"=100'

MARBAUGH-10-9136



NOTES:

1. SEE SPECIFICATION SECTION 01110 FOR LIMITS ON SEQUENCE OF CONSTRUCTION.
2. ABANDON IN PLACE AND FILL WITH FLOWABLE FILL.
3. UTILITIES AND UNDERGROUND OBSTACLES SHOWN ARE APPROXIMATE. FIELD VERIFY UTILITY LOCATION PRIOR TO COMMENCEMENT OF EARTHWORK AND/OR UTILITY ACTIVITIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO OBSTRUCTIONS AND UTILITY LINES ENCOUNTERED DURING CONSTRUCTION.
4. TEMPORALITY REMOVE CONCRETE BARRIERS, ASPHALT STOCKPILE AND GRAVEL STOCKPILE AND REPLACE AFTER UNDERGROUND WORK IS COMPLETE.
5. REMOVE CONCRETE SLAB AND RESTORE AFTER UNDERGROUND WORK IS COMPLETE.
6. REMOVE CHAIN LINK FENCE AND RESTORE NEW AFTER SITE WORK IS COMPLETE.
7. CONTRACTOR TO REMOVE THE CLEANOUT ON EXISTING 18" SANITARY LINE LOCATED INSIDE THE MANHOLE AND INSTALL SPECIAL FITTINGS TO CONNECT THE NEW SEWER AS REQUIRED TO MAINTAIN THE FLOW THROUGH THE MANHOLE.
8. 8" SUPERNATANT STILL IN SERVICE.

GENE GUSTIN WAY –ENLARGED EXISTING AND ULTILITY DEMOLITION PLAN 3

SCALE: 1"=20'

RECORD DRAWING

THIS RECORD IS NOT WARRANTED BUT IS BELIEVED TO REPRESENT CONDITIONS UPON COMPLETION OF CONSTRUCTION WITHIN REASONABLE TOLERANCES, BASED UPON THE INFORMATION FURNISHED TO THE ENGINEER PERTAINING TO CHANGES MADE DURING CONSTRUCTION.

GREELEY AND HANSEN
7820 Innovation Boulevard, Suite 150
INDIANAPOLIS, INDIANA 46278

DESIGNED	KLC
DRAWN	WAL
CHECKED	GED
APPROVED	

NO.	DATE	APPD	REVISION
2	12/2013	KLC	RECORD DRAWING REVISIONS

SCALE
20 0 20 40 FT
1"=20'

CITY OF ANDERSON, INDIANA
WATER POLLUTION CONTROL PLANT
FACILITY IMPROVEMENTS
DIVISION II

GENERAL
GENE GUSTIN WAY
ENLARGED EXISTING SITE AND UTILITY DEMOLITION PLAN 3

FILE NAME 01798FAG07.DWG
DWG AG7
SHEET 7 OF 186
DATE SEPTEMBER 2011 REV 2

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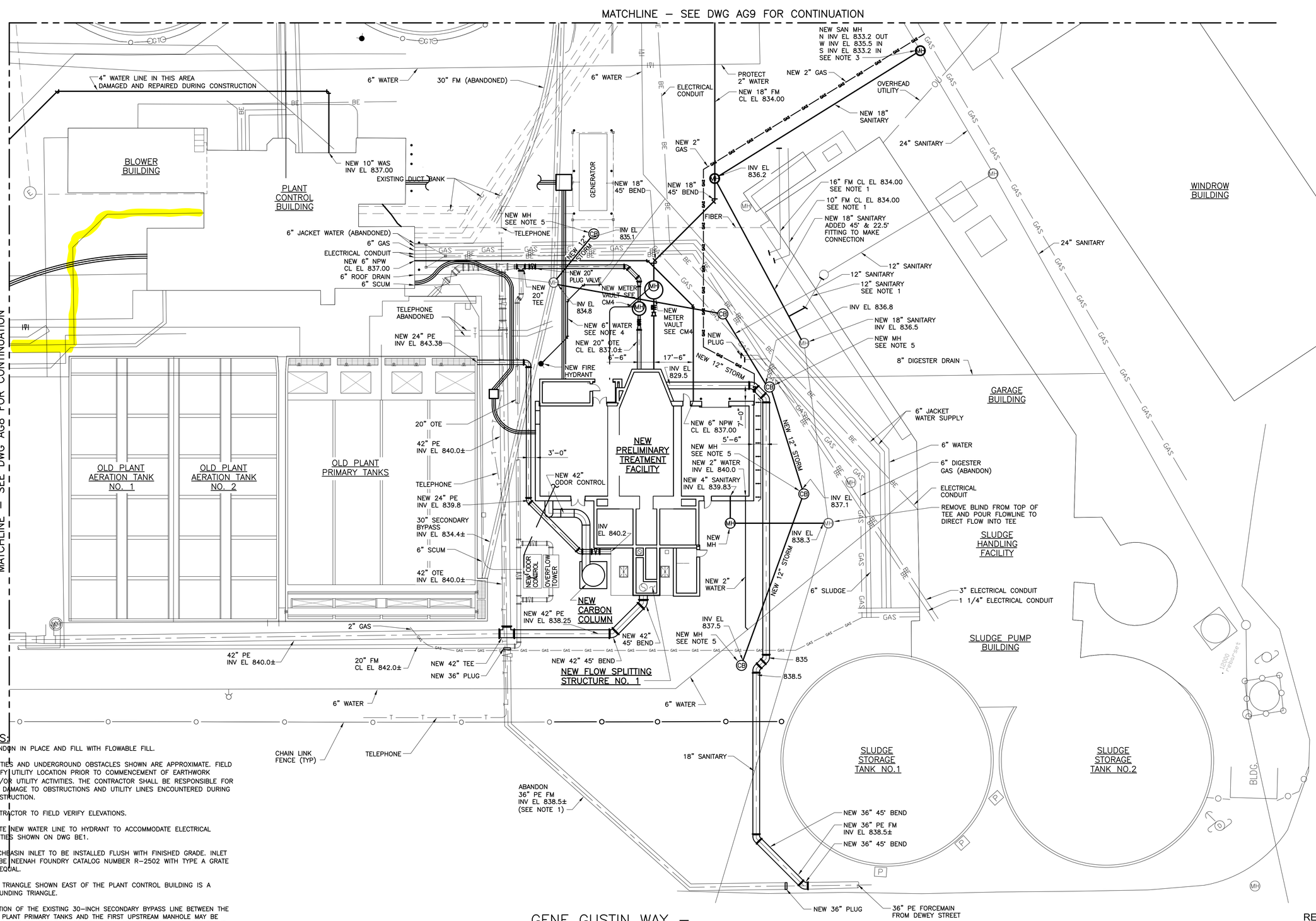

NOTES:

1. ABANDON IN PLACE AND FILL WITH FLOWABLE FILL.
2. UTILITIES AND UNDERGROUND OBSTACLES SHOWN ARE APPROXIMATE. FIELD VERIFY UTILITY LOCATION PRIOR TO COMMENCEMENT OF EARTHWORK AND/OR UTILITY ACTIVITIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO OBSTRUCTIONS AND UTILITY LINES ENCOUNTERED DURING CONSTRUCTION.
3. CONTRACTOR TO FIELD VERIFY ELEVATIONS.
4. ROUTE NEW WATER LINE TO HYDRANT TO ACCOMMODATE ELECTRICAL UTILITIES SHOWN ON DWG BE1.
5. CATCHBASIN INLET TO BE INSTALLED FLUSH WITH FINISHED GRADE. INLET TO BE NEENAH FOUNDRY CATALOG NUMBER R–2502 WITH TYPE A GRATE OR EQUAL.
6. THE TRIANGLE SHOWN EAST OF THE PLANT CONTROL BUILDING IS A GROUNDING TRIANGLE.
7. PORTION OF THE EXISTING 30–INCH SECONDARY BYPASS LINE BETWEEN THE OLD PLANT PRIMARY TANKS AND THE FIRST UPSTREAM MANHOLE MAY BE ABANDONED TO FACILITATE CONSTRUCTION OF NEW PRELIMINARY TREATMENT FACILITY. CONTRACTOR TO VERIFY NO LIVE CONNECTIONS IN SECTION TO BE ABANDONED. PLUG THE LINE AT FIRST UPSTREAM MANHOLE AND FILL SECTIONS REMAINING WITH FLOWABLE FILL.

GENE GUSTIN WAY – ENLARGED NEW SITE AND UTILITY PLAN 3

SCALE: 1"=20'

RECORD DRAWING

THIS RECORD IS NOT WARRANTED BUT IS BELIEVED TO REPRESENT CONDITIONS UPON COMPLETION OF CONSTRUCTION WITHIN REASONABLE TOLERANCES, BASED UPON THE INFORMATION FURNISHED TO THE ENGINEER PERTAINING TO CHANGES MADE DURING CONSTRUCTION.

FILE: J:\Projects\01798F Anderson WPC Improvements – Div 2\21 CADD Files\21.110 Conformed Drawings\01798FAG10 1:1 01/27/12 15:10 GH–H

GREELEY AND HANSEN
7820 Innovation Boulevard, Suite 150
INDIANAPOLIS, INDIANA 46278

DESIGNED KLC
DRAWN WAL
CHECKED GED

APPROVED

NO.	DATE	APPD	REVISION
2	12/2013	KLC	RECORD DRAWING REVISIONS

SCALE
20 0 20 40 FT
1"=20'

CITY OF ANDERSON, INDIANA
WATER POLLUTION CONTROL PLANT
FACILITY IMPROVEMENTS
DIVISION II

GENERAL
GENE GUSTIN WAY
ENLARGED
NEW SITE AND UTILITY PLAN 3

FILE NAME 01798FAG10.DWG
DWG AG10
SHEET 10 OF 186
DATE SEPTEMBER 2011 REV 2