SECTION 11218 - NON-CLOG VERTICAL COLUMN SOLIDS HANDLING PUMPS

City of San Diego, CWP Guidelines

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NTS: This specification is written for pumps with external water flush lubrication and vertical solid shaft motors. It is necessary to start the water flush flow before the pumps start in order to flush and lubricate the bearings before shaft rotation. Coordinate the required time delay with electrical and instrumentation.

Operational strains on shafts, bearings, shaft seals, etc., on variable speed pumps differ greatly from that experienced by pumps operating at constant speed at or near the best efficiency point. A much more rugged pump is required for variable speed applications. Options are indicated for constant, two-speed and variable speed pumping applications.

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PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

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NTS: Select "suction bell" for self-cleaning wet well installations. Select "inlet well" if a barrel or can inlet is required. Select the "custom engineered" pumps clause if variable speed drive pumps are specified.

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A. **General:** The WORK of this Section includes providing non-clog vertical column-type pumps for pumping [unscreened municipal sewage] [return activated sludge] [primary effluent] [ ]. Each pump shall consist of a bowl assembly with [suction bell] [inlet well], discharge column assembly, vertical electric [two-speed] motor, [flywheel,] [variable frequency drive controller,] [above] [below] grade discharge head, supports, and all appurtenances required to provide a complete pumping system. Equipment furnished under this Section shall conform to the requirements of this Section and the Related Sections. [The "custom engineered" pumps requirements specified in Section 11175 apply to the WORK of this Section.]

B. **Type:** Pumps furnished under this Section shall be vertical column nonclog mixed flow pumps specifically engineered to pump unscreened wastewater. Mixed flow pumps with a lower bearing assembly located below the impeller eye and semi open impellers are specifically excluded and will be rejected. All liquid passages from inlet to discharge shall be designed to avoid material such as rags, strings, and plastic from clogging, fouling or accumulating in the pump. The pump shall be designed to support the entire weight of the pump bowl assembly, column, discharge head, [flywheel,] and motor on a baseplate designed to span an opening in the foundation slab of sufficient size to allow removal of the complete pumping element without disassembly.

C. **Unit Responsibility:** The CONTRACTOR shall cause the equipment specified under this Section, including the motors [and the variable speed drives specified under Section 11033], to be furnished by the pump manufacturer, as provided in Section 11000. The CONTRACTOR shall furnish a Certificate of Unit Responsibility Assignment as provided in Section 11175.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 11000 Equipment, General Requirements
2. Section 11002 Equipment Supports, Grouting and Installation
[3. Section 11030 Variable Speed Drives, General]
[4. Section 11033 Variable Frequency Drives]
5. Section 11175 Pumps, General

1.3 SPECIFICATIONS AND STANDARDS

A. Specifications and standards shall comply with Sections 11000 and 11175. Where this Section is silent on any subject, item or equipment, the requirements of Section 11175 shall govern.

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300, in addition to the requirements of Sections 11000 and 11175:

1. Documentation supporting the performance of the pump with the indicated submergence. The manufacturer shall specifically accept the submergence indicated and warrant that there is no objection to the configuration of the intake structure, as required under paragraph 11218-2.1B.

1.5 OWNER'S MANUAL

A. OWNER'S MANUAL requirements shall be as set forth in Sections 11000 and 11175.

1.6 SERVICES OF MANUFACTURER

A. Services of the manufacturer shall be provided in accordance with Section 11175 and as follows:

1. **Inspection, Startup, and Field Adjustment**: An authorized representative of the manufacturer shall visit the site for not less than [ ] day to check the installation, supervise start-up, and supervise testing and adjustment of pumps.

2. **Instruction of OWNER'S Personnel**: The authorized service representative shall instruct the OWNER'S personnel in the skills required for each Trade Group indicated and the duration indicated. This includes all aspects of pump operation and maintenance, including step-by-step troubleshooting procedures with necessary test equipment. Instruction shall include, but not be limited to, review of operation and maintenance manual; installation and

removal of pumps, motors and shafts; service and replacement of bearings; service and flushing of seal water system; replacement and service of seals; daily maintenance requirements; and long-term maintenance provisions. Instruction of the OWNER'S personnel shall be conducted separate from the start-up and testing activities. Each of the OWNER'S Trade Groups will be instructed individually, and no more than six hours will be scheduled in one day. Durations of instruction are:

Trade Group	Class Hours	Field Hours
Electricians	[3]	[3]
Electronics Technicians	[3]	[3]
Operations	[3]	[3]
Plant Maint. Technicians	[3]	[3]

1.7 FACTORY TESTS

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NTS: Select witnessed factory tests for pumps with variable speed drives.

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A. Each pump shall be factory tested in accordance with the requirements established in Section 11175 and shall be a [witnessed] [non-witnessed] test.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **General:** The pumps shall be shipped as assembled units for erection by the CONTRACTOR, unless shipping limitations or special installation requirements dictate otherwise. If disassembled, the equipment shall be shipped in the minimum practical number of pieces for field assembly by the CONTRACTOR. Other requirements for product delivery, storage and protection are described in paragraph 11000-1.10.

B. **Special Monitoring:** For pumps 8 inches and larger and for variable speed drives furnished under this Section, a recording accelerometer, designed to record the magnitude of sudden impacts in three directions (X, Y, Z) on continuous strip charts with both time and "g" force scales, shall be shipped with, and fixed to each separately packed assembly or its packing crate. Upon arrival of each shipment, the CONTRACTOR shall immediately notify the CONSTRUCTION MANAGER; the accelerometer shall be removed in the presence of representatives of the CONSTRUCTION MANAGER and the CONTRACTOR. If the magnitude of the maximum acceleration exceeds 3.0 g, the assembly or subassembly shall be dismantled and inspected and tested for damage. All damage shall be corrected to the complete satisfaction of the CONSTRUCTION MANAGER before the assembly is incorporated into the work. The CONTRACTOR shall bear all costs arising out of dismantling, inspection, testing, repair, and reassembly, even if no damage is found.

Large floor-mounted variable speed drive units should be shipped in special vans with air shocks.

1.9 PUMPED FLUID AND OPERATING CONDITIONS:

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NTS: Provide a concise, but complete, description of the application, describing the pumped fluid, the installation environment, and the method of starting and stopping and operating the pumps in separate paragraphs.

The CITY desires that the pump suction/inlet piping practices recommended in ANSI/HI 9.8, a nationally recognized consensus standard, be incorporated in the design of its projects. Exceptions to this requirement must be submitted in writing to the CITY's project manager, and must be approved in writing by the CITY's project manager in advance of incorporating any exceptions into the design. The performance characteristics of installations that do not conform to the standard are to be confirmed by physical modeling as established in the standard. Physical modeling is expensive and requires months to complete.

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A. **Pumped Fluid:** The fluid to be pumped is [unscreened municipal wastewater] [return activated sludge] [primary effluent] [ ]. The fluid is anticipated to range between 64 degrees F and 78 degrees F and contain up to [450] [2500] [ ] mg/L of solids consisting of [grit, rags, and organic material with small quantities of petroleum products and animal fats and greases] [organic and inorganic materials, and petroleum products, including grease]. [Owing to the presence of grit, the fluid is expected to be somewhat abrasive.]

B. **Installation Environment:** [The pumps will be installed in a reinforced concrete structure designed to provide self-cleaning wet well geometry in accordance with ANSI/HI 9.8, based upon a maximum inlet velocity of 4 ft/second at the flow established under Operating Condition B.] [Pump discharge heads will be exposed to the weather.] Pumps with intake velocities greater than this value at Operating Condition B shall be furnished with a bell increaser to achieve the specified maximum velocity.] [The pump will be installed in an inlet well conforming to the requirements of this Section and furnished by the pump manufacturer in accordance with the unit responsibility requirements prescribed in Section 11175] [ ]. Drive control equipment will be installed in a weather protected, conditioned space.

C. **System Operation:** [The pumps will be operated at variable speed in response to the control system specified in Section [13300] and configured to control the wet well liquid surface elevation to mimic the normal depth vs flow curve in the influent sewer and match pumping rate to the rate of flow entering the pumping station. The number of pumps in service will be altered as required to achieve this objective and control liquid levels. The pump drives will be adjusted to establish minimum speed with one pump in service when the wet well level is [at the invert elevation for the influent sewer,] and at maximum speed with all duty pumps in service when the liquid level is at the seven tenths depth of flow in the influent sewer (at peak flow). When more than one pump is in service, all pumps will operate at the same speed, responding to a common control signal. The pumps will obtain the fluid to be pumped from a trench type wet well through the specified inlet piping. It is expected this equipment will be used for cleaning the wet well using

the method described in ANSI/HI 9.8 on a weekly cycle.] [The pumps will be operated at [constant] [two-] speed in response to the control system specified in Section [13300]. Generally, all pumps will be controlled [to operate at high speed or low speed] to pump a pre-established rate of flow, according to the return activated sludge pumping control system.] [ ]

[Equipment furnished under this Section shall be equipped with flywheel assemblies for the control of hydraulic transient forces resulting from pumping operations.]

1.10 PERFORMANCE CRITERIA:

Performance of pumps furnished under this Section shall be guaranteed under the terms of paragraph 11175-1.7C. Field vibration shall be measured in accordance with requirements specified in Section 11175. Non-conforming pumps will be rejected.

PART 2 -- PRODUCTS

2.1 PUMP NAME: [ ] (P-[ ] through P-[ ])

A. **General**: Each non-clog vertical column-type solids handling pump will be driven [at constant speed] [by a two-speed motor] [at variable speed using the output from a single variable frequency drive]. Pumps shall conform to the following requirements:

1.	Number of pumping units	- [ ]	
2.	Location	- [ ]	
3.	Service	- [ ]	
4.	Operation (hours per day)	- [ ]	
5.	Drive	-	[Constant] [two-] [variable] speed

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NTS: For pumps discharging to long new pipelines (over 1,000 feet in length), two system curves shall be developed by the DESIGN CONSULTANT, as recommended in ANSI/HI 9.6.1.5.5.2: one for the system as it will be installed; and a second to represent the condition of the system after some increase in pipe roughness has occurred. Pump design operating condition points shall be specified for the entire range of new and aged pipe conditions, since the pumps will be required to perform satisfactorily for both conditions.

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B. **Operating Conditions**: The specifications and drawings provide information relating to the conditions for installation of the equipment to be provided under this Section. The CONTRACTOR shall submit the equipment manufacturer's certificate attesting to the manufacturer's unqualified acceptance of the configuration, dimensions and operating levels in the wet well as indicated. The certificate shall include assurance that the proposed equipment will

function free from cavitation and vibration at all operating speeds and wet well levels indicated and that the submergence provided exceeds the pump's net positive suction head (NPSH) margin considerations as set forth in ANSI/HI 2.3 at paragraph 2.3.2.17. The certificate shall be notarized and shall be signed under penalty of perjury by an officer of the pump manufacturing company.

{[Variable Speed Applications]

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NTS: For the FULL SPEED operating conditions, ***do not state the speed***. Condition A flow should be the result of the targeted maximum flow for the installation divided by the number of pumps in service. Condition A head is the system head at the worst (lowest) assumed 'C' value at the rated flow, but does not include the value of the individual pump losses ('pump correction loss').

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1. Condition A: Full Speed - Maximum Head Operation (See Notes a and e):

Capacity, gpm	-	[ ]
Total head, feet	-	[ ]
NPSHA, feet	-	[ ]

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NTS: Condition B is the so-called 'runout condition'. Condition B head is the system head at the best (highest) assumed 'C' value at the indicated flow, but does not include the value of the individual pump losses ('pump correction loss'). The flow at condition B head is unique to the individual pump selection and occurs at full pump speed so do not list a flow except as provided in Note b.

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2. Condition B: Full Speed - Minimum Head Operation (See Notes b and e)

Capacity, gpm	-	from pump H/Q curve
Total head, feet	-	[ ]
NPSHA, feet	-	[ ]

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NTS: ***Never insert a speed in the reduced speed portion of the table.*** The speeds necessary to achieve the required operation are unique to each individual pump vendor's product.

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3. Condition C: Reduced Speed - Continuous Operation (See Notes c and e)

Capacity, gpm	-	[ ]

Total head, feet	-	[ ]
Pump speed, rpm	-	Reduced
NPSHA, feet	-	[ ]

4. Condition D: Reduced Speed - Startup/Shutdown (See Notes d and e)

Capacity, gpm	-	Zero
Total head, feet	-	[ ]
Pump speed, rpm	-	Minimum
NPSHA, feet	-	[ ]

NOTES:

*a. Condition A shall be taken as the rated, continuous-duty operating condition with the pump operating **at maximum speed against maximum anticipated system head**. Performance at the rated condition shall be guaranteed in accordance with Section 11175. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this Section should be selected to achieve Condition A performance, but also operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A may be located in the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.*

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NTS: While the flow used to establish Condition B should not be listed in the Operating Conditions table, it should be inserted into the blank in Note b to indicate the basis for the NPSHA information.

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*b. Condition B head is presented to indicate operating conditions when the pump is operating at **maximum speed against minimum anticipated system head,** assuming a hypothetical head-capacity curve. **Condition B shall be used for pump selection**. **Condition B shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.** Pumps with head-capacity curves steeper than that assumed will produce less flow at lower head. The reverse will occur with pumps having a shallower head-capacity curve. **Proposed pump selections meeting this discharge head requirement by operating the equipment at less than full speed will be rejected.** NPSHA, as listed for Condition B is calculated on a pumped flow of [ ] mgd.*

*c. Condition C is the anticipated **continuous duty minimum speed condition.** Pumps furnished under this specification Section shall be capable of sustained (24 hours per day) operation at this condition within the requirements set forth in Section 11175. Condition C shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.*

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NTS: Condition D is intended to inform the manufacturer of the conditions imposed upon startup and shutdown. If the pumps are to be started and stopped against a closed valve, then so state.

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d. Condition D represents the expected momentary (startup/ shutdown) condition. Pumps furnished under this specification Section will operate for no more than 30 seconds at this condition when initiating or terminating a service cycle. The maximum anticipated number of service cycles is 12 per day.

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NTS: NPSHA data is dominated by considerations associated with the pump setting (elevation). Therefore, it is imperative that the drawings show the elevation of the housekeeping pad for the pump discharge head for use by the pump manufacturer in responding to NPSH margin requirements. To avoid the potential for conflict, do not list the pump discharge centerline or housekeeping pad elevation in the Specifications. Section 11175 places restrictions on NPSH margin (NPSHA/NPSHR). The design engineer, specifier and submittal reviewer should become completely familiar with these requirements and the procedures established in ANSI/HI 9.6.1 to make certain that the design incorporates a setting that will allow all reasonable candidate pump designs to comply with these restrictions and rule out those designs that do not. ***Bear in mind: NPSHA must exceed NPSHR by a wide margin at all specified operating conditions and that this margin requirement will vary depending on several considerations. The bottom line with respect to installation costs is that the greater the NPSHR for a given pump, the lower a pump inlet must be below the inlet hydraulic gradient.*** The specifications, under Section 11175, require the pump manufacturer to demonstrate by calculation and supporting documentation that the proposed pump meets the NPSHA/NPSHR margin limitations established in the specification and in ANSI/HI 9.6.1.

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e. Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 2.1 – 2.6. The performance requirements listed above include static lift, velocity head losses at the point of discharge, and dynamic losses associated with connected valving, fittings, and piping, but not internal pump losses. ***The performance requirements listed above do not include pump inlet, column, and discharge head losses.*** *A separate curve for these values shall be submitted with the pump performance curve as part of the documentation required under Section 11175. Net positive suction head available (NPSHA) in the above tabulation is referred to the housekeeping pad supporting the pump discharge head shown, and is calculated in accordance with ANSI/HI 2.3 for average barometric pressure and maximum temperature conditions. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump installation details. An allowance of five feet (negative) has been included for the presence of volatile constituents in the pumped fluid. Required NPSHA margin shall be as specified in Section 11175.*

f. The pumps will be operated at variable speed in response to the control system specified in Section [13300]. To permit the pump to operate at or near best efficiency during reduced-speed operation, it is preferred that the rated condition lie to the right of the best efficiency point on the pump's head capacity curve.

g. Maximum expected surge pressure is [ ] psig. **}**

{[Constant Speed Applications]

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NTS: Condition A flow should be the result of the targeted maximum flow for the installation divided by the number of pumps in service. Condition A head is the system head at the worst (lowest) assumed 'C' value at the rated flow, but does not include the value of the individual pump losses ('pump correction loss').

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5. Condition A: Maximum Head Operation (See Notes a and d):

Capacity, gpm	-	[ ]
Total head, feet	-	[ ]
NPSHA, feet	-	[ ]

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NTS: Condition B is the so-called 'runout condition'. Condition B head is the system head at the best (highest) assumed 'C' value at the flow indicated, but does not include the value of the individual pump losses ('pump correction loss'). The flow at condition B head is unique to the individual pump selection so do not list a flow except as provided in Note b.

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6. Condition B: Minimum Head Operation (See Notes b and d):

Capacity, gpm	-	from pump H/Q curve
Total head, feet	-	[ ]
NPSHA, feet	-	[ ]

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NTS: Condition C is the anticipated continuous duty maximum head condition. Condition C head is the system head at the worst (lowest) assumed 'C' value plus the value of the individual pump losses ('pump correction loss') at the flow indicated. The flow at condition C head is unique to the individual pump selection so do not list a flow. Condition C is optional and is provided to describe a head condition that is not adequately described by Conditions A and B.

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7. Condition C: Continuous Duty Maximum Head Operation (See Notes c and d):

Capacity, gpm	-	from pump H/Q curve
Total head, feet	-	[ ]
NPSHA, feet	-	[ ]

NOTES:

a. Condition A shall be taken as the rated, continuous-duty operating condition with the pump operating ***against maximum anticipated system head.*** *Performance at the rated condition shall be guaranteed in*

accordance with Section 11175. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this Section should be selected to achieve Condition A performance, but also operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A may be located in the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.

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NTS: While the flow used to establish Condition B should not be listed in the Operating Conditions table, it should be inserted into the blank in Note b to indicate the basis for the NPSHA information.

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b. Condition B head is presented to indicate operating conditions when the pump is operating ***at minimum anticipated system head****, assuming a hypothetical head-capacity curve.* ***Condition B shall be used for pump selection. Condition B shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.*** *Pumps with head-capacity curves steeper than that assumed will produce less flow at lower head. The reverse will occur with pumps having a shallower head-capacity curve. NPSHA, as listed for Condition B is calculated on a pumped flow of [ ] mgd.*

c. Condition C is the ***anticipated continuous duty maximum head condition.*** *Pumps furnished under this specification shall be capable of sustained (24 hours per day) operation at this condition within the requirements set forth in Section 11175. Condition C shall be located within the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.*

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NTS: NPSHA data is dominated by considerations associated with the pump setting (elevation). Therefore, it is imperative that the drawings show the elevation of the housekeeping pad for the pump discharge head for use by the pump manufacturer in responding to NPSH margin requirements. To avoid the potential for conflict, do not list the pump discharge centerline or housekeeping pad elevation in the Specifications. Section 11175 places restrictions on NPSH margin (NPSHA/NPSHR). The design engineer, specifier and submittal reviewer should become completely familiar with these requirements and the procedures established in ANSI/HI 9.6.1 to make certain that the design incorporates a setting that will allow all reasonable candidate pump designs to comply with these restrictions and rule out those designs that do not. ***Bear in mind: NPSHA must exceed NPSHR by a wide margin at all specified operating conditions and that this margin requirement will vary depending on several considerations. The bottom line with respect to installation costs is that the greater the NPSHR for a given pump, the lower a pump inlet must be below the inlet hydraulic gradient.*** The specifications, under Section 11175, require the pump manufacturer to demonstrate by calculation and supporting documentation that the proposed pump meets the NPSHA/NPSHR margin limitations established in the specification and in ANSI/HI 9.6.1.

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d. Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 2.1 – 2.6. The performance requirements listed above include static lift, velocity head losses at the point of discharge, and dynamic losses associated with connected valving, fittings, and piping, but not internal pump losses. ***The performance requirements listed above do not include pump inlet, column, and discharge head losses.*** *A separate curve for these values shall be submitted with the pump performance curve as part of the documentation required under Section 11175. Net positive suction head available (NPSHA) in the above tabulation is referred to the housekeeping pad supporting the pump discharge head shown, and is calculated in accordance with ANSI/HI 2.3 for average barometric pressure and maximum temperature conditions. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump installation details. An allowance of five feet (negative) has been included for the presence of volatile constituents in the pumped fluid. Required NPSHA margin shall be as specified in Section 11175.*

e. The pumps will be operated at constant speed in response to the control system specified in Section [13300].

f. Maximum expected surge pressure is [ ] psig. **}**

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NTS: Note that all specified operating conditions require net positive suction head (NPSH) information. Provide NPSHA information for any added operating conditions.

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C. **Design Requirements**:

1. **General:** The pumps shall be specifically designed to pump the fluid described in paragraph 11218-1.9, and shall comply with the requirements specified in Section 11175.

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NTS: Discharge head anchor bolts for this type of pump can rarely be designed to withstand the hydraulic thrust developed at the elbow in larger sizes (> 24-inch nozzle diameters). The arrangement of the discharge piping should provide for the nozzle to be restrained to a wall or other anchor on the discharge piping. See the NTS in Section 11175 under "Anchorage" for additional information.

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The rotor and critical speed analysis requirements specified in paragraph 11175-1.10, Rotor and Critical Speed Analysis and System Design, apply to the driven and drive equipment, including supports and appurtenances, for variable speed drive pumps furnished under this Section. In addition, the requirements specified in paragraph 11175-1.10 for overhung shaft pumps, apply to the pumps furnished under this Section.

2. Minimum solid sphere capable of passing through pump (in. dia.) - [3]

[3. Maximum pump speed (rpm) - [ ]]

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NTS: Note that bowl efficiency is indicted as the maximum (minimum). This means the minimum acceptable efficiency at the peak of the efficiency/capacity curve, not the efficiency at the rated condition.

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4. Max bowl efficiency, minimum (percent) - []

[5. Rotating moment of inertia (WK^2) ($lb\text{-}ft^2$) - [ ]]

[The rotating moment of inertia requirement applies to the sum of the moments of inertia of the motor rotor, flywheel, shafting, pump rotor, and water entrained in the pump rotor.]

6. Maximum motor size (hp) - [ ]

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NTS: Depending on the method of driving the pump, another line may be needed to indicate motor speed or other considerations.

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[7. Maximum motor speed (rpm) - [ ]]

D. **Pump Dimensions**:

1. Min. discharge nozzle size (inches) - [ ]

2. Min. inlet bell connection size (inches) - [ ]

3. Flange rating (psig) - [ ]

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NTS: The suction bell diameter should be based upon a maximum inlet velocity of 4 ft/sec., as stated in paragraph 11218-1.9B. Delete the next two requirements for barrel or can type pumps.

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[4. Min. suction bell diameter (inches) - [ ]]

[5. Elevation of suction bell inlet (feet) - [ ]]

2.2 PUMP REQUIREMENTS

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NTS: Pump construction is covered in Section 11175, which relies upon API 610 for basic requirements for materials and features. The DESIGN CONSULTANT should verify that the referenced API 610 requirements are suitable for the specific application, and list exceptions in the following paragraphs.

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A. **General:** Construction of non-clog vertical column solids handling pumps shall conform to the requirements set forth in Section 11175, except as described in the following paragraphs.

B. **Materials:**

1.	Impeller	-	Cast stainless steel
2.	Lineshaft, bowl and diffuser bearings	-	Commercial bronze backed rubber with external water flush lubrication
3.	Bearing, packing box connector	-	Bronze, ASTM B 505
4.	Flanged column pipe and discharge head	-	Steel, ASTM A 283, Grade D or ASTM A 53
5.	Seal	-	Split mechanical seal without SpiralTrac per Section 11175
[6.	Flywheel frame	-	Steel, ASTM A 36, welded and stress relieved]
[7.	Flywheel shaft	-	Steel, ASTM A108, Class C1144 or Grade 1045; ASTM 576, Grade 1045; or ASTM A322, Grade 4140]
[8.	Flywheel rotor	-	Ductile cast iron, ASTM A395 Grade 60-40-18 or ASTM A571]

C. **Pump Construction**:

1. **Bowl Assembly:** The pump bowl shall be free of blow holes and sand holes. The discharge bowl shall contain symmetrically arranged diffusion vanes. The impeller shall be of the enclosed nonclog mixed flow type, statically and dynamically balanced. An axial type impeller wearing ring shall be fitted to the impeller entrance port. A mating stationary wearing ring shall be provided in the bowl casting. Wearing rings shall conform to the requirements in Section 11175. The impeller and bowl diffusion vanes shall be of hydrofoil design with well-rounded leading edges to prevent the accumulation of fibrous and stringy material. [The bowl shall be fitted with an inlet bell with a diameter not less than that specified in paragraph 11218-2.1C.]. The impeller shall be secured to the shaft using a key and cap screw with alignment maintained by upper and lower sleeve bearings. The bowl and diffuser bearings shall be water lubricated.

   The suction bell shall be free of bearing hubs and supporting ribs. Vanes, to correct swirl in the flow approaching the impeller eye, will be permitted so long as there is no obstruction that can prevent large diameter solids from approaching the impeller eye and the vanes are shaped to permit strings and rags to pass through to the impeller entrance.

2. **Discharge Column Assembly:** The discharge column shall be furnished in lengths of not over 10 feet and shall be connected by flanged joints registered to provide alignment after assembly. The column pipe shall contain a splitter vane to serve as bearing retainers and lineshaft enclosing tube struts and to prevent stringy material from accumulating on the shaft enclosing tube. The vane shall run the entire length of the column, shall be aligned with a bowl diffusion vane and discharge elbow splitter vane, and shall be securely welded in place. Use of strut type bearing retainers is not acceptable.

3. **Shafts:** Lineshafting shall be furnished in interchangeable sections of not over 10 feet in length and shall be coupled with threaded couplings. An enclosing tube shall be provided to house the lineshaft. The enclosing tube shall be furnished in interchangeable sections not to exceed 5 feet in length with ends machined to receive lineshaft connector bearings.

4. **Discharge Head:** A base shall be provided for mounting of the driver and support of the complete pump[, flywheel,] and driver. The support shall be designed in accordance with Section 11175 and in accordance with the UBC for seismic zone 4. Discharge elbows shall be of the two-cut miter [above] [below] grade type as indicated incorporating a splitter vane to prevent the collection of stringy material. The type of connection to the discharge piping shall be as indicated. The discharge head shall have a drilled and tapped drain connection which shall be piped to drain to the station wet well through the support plate.

5. **Tension Nut Assembly:** The lineshaft enclosing tube shall terminate in a tension nut assembly. The assembly shall contain a sleeve bearing, and mechanical seal. The seal shall not require a wearing sleeve for the shaft, and shall be as specified in paragraph 11175-2.4A.7. There shall be no reduction in shaft size through the seal area.

6. **Shaft Coupling:** The shaft coupling shall be the adjustable three-piece type to permit positioning of the rotor and shall conform to the requirements specified in paragraph 11000-2.6.

[7. **Flywheel:** The flywheel shall consist of cast weight in the form of a torus, keyed and locked on a shaft supported by bearings at each end of the shaft. The size of the weight and the distance of the torus centroid from the center of the shaft shall be sufficient to achieve the overall rotating moment of inertia (WK^2) specified for the pump rotating system under paragraph 11218-2.1C. Cantilevered designs employing only one set of bearings will not be permitted. Bearings shall be selected in accordance with ABMA 9 or 11 for an L-10 life of not less than 100,000 hours. Input and output bearings shall be held in place by rigid fabricated steel struts. The entire assembly shall be balanced in accordance with paragraph 11175-2.7 and shall be furnished with a fabricated steel enclosure designed to provide protection against accidental entry of tools or other objects and to provide enclosure protection in accordance with OSHA requirements. Top and bottom end plates shall be finished flat and shall have registered alignment fits in accordance with the requirements of API 610. The flywheel shaft shall be direct coupled to the motor output shaft and the pump input shaft by flexible couplings conforming to the requirements of paragraph 11000-2.6.]

[8. **Inlet Well:** The pump shall be installed in a fabricated steel inlet well designed in accordance with ANSI/HI 9.8. The inlet well shall contain anti-rotation baffles and anti-vortex baffles in accordance with the requirements of that standard. The CONTRACTOR

shall cause the pump manufacturer to be fully responsible for the design and fabrication of the inlet well as a part of the manufacturer's Unit Responsibility duties.]

2.3 PUMP DRIVE

A. **Motor**: The pump shall be driven by a heavy duty, high efficiency [ODP] [TEFC] [TENV], vertical, solid shaft, [inverter duty variable speed] [two-speed] [constant speed] electric motor suitable for [480]-volt, [3]-phase, 60 Hz ac power supply in accordance with Section 16040. The motor bearings shall be designed to accept thrust loads imposed by the pump and the motor shall be fitted with a non-reverse clutch.

[B. **Variable Frequency Drive**: The variable frequency drive controller shall conform to the requirements of Sections 11030 and 11033.]

2.4 PAINTING

A. All external surfaces of the pump, [flywheel] and motor shall be coated as specified in Section 09800. All interior wetted ferrous surfaces of the pump shall be coated [with fusion bond epoxy] as specified in Section 09800.

2.5 NAMEPLATES, TOOLS, AND SPARE PARTS

A. **Spare Parts**: The WORK includes the following spare parts for each pump:

1. 2 sets special tools required for maintenance
2. 1 set of wearing rings
3. 1 mechanical seal, complete
4. 1 complete set of lineshaft bearings for one pump
5. 1 lower bearing assembly
6. 1 upper bowl bearing
7. 1 set of all washers, gaskets, and O-rings

2.6 MANUFACTURERS

A. Pursuant to the limitations described in paragraph 11000-2.1D, candidate pump manufacturers include [Fairbanks Morse, and Patterson], or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The pump manufacturer shall provide the complete pumping system and factory trained personnel to supervise installation and initial operation of all components. The pumps shall be aligned, connected and installed at the locations indicated and in accordance with the manufacturer's recommendations and the requirements of Section 11175. The installation shall be certified by the manufacturer.

3.2 FIELD TESTING

A. After completion of the installation, each pumping unit shall be field tested in accordance with Section 11175 to ensure compliance with the performance requirements as indicated.

** END OF SECTION **