

SECTION 44 42 56.09
NON-CLOG DRY-PIT CENTRIFUGAL PUMPS

EQUIPMENT AND COMPONENT NUMBER(S)

PMP-3311: RAS Pump 1.
PMP-3411: RAS Pump 2.
PMP-3511: RAS Pump 3.
Spare RAS Pump.

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Bearing Manufacturers' Association (ABMA):
 - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11, Load Rating and Fatigue Life for Roller Bearings.
 2. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - b. B106.1, Design of Transmission Shafting.
 3. ASTM International (ASTM): A48/A48M, Standard Specification for Gray Iron Castings.
 4. Department of Defense (DoD) Test Method Standard: MIL STD 167, Mechanical Vibrations of Shipboard Equipment.
 5. Hydraulic Institute Standards (HIS):
 - a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
 - b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
 6. International Organization for Standardization (ISO): 1940 Balance Quality Requirements of Rigid Rotors.
 7. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
 8. Occupational Safety and Health Administration (OSHA).

1.02 DEFINITIONS

- A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each pump assembly.
 - b. Complete pump and motor catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Plan and section dimensional outline drawings of the pumps and motors identifying all components, anchor bolts, external connections, and appurtenances.
 - 1) Include all components identified with quantity, part name and corresponding materials of construction complete with ASTM designation on sectional drawings.
 - d. Performance data curves showing head, capacity, horsepower demand, net positive suction head required (NPSH3), and pump efficiency over entire operating range of pump, from shutoff to maximum capacity.
 - 1) Include the pump's preferred operating range (POR) and the manufacturer's defined maximum allowable operating range (AOR) for continuous steady state service on performance curves.
 - 2) Indicate separately head, capacity, horsepower demand, NPSH3, and overall efficiency required at the AOR's minimum and maximum continuous stable flow conditions and at the Rated Conditions and at Secondary Conditions (if applicable).
 - e. For variable speed motors, provide performance data curves for 50, 60, 70, 80, and 90 percent of nominal speed.
 - f. Certified detail structural, mechanical, and electrical drawings showing equipment dimensions, arrangement, assembly, including locations and type of connections and weights of major equipment and components.
 - g. Power and control wiring diagrams, including terminals and numbers.
 - h. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
 - i. Factory finish system.
 - j. Bearing life calculation confirming compliance with L10 bearing life requirement.
 - k. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, that factory finish system is identical to requirements specified herein.
5. Factory Functional and Performance Test Reports and Log.
6. Field Functional and Performance Test Reports and Log.
7. Field driver shaft laser alignment report.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 67 00, Product Requirements.
9. Suggested spare parts list to maintain equipment in service for period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
11. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 EXTRA MATERIALS

A. Furnish for each set of pumps:

1. Complete set(s) bearings.
2. Complete set(s) gaskets and O-ring seals.
3. Complete set(s) of shaft sleeves.
4. Complete set(s) keys, dowels, and pins.
5. Complete mechanical seal(s).
6. Set of Impeller and casing wear rings.
7. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics:

1. Provide a complete, coordinated, and fully functional operating system.
2. Coordinate pump requirements with motor manufacturer and be responsible for pump and motor requirements.
3. Pumps supplied under this section to be a standard product of manufacturer and to have proven reliability.

- B. Functional Characteristics: None.
- C. Performance Characteristics: None.

2.02 SUPPLEMENTS

- A. Specific service, performance, and design requirements are attached to this section as supplements.

2.03 EQUIPMENT

A. Pump:

- 1. Physical Characteristics:
 - a. Heavy-duty, solids handling, non-clog, dry pit design.
 - b. Configuration: See Supplements.
 - c. See the Drawings for pump orientation.
- 2. Functional Characteristics: None.
- 3. Performance Characteristics:
 - a. Continuously rising head-capacity curve from runout to shutoff.
 - b. Designed to operate continuously at any point on specified operating range of performance curve without cavitation, overheating, or excessive vibration.
 - c. Motor nameplate horsepower rating not to be exceeded by pump brake horsepower required at any point on nominal pump performance curve.

B. Casing:

- 1. Physical Characteristics:
 - a. Back pullout design allowing for removal of rotating element without disturbing piping connections.
 - b. Heavy wall, one-piece volute construction with integral flanged discharge flange and smooth fluid passages. Provide drilled and tapped volute priming and drain connections.
 - c. Wear ring securely fastened to casing (or suction cover) with recessed stainless steel screws.
 - d. Provide handhole for cleanout purposes at volute centerline located to provide access to interior of pump.
 - e. Flanges:
 - 1) Conform to ASME B16.1, Class 125-pound, flat face standard.
 - 2) Provide 1/2-inch gauge connection drilled and tapped in discharge flange.
- 2. Functional Characteristics: None.
- 3. Performance Characteristics: Diffusion vanes or stationary guides are not allowed.

C. Suction Cover (Fronthead):

1. Physical Characteristics:
 - a. Single-piece construction designed to provide even flow to impeller eye.
 - b. Machine register fitted to casing. Flanged connection conforming to ASME B16.1, Class 125-pound, flat face standard.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

D. Stuffing Box Cover (Backhead):

1. Physical Characteristics:
 - a. Single-piece construction designed with integral stuffing box suitable for use of either conventional packing or mechanical seal. Drilled and tapped 3/4-inch drain connection and large openings to allow easy access to stuffing box.
 - b. Designed for installation of a minimum of five rings of packing and a split type lantern ring and a split type gland follower. Provide stuffing box with 1/4-inch minimum drilled and tapped connection for injection or venting of the stuffing box.
 - c. Machine register fitted to casing.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

E. Bearing Frame and Bearings:

1. Physical Characteristics:
 - a. Removable, single-piece construction.
 - b. Machined for accurate bearing alignment and completely enclosing shaft between bearings.
 - c. Provide jacking screws for adjustment of impeller.
 - d. Grease packed at factory and provided with grease fittings for bearing lubrication.
2. Functional Characteristics: Provide with retainer covers on inboard and outboard ends of frame equipped with lip-type grease seals to prevent entrance of contaminants.
3. Performance Characteristics: Single or double row bearings at inboard and outboard ends designed to take radial, weight, and thrust loads of pump and associated shafting loads. Bearings to be designed for an L10 life, of 50,000 hours per ABMA at best efficiency point.

F. Impeller:

1. Physical Characteristics:
 - a. Single suction, enclosed, non-clogging type design with extremely smooth passageways to prevent clogging.

- b. Single-piece construction.
 - c. Wear ring securely fastened to impeller with recessed stainless steel screws. Impeller wear ring to be a minimum of 50 Brinell softer than suction head wear ring.
- 2. Functional Characteristics: Secure to shaft with stainless steel bolt, washer, and key to prevent loosening from either forward or reverse rotation.
- 3. Performance Characteristics: Dynamically balanced to assure vibration limits for pump are not exceeded.

G. Shaft:

- 1. Physical Characteristics:
 - a. Accurately machined over entire length and precision ground at bearing locations.
 - b. Provide keyways at both ends.
- 2. Functional Characteristics: Designed to transmit full motor horsepower with a liberal safety factor to carry maximum loads imposed and to meet pump vibration requirements.
- 3. Performance Characteristics: Provide renewable, hooked shaft sleeve positively secured to shaft to prevent leakage.

H. Pump Base:

- 1. Physical Characteristics: None.
- 2. Functional Characteristics: Rugged, heavy duty, with ample strength for support of entire pump and imposed static and operational loads.
- 3. Performance Characteristics: None.

I. Coupling:

- 1. Physical Characteristics: None.
- 2. Functional Characteristics: Designed to provide flexible connection between pump and motor.
- 3. Performance Characteristics:
 - a. Flexible coupling to be designed to carry maximum horsepower of motor, including service factor, and additional forces imposed by rotating assembly.
 - b. Flexible coupling selection to take into account torsional analysis of complete pump and motor drive system. There is to be no torsional critical speed within 15 percent above or below specified speed range. Number of vanes times the rpm are part of this speed range.
 - c. Provide fabricated coupling guard to comply with OSHA safety standards.

J. High Ring Base:

1. Physical Characteristics: Cast iron or fabricated steel of adequate height to allow access to flexible coupling and designed to carry weight of motor without undue vibration to pump assembly.
2. Functional Characteristics: None.
3. Performance Characteristics: Provide with shaft guard to comply with OSHA safety standards.

2.04 ACCESSORIES

A. Physical Characteristics:

1. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
2. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
3. Anchor Bolts: Type 316 stainless steel, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.05 FACTORY FINISHING

A. Physical Characteristics: Prepare and prime and finish coat in accordance with Section 09 90 00, Painting and Coating, System No. 4.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.06 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments:

1. Factory testing to be in accordance with the standards of the Hydraulic Institute, latest edition.
 - a. Pump Test Acceptance Grade: 1E.
2. Test all equipment furnished with the actual motor to be provided for factory tests.

3. Factory tests to include the following:
 - a. Hydrostatic testing of pump pressure containing components, to include as a minimum, pump volute, suction cover, and stuffing box cover. Test pressure to be the greater of 150 percent of rated condition or 125 percent of pressure at rated speed with discharge valve closed. Test for 10 minutes.
 - b. Performance testing of fully assembled pump, per Hydraulic Institute Standard 14.6. Performance testing to be at rated speed.
 - c. Dynamically balance rotating assembly to ISO 1940, Grade G6.3 or better prior to final assembly.
 - d. Vibration testing of fully assembled pump with the Project motor at full rated speed.
 - 1) Limits of Vibration of Fully Assembled Pump: Less than 90 percent of those established in standards of the Hydraulic Institute.
 - e. Include complete test records and performance curves certified correct by an authorized representative of the pump manufacturer of each test performed.
 - f. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
 - g. Make necessary adjustments, realignments, and retest to bring pumps into compliance.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's written and printed instructions.
- B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.
- C. Adjust pump assemblies such that driving units are properly aligned via laser alignment, plumb, and level with driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of pump pedestals and concrete foundation with a poured, nonshrink grout of the proper category, as specified in Section 03 62 00, Grouting. Remove wedges after grout is set and pack void with grout.

- E. Connect suction and discharge piping without imposing strain to pump flanges.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

- A. Touchup damaged areas in accordance with and as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD TESTING AND FACILITY STARTUP

- A. Field Testing and Facility Startup shall be in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.
- B. Facility startup specifies the order and prerequisites for the following tests of the equipment:
 - 1. Field functional testing.
 - 2. Software operational testing.
 - 3. Performance testing.
 - 4. Demonstration testing.
- C. All Field Testing and Facility Startup shall be performed using a qualified representative provided by the Manufacturer as specified in Section 01 91 14, Equipment Testing and Facility Startup, Section 01 43 33, Manufacturers' Field Services, and as elaborated upon in this section.

3.04 FIELD QUALITY CONTROL

- A. Functional Tests:
 - 1. Conduct on each pump, system, and subsystem as specified in Section 01 91 14, Process Equipment Testing and Facility Startup.
 - 2. Alignment:
 - a. Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
 - b. Verify alignment of complete extended shaft assembly, including angularity of pump and motor shafts, meets requirements of shafting manufacturer.
 - c. Shafting manufacturer's authorized representative shall verify installation alignment and prepare and submit a report confirming compliance.
 - 3. Flow Output: Measure using plant instrumentation and storage volumes.
 - 4. Operating Temperatures and Vibration: Monitor bearing areas on pump and motor for abnormally high temperatures or vibrations.

- B. Performance Test: Conduct on each pump as specified in Section 01 91 14, Process Equipment Testing and Facility Startup.
1. Test in accordance with Hydraulic Institute Standard 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
 2. Perform under simulated operating conditions at full rated speed and at a reduced speed as approved by Contracting Officer.
 3. Test for a continuous 3-hour period without malfunction.
 4. Test Records and Report: Prepare and submit a complete test report along with the test records in accordance with Hydraulic Institute Standard 14.6.
 5. Use of plant instrumentation is allowed for tests. Provide additional instrumentation required to obtain required test data per the Hydraulic Institute.

3.05 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative:
1. Present at Site or classroom designated by Contracting Officer for minimum person-days listed below, travel time excluded:
 - a. 1 person-day for installation assistance and inspection.
 - b. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - c. 1/2 person-day for prestartup classroom or Site training.
 - d. 1 person-day for facility startup.
 - e. 1/2 person-day for post-startup training of Contracting Officer's personnel.
 - f. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the Contracting Officer. Provide training session in accordance with Section 01 79 00, Demonstration and Training.
- B. Refer to Section 01 67 00, Product Requirements, for Certificate of Proper Installation, Certificate of Compliance, and other relevant requirements.
- C. Refer to Section 01 91 14, Equipment Testing and Facility Startup.

3.06 SUPPLEMENT

- A. The supplement listed below, following "End of Section," is a part of this specification:
1. RAS Pumps 1, 2, 3, and a Spare Data Sheet.

END OF SECTION

RAS PUMPS 1, 2, 3, AND A SPARE DATA SHEET

Tag Numbers: PMP-3311, PMP-3411, PMP-3511 and Spare

Pump Name: RAS Pumps 1, 2, 3 and a Spare

Manufacturer and Model Number:

(1) Xylem/Flygt, Model 8x8x14 NSW

(2) "Or-equal"

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Activated Sludge

Pumping Temperature (Fahrenheit): Normal: Approximately 60 (near ambient)

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 1.0 Cp

Vapor Pressure at 60 Degrees F: 1

Abrasive (Y/N): Y

Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/L): Less than 10,000

Min. NPSH Available (Ft. Absolute):

Area Classification: Unclassified

Ambient Temperature (F): 50-80

Location Indoor/Outdoor: Indoors

Elevation (ft): 6,800

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 850 Secondary (Reduced Speed): 173

Total Dynamic Head (Ft): Rated: 8.1 Secondary (Reduced Speed): 7.0

BHP at Rated Flow and Rated TDH: 2.6

NPSH Required, Max. (Ft Absolute) at Rated Point: 9

Shutoff Pressure Range at Rated Point (Ft): 15-16

Min. Rated Pump Hydraulic Efficiency (%): 75

Max. Pump Speed at Rated Capacity (rpm): 584

Constant Speed: N

Adjustable Speed: Y Minimum Pump Speed: 340

Maximum Power, Rated Impeller (BHP): 2.6

Sphere Size Required (to pass through impeller), Min. (in): 2

PHYSICAL CHARACTERISTICS

Configuration: Horizontal, Frame Mounted: Y
Vertical, Close-Coupled: N
Vertical, Extension Shafting: N

Size: Suction (in.): 8 Discharge (in.): 8

Casing: Single Volute: Y
Tangential Discharge: Y Centerline Discharge:

Impeller: Enclosed: Two Vane: 2 vane minimum
Bladeless: N

Wear Rings: Manufacturer's standard for abrasive service

Shaft Sleeve: Yes X No

Pump Base: Heavy Duty Fabricated Steel: Y
Cast Iron Combination Base Elbow: N
Cast Mounting Pads Integral with Casing: N

Suction Elbow: Yes No X Type:
Material: Cast Iron, ASTM A48 Class 30

Drive Type: Belt Drive: Inline Speed Reducer: Y

Coupling: Standard Flexible Type: Spacer Type:
Manufacturer: Manufacturers Standard: Y

Seal: Packing: N
Mechanical Seal: Y Single: Y Double: N
Mechanical Seal Manufacturer/Model: John Crane Style 21, "Or-equal"
Lubrication: External water

Materials: Pump Castings (includes casing, suction cover, stuffing box cover, bearing frame):
Cast Iron, ASTM A48/A48M Class 30 With 3% Nickel
Impeller: Cast Iron, ASTM A48/A48M Class 35 with 3% Nickel

Pump Shaft: High Strength Steel AISI 1045 Steel, HR
Type 4140 Alloy Steel Type 410 Stainless Steel Y

Shaft Sleeve: Type 316L Stainless Steel Y

Wear Rings: Hardened Stainless Steel Y

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 3 Voltage: 460 Phase: 3 Hertz: 60

Synchronous Speed (rpm): 1,800

Service Factor (at max. ambient temp.): 1.0

Inverter Duty Rated (Y/N): Y Thermal Protection: N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve within the allowable operating range.

Enclosure: DIP EXP ODP TEFC X CISD-TEFC
TENV WPI WPII N SUBM

Mounting Type: Horizontal Y Vertical Solid Shaft: N

REMARKS: Provide two, 1/2 (min), NPT pump discharge gauge connections, plugged.
