

SECTION 11200 - HORIZONTAL SPLIT-CASE PUMPS

City of San Diego, CWP Guidelines

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NTS: This specification is for pumps with discharge nozzles 10 inches in diameter and less. These pumps are normally applied in pumping potable water, screened water that does not contain large solids, process water, hear reservoir and chilled water system circulation, potable water booster stations, and service water applications.

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 both constant and variable speed pumping applications.

Certain precautions must be taken in the design of intake piping to split case pumps to avoid asymmetrical loading of the pump bearings. See the Hydraulic Institute Centrifugal Pump Standard (ANSI/HI 1.4).

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PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

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NTS: Select the “custom engineered” pumps clause if variable speed drive pumps are specified **and** the application is demanding in terms of NPSHA limitations, range of heads to be encountered, pumped fluid characteristics, or range of flows to be accommodated.

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- A. **General:** The WORK of this Section includes providing horizontal shaft, horizontal suction impeller, split-case, double suction, single-stage centrifugal pumps, including horizontal [constant speed] [variable speed] electric motors and all appurtenant work, complete, for pumping [] [with small amounts of mildly abrasive solids] [potable water]. 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 shall be of the horizontal, dry pit, double horizontal-suction, volute-casing, enclosed impeller, split-case centrifugal type, designed so that the impeller, shaft and bearings can be removed without disturbing the connecting piping, bottom casing half, or motor. Design-specific speed, as defined by ANSI/HI 1.1, shall be between 2500 and 4000. The pump and motor shall each be supported on a common base conforming to the requirements of Sections 11175 and 11002.

- C. **Unit Responsibility:** The CONTRACTOR shall cause the equipment specified under this Section, including [the engine drives] [the variable speed drives specified under Section 11033 and] [the motors], 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 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 service representative of the manufacturer shall visit the site for not less than [] days 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:

<u>Trade Group</u>	<u>Class Hours</u>	<u>Field Hours</u>
Electricians	[3]	[3]
Electronics Technicians	[3]	[3]
Operations	[3]	[3]

1.5 SHOP DRAWINGS AND SAMPLES

- A. Submittal requirements shall be as set forth in Sections 11000 and 11175.

1.6 OWNER'S MANUAL

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

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 PUMPED FLUID AND OPERATING CONDITIONS:

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NTS: Provide a concise, but complete, description of the application, describing the pumped fluid and any constituents, pH, etc., 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 [], is anticipated to range between [64] and [78] degrees F, will have a pH of [], and will contain the following constituents: [].
- B. **Installation Environment:** The pumps will be installed in a [dry pit] [] and obtain the fluid to be pumped via the indicated piping connected to a [wet well] [] designed in accordance with the requirements of ANSI/HI 9.8. Drive control equipment will be installed in a weather protected, conditioned space.
- C. **System Operation:** The pumps will be operated at [constant] [variable] speed in response to the control system specified in Section [13300]. [The pumps will be started and stopped against a closed

valve.] [When more than one pump is in service, all pumps will operate at the same speed, responding to a common control signal.] []

1.9 PERFORMANCE CRITERIA:

- A. 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:** The CONTRACTOR shall furnish [] horizontal, centrifugal, split-case, double suction pumps as indicated in this Section, to conform to the following requirements:

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

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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:**

{ **[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 plus the value of the individual pump losses ('pump correction loss') at the rated flow.

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 plus the value of the individual pump losses ('pump correction loss') at the flow indicated. 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 Duty 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. 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. **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. 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 pump inlet piping (not the centerline of the pump inlet flange) for use by the pump manufacturer in responding to NPSH margin requirements. To avoid the potential for conflict, do not list the centerline 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 1.1 – 1.6. Net positive suction head available (NPSHA) in the above tabulation is referred to the pump inlet piping at centerline elevation (project datum) as shown and is calculated in accordance ANSI/HI 1.3 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 as a margin of safety. This margin shall be exclusive of the required NPSHA margin 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 plus the value of the individual pump losses ('pump correction loss') at the rated flow.

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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 plus the value of the individual pump losses ('pump correction loss') at the flow indicated. 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.

- 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. 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. **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.** 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 pump inlet piping (not the centerline of the pump inlet flange) for use by the pump manufacturer in responding to NPSH margin requirements. To avoid the potential for conflict, do not list the centerline 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 1.1 – 1.6. Net positive suction head available (NPSHA) in the above tabulation is referred to the pump inlet piping at centerline elevation (project datum) as shown and is calculated in accordance ANSI/HI 1.3 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 as a margin of safety. This margin shall be exclusive of the required NPSHA margin 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 11200-1.8, and shall comply with the requirements specified in Section 11175.

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. This requirement does not apply to constant speed pumps furnished under this Section.

- 2. Max pump efficiency at max speed, min (percent) - []
- 3. Maximum pump speed (rpm) - []
- 4. 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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- [5. Max [motor] [engine] speed (rpm) - []]

D. Pump Dimensions:

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NTS: Avoid velocities at pump inlet connections greater than about 14 ft/sec if possible.

Note: ANSI/HI 9.8, at paragraph 9.8.4, limits velocities in the piping approaching the pump to 8 ft/sec. In addition, the standard also dictates a straight section of not less than five nominal pipe diameters downstream from any valve or fitting and upstream from any size reduction for the pump inlet connection.

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1. Impeller diameter, min (in) - []
2. Suction flange, min size (in) - []
3. Discharge flange, min size (in) - []

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 horizontal, split-case 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, ASTM A 744]
[Aluminum bronze, ASTM B 148]
2. Wear Rings - Bronze ASTM B 584 for the impeller;
Stainless steel, ASTM A 743, CF8M for the casing; renewable.
3. Seal - split mechanical seal per Section 11175
4. Bearings - Minimum L-10 bearing life: 100,000 hours at
continuous maximum load and speed.
- [5. Seal tubing] - [Type 316 stainless steel]

- C. **Drive:** [Direct drive] [Variable speed drive] [Engine drive] [with horizontal, heavy-duty, high efficiency, [inverter duty] [constant speed] electric motor suitable for [460]-volt, [3]-phase, 60-Hz ac power supply, in accordance with Section 16040.] [For variable speed drive see Sections [11030 to 11033.]

D. **Equipment Features:**

1. **Casing:** The casing shall be double volute type tapped for seal water connections. Unless otherwise indicated, the seal lubrication water shall be the pumped fluid. Air vent and drain connections shall be provided on the highest and lowest points of the volute. The vent shall be valved and piped to the pump pad equipment drain and fitted with a separate connection for priming. The casing drain shall be valved and piped to the equipment pad drain. The casing shall be axially split, with the top portion removable without disturbing inlet and discharge connections to expose bearings and shaft seals. The entire rotating element shall be removable without disturbing inlet and outlet connections. The bottom portion of the casing shall be cast with mounting pads suitable for bolting and doweling to the base plate. Lifting eye bolts or lugs shall be provided on both casing halves. The casing halves shall be doweled for ease in assembly and alignment.

The casing bearing frame areas shall be shaped to conduct shaft leakage to drilled and tapped drain openings. Split wearing rings shall be provided at the impeller inlet openings. ANSI B16.5 150 psi flanged connections shall be provided on both the inlet and discharge nozzles. The pumps shall have a horizontal inlet connection as indicated. The casing shall be designed for an internal working pressure of not less than 175 psig.

2. **Impeller:** The impeller shall be double suction, enclosed, and keyed to the pump shaft. All water passages shall be finished smooth and polished inside and out. The impeller shall be fitted with renewable wearing rings. The impeller, with wearing rings and shaft attached, shall be statically and dynamically balanced to the criteria established by ANSI/HI 1.5, Figure 1.106.
3. **Wearing Rings:** Replaceable casing and impeller wearing rings shall be provided in accordance with Section 11175. Impeller wearing rings shall be secured with stainless steel set screws. Case wearing rings shall be retained with either stainless steel fasteners or tongue and groove registers mating with similar registers on the casing.
4. **Shaft:** Shafts shall have no reduction in size through the seal area as specified in paragraph 11175-2.4. Threaded and setscrew positioners shall be provided to center the impeller on the shaft. Shafts shall be designed for a maximum deflection of 0.0015 inches at any specified operating condition. Shields shall be provided to prevent water leakage at the shaft from reaching the bearings.
5. **Shaft Seal:** Shaft seals shall be the mechanical type conforming to the requirements specified in paragraph 11175-2.4. Seal lubrication water shall be provided from valved taps on the pump discharge.
6. **Bearings and Bearing Frame:** Bearing frames and housings may be either cast integrally with the casing or cast separately. If cast separately, a doweling feature shall be provided to align the bearing housing with the shaft. Bearings shall be as specified in paragraph 11000-2.8.
7. **Couplings:** Couplings shall conform to paragraph 11000-2.6 and shall be sized to allow removal of the wearing rings and pump rotor without disturbing the motor. An equipment guard conforming to paragraph 11000-2.13 shall be provided.
8. **Baseplate:** Baseplates shall conform to the requirements of Sections 11002 and 11175.

2.3 NAMEPLATES, TOOLS AND SPARE PARTS

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

1. 2 sets of all gaskets and O-rings
2. 2 sets of all pump and motor bearings
3. 1 set of all mechanical seals
4. 2 sets of all wear rings
5. 2 sets of all shaft sleeves

Spare parts shall be stored in tool boxes and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the boxes.

2.4 MANUFACTURERS

A. Pursuant to the limitations described in paragraph 11000-2.1D, candidate pump manufacturers include [Fairbanks Morse, Goulds, Ingersoll-Dresser Pump Co., Patterson, Peerless, Aurora, (Crane Company, Deming Division), and Pacific Pumping Company], or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. **General:** Pumping equipment shall be installed in accordance with the manufacturer's written instructions.
- B. General installation requirements shall be as indicated in Section 11175.

3.2 FIELD TESTING

- A. Field testing of the pumps shall be performed in compliance with Section 11175.

**** END OF SECTION ****