NOTICE: This standard has either been superseded and replaced by a new version or discontinued Contact ASTM International (www.astm.org) for the latest information.



### Standard Specification for Centrifugal Pump, Shipboard Use<sup>1</sup>

This standard is issued under the fixed designation F 998; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers the requirements applicable to the design and construction of centrifugal pumps for shipboard application. The six classes of service covered by this specification are as follows:

1.1.1 Class 1—Boiler feedwater and other freshwater applications with temperatures above 212°F (100°C),

1.1.2 Class 2-Condensate water,

1.1.3 Class 3—Freshwater except Classes 1 and 2,

1.1.4 Class 4—Seawater in which total head produced per stage does not exceed 50 psi (345 kPa),

1.1.5 Class 5—Seawater in which total head produced per stage exceeds 50 psi (345 kPa), and

1.1.6 Class 6—Hydrocarbon pumps (less than 1500 SSU).

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

### 2. Referenced Documents

2.1 ASTM Standards:

A 193/A 193M Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service<sup>2</sup>

A 216/A 216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service<sup>3</sup>

A 276 Specification for Stainless Steel Bars and Shapes<sup>4</sup>

- A 494/A 494M Specification for Castings, Nickel and Nickel Alloy<sup>3</sup>
- A 743/A 743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant, for General Application<sup>3</sup>
- B 148 Specification for Aluminum-Bronze Sand Castings<sup>5</sup>
- B 164 Specification for Nickel-Copper Alloy Rod, Bar, and  $Wire^{6}$
- B 369 Specification for Copper-Nickel Alloy Castings<sup>5</sup>

- B 505 Specification for Copper-Base Alloy Continuous Castings<sup>5</sup>
- B 584 Specification for Copper Alloy Sand Castings for General Applications<sup>5</sup>
- F 467 Specification for Nonferrous Nuts for General Use<sup>7</sup>
- F 467M Specification for Nonferrous Nuts for General Use<sup>7</sup>
- F 468 Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use<sup>7</sup>
- F 468M Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use<sup>7</sup>
- F 1511 Specification for Mechanical Seals for Shipboard Pump Applications<sup>8</sup>
- 2.2 ANSI Standards:
- B1 ISO Metric Screw Threads (ANSI-B1 Report)<sup>9</sup>
- B1.1 Unified Screw Threads<sup>9</sup>
- B16.1 Cast Iron Pipe Flanges and Flange Fittings<sup>9</sup>
- B16.5 Steel Pipe Flanges, Flanged Valves and Fittings, 150, 300, 400, 600, 900, 1500 and 2500 lb.<sup>9</sup>
- B16.11 Forged Steel Fittings, Socket Welding and Threaded<sup>9</sup>
- B16.24 Bronze Flanges and Flanged Fittings, 150, 300lb<sup>9</sup> 2.3 *Hydraulic Institute Standards:*
- ANSI/HI 1.1-1.5 American National Standard for Centrifu-
- gal Pumps for Nomenclature, Definitions, Applications
  - and Operation<sup>9</sup>
- ANSI/HI 1.6 American National Standard for Centrifugal Pump Tests<sup>9</sup>
- ANSI/HI 9.1-9.5 American National Standard for Pumps— General Guidelines for Types, Definitions, Applications and Sound Measurements<sup>9</sup>
- 2.4 AFBMA Standards:
- 9 Load Ratings and Fatigue Life for Ball Bearings<sup>10</sup>
- 11 Load Ratings and Fatigue Life for Roller Bearings<sup>10</sup>
- 2.5 ISO Standards:
- ISO 9001 Quality Systems and Quality Assurance—Design/ Development, Production, Installation and Service<sup>9</sup>

### 3. Terminology

<sup>&</sup>lt;sup>1</sup> This specification is under the jurisdiction of Committee F-25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery.

Current edition approved May 10, 2000. Published September 2000. Originally published as F 998 – 97. Last previous edition F 998 – 97.

<sup>&</sup>lt;sup>2</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>&</sup>lt;sup>3</sup> Annual Book of ASTM Standards, Vol 01.02.

<sup>&</sup>lt;sup>4</sup> Annual Book of ASTM Standards, Vol 01.03.

<sup>&</sup>lt;sup>5</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>&</sup>lt;sup>6</sup> Annual Book of ASTM Standards, Vol 02.04.

<sup>3.1</sup> Definitions:

<sup>&</sup>lt;sup>7</sup> Annual Book of ASTM Standards, Vol 15.08.

<sup>&</sup>lt;sup>8</sup> Annual Book of ASTM Standards, Vol 01.07.

<sup>&</sup>lt;sup>9</sup> Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

<sup>&</sup>lt;sup>10</sup> Anti-Friction Bearing Manufacturers Association, Inc., 1101 Connecticut Ave., N.W., Suite 700, Washington, DC 20036.

3.1.1 *best efficiency point (BEP)*, *n*—the capacity and head in which the pump efficiency is the highest.

3.1.2 *BHP*, n—power delivered to the pump from the driver in brake horse power.

3.1.3 *capacity*, *n*—the total volume output per unit of time. 3.1.4 *centrifugal pump*, *n*—a kinetic machine converting mechanical energy into hydraulic energy through rotating motion.

3.1.5 *close coupled pumps*, n—in this arrangement, no coupling is provided between the pump and the motor shafts, and the pump housing is flange mounted to the motor. The pump impeller is directly mounted to the motor shaft.

3.1.6 *coupled pumps*, *n*—in this arrangement, the pump and the motor must use a coupling to transmit the power from the driver to the pump shaft.

3.1.7 gallons per minute (GPM), n—U.S. customary unit for capacity.

3.1.8 *head*, n—the expression of the energy content of the liquid referred to in any arbitrary datum. It is expressed in units of energy per unit of weight liquid. The measuring unit for head is foot (metre) of liquid.

3.1.9 *head, total discharge, n*—the sum of the pump's discharge gauge head, the velocity head at the gauge connection, and the elevation difference between the pump centerline and the gauge centerline.

3.1.10 *head, total, n*—the measurement of energy increase per unit weight of the liquid, imparted to the liquid by the pump, and is the difference between the total discharge head and the total suction head.

3.1.11 *head, total suction, n*—the sum of the pumps suction gauge head, the velocity head at the gauge connection, and the elevation difference between the pump inlet centerline and the gauge centerline.

3.1.12 *head, maximum rated, n*—the most head a pump can generate with the correct impeller diameter for the service conditions.

3.1.13 *hydrostatic test*, *n*—applying static pressure to the assembled pump or pressure containing components to determine structural integrity of the unit.

3.1.14 *maximum allowable working pressure*, *n*—the maximum discharge pressure that could occur in the pump when it is operated at the rated speed and suction pressure for a given application.

3.1.15 *maximum BHP rated impeller*, *n*—the highest power required by a pump with the correct impeller diameter for the service condition.

3.1.16 *minimum continuous flow*, n—the lowest possible flow rate at which the pump can run without generating excessive heat within the unit or damage to the pump.

3.1.17 *net positive suction head available (NPSHA)*, *n*—the total suction head absolute, determined at the first stage impeller datum, less the absolute vapor pressure of the liquid at a specific capacity.

3.1.18 *net positive suction head required (NPSHR)*, *n*—the amount of suction head over vapor pressure required at the pump to prevent more than a 3 % loss in total head from the first stage of the pump at a specific capacity.

3.1.19 nonmetallic materials, n-any material that would

not be recognized as a metal. Examples include plastics, fiberglass resins, carbon fiber, fiberglass-reinforced vinyl ester, polytetrafluoroethylene (PTFE), or any similar material.

3.1.20 *non-overloading power characteristics*, *n*—this characteristic requires that the driver be sized for the highest possible power requirement from the pump.

3.1.21 *OEM*, *n*—original equipment manufacturer of the pump unit.

3.1.22 *pounds per square inch absolute (PSIA)*, *n*—the U.S. customary measure of pressure with zero as a true absolute zero in pounds per square inch.

3.1.23 *pounds per square inch gauge (PSIG)*, *n*—the U.S. customary measure of pressure with zero being adjusted to atmospheric pressure in pounds per square inch.

3.1.24 *pump efficiency (Eff)*, *n*—the ratio of the energy imparted to the liquid by the pump to the energy supplied to the pump from the driver.

3.1.25 *pump unit*, n—a typical pump unit consists of a separate pump and driver, combined pump and driver (close coupled), coupling, and coupling guard, and may include a gear box and base plate.

3.1.26 *rated point*, *n*—applies to the capacity, head, net positive suction head, and speed of the pump as specified by the order.

3.1.27 specific gravity (Sp. Gr.), *n*—the ratio of the density of the liquid to the density of water at  $64^{\circ}F$  (17.8°C).

3.1.28 vapor pressure, n—the pressure exerted when a liquid is in equilibrium with its own vapor. The vapor pressure is a function of the substance and of the temperature.

3.1.29 *viscosity*, n—the resistance of a fluid to shear motion, its internal friction.

### 4. Ordering Information

4.1 Fig. 1 and Fig. 2 are provided for use by the procuring activity and the OEM. The sections of Fig. 1 and Fig. 2 marked "User Defined," must be completed by the procuring activity and submitted with the request for bid. This will ensure that the potential bidder provides a pump unit that meets all performance, operational, and reliability requirements of the purchaser. The OEM will fill out all sections of Fig. 1 and Fig. 2 marked "OEM Defined," and return the data sheet to the purchaser upon delivery of the pump.

4.2 For the convenience of the procuring activity, Fig. 1 and Fig. 2 are provided in both U.S. customary and SI versions.

#### 5. Material

5.1 The materials cited in Table 1 are provided as a guide. Other materials may be substituted as approved by the purchasing activity and as specified in Fig. 1 and Fig. 2.

5.2 When selecting material combinations, the pump supplier shall take into consideration the conditions under which the various materials interact with each other. Material hardness shall be such that any rubbing, sliding, or tight clearance parts shall be selected so that no binding or galling occurs. Special care shall be taken with Class 4 and 5 pump materials that interact with each other in a seawater environment.

5.3 Consideration shall be given to the use of nonmetallic (composite) pump components where the use of that material can benefit the operation and maintenance of the pump.

# (新) F 998

### **CENTRIFUGAL PUMP ORDERING DATA (ENGLISH)**

USER/CUSTOMER OEM/BIDDER	DATE		
CLASS(1 THRU 6) NO. OF PUMPS NO. OF DRIVERS (MOTORS/TURBIN	E) ITEM NO		
<b>OPERATING CONDITIONS (PURCHASUER-DEFINED)</b>	PERFORMANCE (OEM-DEFINED)		
FLUID	PERFORMANCE CURVE NO.		
°F RATED °F MAX (GPM) RATED	RPM NPSH (WATER)		
SP. GR. AT RATED PT TOTAL HEAD, (FT)RATED	EFF% BHP RATED		
VAP. PRESS. AT RATED PT SUCT. PRESS. (PSIG) MAX, RATED	MAX. BHP RATED IMPELLER		
VISCOSITY AT RATED, SSU NPSHA, (PSIG)	MAX. HEAD RATED		
AMBIENT CONDITIONS	MAX DISCH. PRESS. (PSIG)		
PITCH ROLL LIST TRIM	MIN CONTINUOUS (GPM)		
	TESTING (PURCHASER-DEFINED)		
	□ HYDRO TEST □ WITNESS □ NON-WITNESS		
CONSTRUCTION (PURCHASER REQUIREMENTS)	□ MECH TEST □ WITNESS □ NON-WITNESS		
	□ PERF TEST □ WITNESS □ NON-WITNESS		
	□ NPSH □ WITNESS □ NON-WITNESS		
PUMP TYPE:  HORIZ  VERT  CLOSE COUPLED  OEM OPTION (CHECK ONLY	□ VIBRATION □ WITNESS □ NON-WITNESS		
IF OEM CAN SPECIFY ALTERNATE)	□ ACOUSTIC □ WITNESS □ NON-WITNESS		
SPLIT: 🗆 RADIAL 🗇 AXIAL	DISMANTLE/INSPECT AFTER TEST		
PAINTING/COATINGS SPECIFICATION:	• OTHER :		
ACOUSTICS SPECIFICATION:, OR			
dBA, CENTERBAND VALUES CONNECTIONS: SIZE TYPE (0-RING, ETC)			
DRAIN/VENT	· · · · · · · · · · · · · · · · · · ·		
	TEST REPORTS REQUIRED		
Discharge gage	a test reforts required		
PUMP DETAILS (OEM-DEFINED) PRESS:  MAX. ALLOW PSIG °F HYDRO TEST PSIG	MATERIALS (PURCHASER DEFINED)		
IMPELLER DIA. RATED MAX IMPELLER TYPE	IMPELLER		
BEARING TYPES: RADIAL THRUST	WEAR RINGS		
LUBE: D OIL D GREASE D PERM. GREASE	SHAFT/SLEEVE		
COUPLING: MFR MODEL	GLAND		
DRIVER HALF MTD. BY: D PUMP MRF. D DRIVER MFR. D PURCHASER	BASEPLATE		
MECH. SEAL: [] MFR. & MODEL MATERIAL CODE	OTHER:		
EXT. SEAL FLUSH COOLING WATER: GPM, PSIG, °F	4-4059 INSPECTIONS (PURCHASER-DEFINED) 1-15		
IN ACCORDANCE WITH ASTM F1511	□ IN-PROCESS REQUIRED		
	□ FINAL		
DRIVER (PURCHASER-DEFINED)	DAYS NOTIF. REQ'D		
MOTOR I TURBINE I OTHER SUPPLIED BY			
BHP RPM FRAME VOLTS/PHASE/HERTZ	ADDED REQUIREMENTS		
MFR BEARINGS SERVICE FACTOR	COMMENTS (OEM & PURCHASER DEFINED)		
TYPE INSULATION AMPS: FL LR			
LUBE TEMP. RISE °F ENCL			
ORIENTATION (REL. TO PUMP INLET)			
FOR STEAM TURBINE DRIVER:			
INLET PRESS EXH. PRESS STEAM TEMP WATER RATE			
OTHER:			
PUMP DATA (AFTER PRODUCTION BY OEM)			
CUSTOMER/USER			
LOCATION CUSTOMER P.O. NO			
ITEM NO (S) EQUIP. NO (S)			
FACTORY ORDER NO (S) PUMP SERIAL NO (S)			
ISSUED BY DATE			
REVISION DATE			
(WORD 6.0, DOCS/FCE/001) FIG. 1 Centrifugal Pump Ordering Date			

## 🕼 F 998

### **CENTRIFUGAL PUMP ORDERING DATA (METRIC)**

CLASQUITHRUGOO OF PURPSNO OF PURPS (ADTORSTURENNE)TTEM OG OPERATING CONDITIONS (PURCILASUER DEFINED)PREPORTANCE CURVE NO PURPORTANCE CONSTRUCTOR (DATA DEFINED) PREPORTANCE CURVE NO VAP PERSS AT RATED TT TOTAL HEAD, dee)AATED MAX K & RATED IMPRILEE NERH (WATER) SUBT PURCISSES (dee) MAX RATED MAX K & RATED IMPRILEE NERH (WATER) NUSHA, dee) AMEENT CONDITIONS NUSHA, dee) AMAX RATED MAX K & RATED IMPRILEE NUSCORTY AT RATED C NUSHA, dee) AMAX M NO CONTINUOUS (Lee) NUSCORTY AT RATED C NUSHA, dee) AMAX M NO CONTINUOUS (Lee) TENTING (PURCHASER REQUIREMENTS) TENTING (PURCHASER DEFINED) DEFANT TEST UNINESS I DNON-WITNESS DATA DATA DATA DATA DATA DATA DAT	USER/CUSTOMER	OEM/BIDDER		DATE	
OPERATING CONDITIONS (PURCIASUER DEFINED)     FREMOMANCE QUANTED (CONTRENO, CONTRENO, CONTRENO, CONTRENO, CONTRENO, CONTRENO, CONTRENDO, CONTRESCO, CO				NO	
"C MATED       "C MAX       (1,ep) RATED       EFF       ~~~ HIP RATED         SP. GR. AT FATED FT.       TOTAL HADD, (be)RATED       EFF       ~~~ HIP RATED         SP. GR. AT FATED FT.       TOTAL HADD, (be)RATED       MAX. READ BATED         MARKENT CONTRINCT AT RATED.       MAX. READ BATED       MAX. READ BATED         MARKENT CONTROLOGNES       MAX. READ BATED       MAX. READ BATED         MARKENT CONTON       MAX. READ BATED       MAX. READ BATED         MARKENT CONTON       LIST       TIM       MIN CONTINUOUS (1,em)         PTCH       ROLL       LIST       TIM       MIN CONTINUOUS (1,em)         CONSTRUCTION (PURCHASER REQUIREMENTS)       DIMON TOTION (THESS. UNON-WITNESS       DIMON WITNESS       DIMON WITNESS         PUMP TYPE: D HORIZ D VERT D CLOSE COUPLED D OEM OPTION (CHECK ONLY       DIMON WITNESS       DIMON WITNESS       DIMON WITNESS         SPLIT: G E ADIAL D AXIA.       DISMARTLEINNEYCT ATTERTEST       DISMARTLEINNEYCT ATTERTEST       DIMON WITNESS       DIMON WITNESS         PUMP TYPE: D HORIZ D VERT D SUCCENTRO       OR       OR       DIMON WITNESS       DIMON WITNESS         SPLIT: G E ADIAL D AXIA.       ON WITNESS DIMON WITNESS       DIMON WITNESS       DIMON WITNESS       DIMON WITNESS         SPLIT: G E ADIAL D AXIA.       ON WITNESS DIMON WITNESS <td< td=""><td>OPERATING CONDITIONS</td><td>S (PURCHASUER-DEFINED)</td><td>PERFO</td><td>RMANCE (OEM-DEFINED)</td></td<>	OPERATING CONDITIONS	S (PURCHASUER-DEFINED)	PERFO	RMANCE (OEM-DEFINED)	
SF GR. FLATED FT	FLUID				
SF GR. FLATED FT	°C RATED °C MAX (Lpm) R				
VAP. PESS. AT ATTED F					
AMMEENT CONDITIONS       MAX DISCIP FEESS. (bar)         PTCH       ROLL       LIST       TRIM       MAX DISCIP FEESS. (bar)         PTCH       ROLL       LIST       TRIM       MIN CONTINUOUS (1,40)         PTCH       ROLL       LIST       TRIM       MIN CONTINUOUS (1,40)         CONSTRUCTION (PURCHASER REQUIREMENTS)       DIVER TOST       UNITNESS       DNON-WITNESS         CONSTRUCTION (PURCHASER REQUIREMENTS)       DIMENT ON UNITNESS       DNON-WITNESS       DNON-WITNESS         PURP TYPE:       LORZ D VERT       CLOSE COUPLED D DEM OPTION (CHECK ONLY       DIMENT AGAIN       DIMENT AGAIN         PATITISKICOLATIONS SPECIFICATIONS       DIMENT AGAIN       DIMENT AGAIN       DIMENT AGAIN         PATITISKICOLATIONS SPECIFICATIONS       OTHER IS IN ON-WITNESS       DON-WITNESS         DINET GARGE       OTHER IS IN ON-WITNESS       DON-WITNESS         DINET GARGE       OTHER IS IN ON-WITNESS       DACOUSTIC       WITNESS DINO-WITNESS         DINET GARGE GAGE       OTHER IS IN ON       MAX       DEPENDING         PRESS DINAL ALOW:       Max       DEPENDING       MATERIALS (PURCHASER DEPINED)         PRESS DINAL ALOW:       Max       DEPENDING       MATERIALS (PURCHASER DEPINED)         DINET GARAE       DEWARK RINGS       GARAND					
AMMEENT CONDITIONS       MAX DISCIP FEESS. (bar)         PTCH       ROLL       LIST       TRIM       MAX DISCIP FEESS. (bar)         PTCH       ROLL       LIST       TRIM       MIN CONTINUOUS (1,40)         PTCH       ROLL       LIST       TRIM       MIN CONTINUOUS (1,40)         CONSTRUCTION (PURCHASER REQUIREMENTS)       DIVER TOST       UNITNESS       DNON-WITNESS         CONSTRUCTION (PURCHASER REQUIREMENTS)       DIMENT ON UNITNESS       DNON-WITNESS       DNON-WITNESS         PURP TYPE:       LORZ D VERT       CLOSE COUPLED D DEM OPTION (CHECK ONLY       DIMENT AGAIN       DIMENT AGAIN         PATITISKICOLATIONS SPECIFICATIONS       DIMENT AGAIN       DIMENT AGAIN       DIMENT AGAIN         PATITISKICOLATIONS SPECIFICATIONS       OTHER IS IN ON-WITNESS       DON-WITNESS         DINET GARGE       OTHER IS IN ON-WITNESS       DON-WITNESS         DINET GARGE       OTHER IS IN ON-WITNESS       DACOUSTIC       WITNESS DINO-WITNESS         DINET GARGE GAGE       OTHER IS IN ON       MAX       DEPENDING         PRESS DINAL ALOW:       Max       DEPENDING       MATERIALS (PURCHASER DEPINED)         PRESS DINAL ALOW:       Max       DEPENDING       MATERIALS (PURCHASER DEPINED)         DINET GARAE       DEWARK RINGS       GARAND					
PITCII       ROLL       LIST       TRIM       MIN CONTINUOUS (pm)         DETTING (PURCHASER REQUIREMENTS)       DETTING (PURCHASER DEFINED)         CONSTRUCTION (PURCHASER REQUIREMENTS)       DEMON-WITNESS       DON-WITNESS         CONSTRUCTION (PURCHASER REQUIREMENTS)       DEMON-WITNESS       DON-WITNESS         PUMP TYPE:       DEMOR 2       VERT       CLOSE COUPLED       DEMON OPTION (CHECK ONLY       DURENT       WITNESS       DON-WITNESS         PUMP TYPE:       DARAL 0       AXIAL       WITNESS       DON-WITNESS       DON-WITNESS         SPLIT:       DARAL 0       AXIAL       DISMANTLEINSPECT AFTER TEST       DISMANTLEINSPECT AFTER TEST         PAINTINGCOATING SPECIFYALTERNATE)       DISMANTLEINSPECT AFTER TEST       DISMANTLEINSPECT AFTER TEST         CONNECTIONS:       SIZE       TYPE (ARING, ETC)       DISMANTLEINSPECT AFTER TEST         DISCHARGE GAGE       DISCHARGE GAGE       DISCHARGE GAGE       DISCHARGE GAGE         DISCHARGE GAGE       DISCHARGE GAGE       DISCHARGE GAGE       DISCHARGE GAGE         PUMP DETALS (COMDENDEND       MATERIAL CODE       DISCHARGE GAGE       DISCHARGE GAGE         DIVER RALE DI MAX       IMPELLER TYPE       MATERIAL S (PURCHASER DEFINED)         MPELLER       MAX       MATERIAL CODE       DISCHARGE GAGE					
CONSTRUCTION (PURCHASER REQUIREMENTS)       UPURD TYPE       UPURD TYPE </td <td></td> <td colspan="3"></td>					
CONSTRUCTION (PURCHASER REQUIREMENTS)					
CONSTRUCTION (PURCHASER REQUIREMENTS) <ul> <li>MECH TEST</li> <li>UNTINESS</li> <li>UNON-WITNESS</li> <li>U</li></ul>				· · · · ·	
PUMP TYPE: D HORZ: D VERT D CLOSE COUPLED D GEM OPTION (CHECK ONLY IF GEM CAN SPECIFY ALTERNATE) SPLIT: D RADAL D AXIA. PAINTINGCOATINGS SPECIFICATION: ACOUSTICS SPECIFICATION: CENTERBAND VALUES CONNECTIONS: D BAANVENT CONNECTIONS: D BAANVENT D DRAINVENT D DRAIN D DRAI	CONSTRUCTION (PURCHASER REQUIREME	NTS)			
UNPENT       UNITNESS       UNINNENTINESS       UNINNENTINESS         PUMP TYPE:       INGREZ       UNINNENTINESS       UNINNENTINESS       UNINNENTINESS         SPLIT:       ID RADIAL       AXIAL       ID DISMANTLEJNSPECT AFTER TEST       ID DISMANTLEJNSPECT AFTER TEST         PAINTINGCOATINGS SPECIFICATION:	······································	,			
PUMP TYFE:       INTRESS       UVERT       CLOSE COUPLED       OEM OPTION (CHECK ONLY       UVERATION       UVERATION         IF GEM CAN SPECIFY ALTERNATE)       INTRESS       INON-WITNESS       INON-WITNESS         SFLIT:       RADIAL       INTRESS ON NON-WITNESS       INON-WITNESS         SFLIT:       RADIAL       INSTANCTORS       INTRESC AFTER TEST         JANTINICONTROS SPECIFICATION:					
IF OEM CAN SPECIFY ALTERNATE)       I ACOUSTIC       I WITNESS       I NON-WITNESS         SPLIT:       I RAJAL       I DISMANTLE/INSPECT AFTER TEST       IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	PLIMP TYPE: IL HORIZ IL VERT IL CLOSE COL	IPLED TO OFM OPTION (CHECK ONLY			
SPLIT:       D ADMANTLE/INSPECT AFTER TEST         PAINTING/COATROGS SPECIFICATION:		•			
PAINTINGCOATINGS SPECIFICATION:, OR, O		(KI)(12)			
ACOUSTICS SPECIFICATION:, OR					
dBA					
CONNECTIONS:       SIZE       TYPE (0-RING, ETC)					
DRAINVENT     DINET GAGE     DISCHARGE GAGE     DISCHARGE GAGE  PUMP DETAILS (DEM-DEFINED)  PRESS: DMAX ALLOW, barCHYDRO TESTbar IMPELLER (DAL RATEDMAXIMPELLER TYPEKASINGADIKASINGADIADIADIADIADIADIADIADIADIADIADIADI				······	
INLET GAGE Instrate of the provided of the		SIZE I YPE (U-RING, ETC)			
DISCHARGE GAGE   PUMP DETAILS (OEM-DEFINED)   PRESS: MAX ALLOW.   bar *C   HYDRO TEST bar   CASING   IMPELLER DIA. RATED   MAX.   IMPELLER TYPE   BEARING TYPES:   RADIAL   THRUST   BASEFLATE   COUPLING:   MER.   MODEL   BIN ACCORDANCE WITH ASTM FISTI   BIN ACCORDANCE WITH ASTM FISTI   BIN ACCORDANCE WITH ASTM FISTI   DIVER (PURCHASER-DEFINED)   INACCORDANCE WITH ASTM FISTI   BIN P   RPM   FRAME   VOLTS/PHASE/HERTZ   ADDED REQUIREMENTS   COMMENTS (OEM & PURCHASER DEFINED)   INPELCERTY   ADDED REQUIREMENTS   COMMENTS (OEM & PURCHASER DEFINED)   INPECCESS REQUIRED   BIN P   RPM   FRAME   VOLTS/PHASE/HERTZ   ADDED REQUIREMENTS   COMMENTS (OEM & PURCHASER DEFINED)   INPECCESS REQUIRED   BIN P   RPM   FRAME   VOLTS/PHASE/HERTZ   ADDED REQUIREMENTS   COMMENTS (OEM & PURCHASER DEFINED)<					
FUMP DETAILS (OEM-DEFINED)       MATERIALS (PURCHASER DEFINED)         PRESS:       MAX ALLOW.       bar       "C_HYDRO TEST_bar       CASING         IMPELLER DIA RATED       MAX       IMPELLER TYPE       NMPELLER         BEARING TYPES: RADIAL       THRUST       WEAR RINOS         JUBE:       OLIC GREASE       GLAND       SHAFTSILEVE         COUPLING: MFR.       MODEL       GLAND       GLAND         DRIVER HALF MTD. BY:       PUMP MRF.       D DIVER MFR.       D URCHASER         MECH. SEAL:       MRE & MODEL       MATERIAL CODE       OTHER:         EXT. SEAL FLUSH COOLING WATER:       Lpm*C_       INSPECTIONS (PURCHASER-DEFINED)         IN ACCORDANCE WITH ASTM FISI       INSPECTIONS (PURCHASER-DEFINED)       INSPECTIONS (PURCHASER-DEFINED)         IN MOTOR       TURBINE D OTHER       SUPPLIED BY       JDAYS NOTF, REQ'D         INFR       BEARINGS       SERVICE FACTOR       COMMENTS (COM & PURCHASER DEFINED)         IUBE       TUBENE DRIVER:       STEAM TURBINE DRIVER:       INSULATION       AMPS: FL         ILUBE       TEMP, RISE *C       ENCL       COMMENTS (COM & PURCHASER DEFINED)         IUBE       TEMP, RISE *C       ENCL       COMMENTS (CEM & PURCHASER DEFINED)         IUME       TEMP, RISE *S			U TEST REPORTS	3 REQUIRED	
PRESS: □ MAX. ALLOWbwr°C HYDRO TESTbwrCASING		Hen Stand			
IMPELLER DIA RATED       MAX       IMPELLER TYPE       IMPELLER         BEARING TYPES: RADIAL       THRUST       WEAR RINOS         LUBE:       OIL:: GREASE DERM. GREASE       GLAND         COUPLING: MFR.       MODEL       GLAND         DRIVER HALF MTD. BY:: D PUMP MRF. D DRIVER MFR. D PURCHASER       BASEPLATE         MECH. SEAL:: D MFR. & MODEL       MATERIAL CODE       OTHER:         EXT. SEAL FLUSH COOLING WATER: Lpm       bar      , *C         IN ACCORDANCE WITH ASTM F1511       D IN-PROCESS REQUIRED       IN-PROCESS REQUIRED         D MOTOR::       TURBINE D'       D IN-PROCESS REQUIRED       D IN-PROCESS REQUIRED         D MOTOR::       TURBINE D'       D IN-PROCESS REQUIRED       D IN-PROCESS REQUIRED         D MOTOR::       TURBINE D'       D IN-PROCESS REQUIRED       D IN-PROCESS REQUIRED         BHP       RPM       FRAME       VOLTS/PHASE/HERTZ       Added REQUIREMENTS         ORIENTATION (REL: TO PUMP INLET)       FOR STEAM TURBINE DRIVER:       COMMENTS (OEM & PURCHASER DEFINED)         FOR STEAM TURBINE DRIVER:       STEAM TEMP.       WATER RATE       MODEL         NULET PRESS       EXH. PRESS.       STEAM TEMP.       WATER RATE       MOTEL         OTHER:       CUSTOMER PRODUCTION BY OEM)       CUSTOMER PRODUCTION BY OEM)				, , ,	
BEARING TYPES: RADIAL THRUST WEAR RINGS   LUBE: OIL:: GREASE FERM. GREASE   COUPLING: MFR. MODEL GLAND   DRIVER HALF MTD. BY: PUMP MRF. D DRIVER MFR.   DRIVER HALF MTD. BY: PUMP MRF. D DRIVER MFR.   MECH. SEAL: OTHER. MATERIAL CODE   OTHER: MATERIAL CODE OTHER:   DRIVER (PURCHASER-DEFINED) IN ACCORDANCE WITH ASTM FISI1 INSPECTIONS (PURCHASER-DEFINED)   DRIVER (PURCHASER-DEFINED) DAYS NOTIF. REQ'D   IMOTOR OTHER SUPPLIED BY Image: Comparison of the supplied by   BHP RPM FRAME   VOLTS/PHASE/HERTZ ADDED REQUIREMENTS   MFR BEARINGS   SERVICE FACTOR IR   LUBE TEMP. RISE *C   ENCL ORIENTATION (REL TO PUMP INLET)   FOR STEAM TURBINE DRIVER: NATER RATE   NILET PRESS STEAM TEMP.   WATER RATE Image: Comparison of the supplied by   UMBER CUISTOMER VOLTS/PHASE/HERTZ   ORIENTATION (REL TO PUMP INLET)   FOR STEAM TURBINE DRIVER:   NLET PRESS   STEAM TURBINE DRIVER:   INLET PRESS   INCLT PRESS   CUISTOMER P.O. NO.   ITHEN NO (S)   FACTORY ORDER NO (S)   ISSUED BY					
LUBE: DOILD GREASE DERM. GREASE       MODEL       GLAND         COUPLING: MFR.       MODEL       GLAND         DRIVER HALF MTD. BY: D PUMP MRF. D DRIVER MFR. D PURCHASER       BASEPLATE         MECH. SEAL: D MFR. & MODEL       MATERIAL CODE       OTHER:         EXT. SEAL FLUSH COOLING WATER: Lpm       , bar       , °C       INSPECTIONS (PURCHASER-DEFINED)         D IN ACCORDANCE WITH ASTM F1511       DATS NOTIF. REQ'D       DATS NOTIF. REQ'D         DRIVER (PURCHASER-DEFINED)       DATS NOTIF. REQ'D       DAYS NOTIF. REQ'D         DMOTOR D TURBINE D OTHER SUPPLIED BY	IMPELLER DIA. RATED MAX.	IMPELLER	<u>1</u>		
COUPLING: MFR.       MODEL       GLAND         DRIVER HALF MTD. BY:       PUMP MRF.       DRIVER MFR.       PURCHASER       BASEPLATE					
DRIVER HALF MTD. BY: D PUNP MRF. D RIVER MATERIAL CODE OTHER:   MECH. SEAL: I MFR. & MODEL MATERIAL CODE OTHER:   EXT. SEAL FLUSH COOLING WATER: Lpm		SHAFT/SLEEVE			
MECH. SEAL:  MAR. & MODEL	COUPLING: MFR MOD	GLAND			
EXT. SEAL FLUSH COOLING WATER: Lpm, bar, °C INSPECTIONS (PURCHASER-DEFINED)   IN ACCORDANCE WITH ASTM F1511 IN-PROCESS REQUIRED   DRIVER (PURCHASER-DEFINED) IN-PROCESS REQUIRED   MOTOR I TURBINE II OTHER SUPPLIED BY DAYS NOTHE REQ'D   BHP RPM FRAME VOLTS/PHASE/HERTZ ADDED REQUIREMENTS ADDED REQUIREMENTS   MFR BEARINGS SERVICE FACTOR COMMENTS (OEM & PURCHASER DEFINED)   TYPE INSULATION AMPS: FL LR COMMENTS (OEM & PURCHASER DEFINED)   UBE TEMP, RISE °C ENCL COMMENTS (OEM & PURCHASER DEFINED)   ORIENTATION (REL TO PUMP INLET) FOR STEAM TURBINE DRIVER:   INLET PRESS EXH. PRESS STEAM TEMP WATER RATE   OTHER:					
IN ACCORDANCE WITH ASTM F1511       IN-PROCESS REQUIRED         IN-PROCESS REQUIRED       In-PROF         IN-PROCESS REQUIRED       In-PROF         BHP       REARINGS       SERVICE FACTOR         INSULATION       AMPS: FL       LR         IUBE       TEMP. RISE °C       ENCL         INDET TEMP. RISE °C       ENCL       COMMENTS (OEM & PURCHASER DEFINED)         ORIENTATION (REL TO PUMP INLET)       FOR STEAM TURBINE DRIVER:       COMMENTS         INLET PRESS       EXH. PRESS.       STEAM TEMP.       WATER RATE         OTHER:       INLET PRESS.       STEAM TEMP.       WATER RATE         UNTOMERAUSER       INLET       INLET       INLET			OTHER:		
IN ACCORDANCE WITH ASIM FISH       IN-FROCESS REQUIRED         Image: Service For the supplied by			INSPEC	TIONS (PURCHASER-DEFINED)	
DRIVER (PURCHASER-DEFINED) □	□ IN ACCORDANCE WITH ASTM F1511		II IN-PROCESS RE	QUIRED	
Image: Motion in turbine is other supplied by			🗆 FINAL		
BHP RPM FRAME VOLTS/PHASE/HERTZ ADDED REQUIREMENTS   MFR BEARINGS SERVICE FACTOR COMMENTS (OEM & PURCHASER DEFINED)   TYPE INSULATION AMPS: FL LR   LUBE TEMP. RISE °C ENCL. COMMENTS (OEM & PURCHASER DEFINED)   ORIENTATION (REL TO PUMP INLET)	DRIVER (PURCHASER-DEFINED)		DAYS NO	TIF. REQ'D	
MFR.       BEARINGS       SERVICE FACTOR       COMMENTS (OEM & PURCHASER DEFINED)         TYPE       INSULATION       AMPS: FL       LR         LUBE       TEMP. RISE °C       ENCL.       ORIENTATION (REL. TO PUMP INLET)         FOR STEAM TURBINE DRIVER:       INLET PRESS.       EXH. PRESS.       STEAM TEMP.         INLET PRESS.       EXH. PRESS.       STEAM TEMP.       WATER RATE         OTHER:       PUMP DATA (AFTER PRODUCTION BY OEM)       CUSTOMER/USER         LOCATION       CUSTOMER P.O. NO.	□ MOTOR □ TURBINE □ OTHER SUPPLIED	BY			
TYPE INSULATION AMPS: FL LR         LUBE TEMP. RISE °C ENCL         ORIENTATION (REL. TO PUMP INLET)         FOR STEAM TURBINE DRIVER:         INLET PRESS EXH. PRESS STEAM TEMP WATER RATE         OTHER:         PUMP DATA (AFTER PRODUCTION BY OEM)         CUSTOMERAUSER	BHP RPM FRAME	VOLTS/PHASE/HERTZ	ADDED REQUIR	EMENTS	
LUBE TEMP. RISE °C ENCL         ORIENTATION (REL. TO PUMP INLET)         FOR STEAM TURBINE DRIVER:         INLET PRESS EXH. PRESS STEAM TEMP WATER RATE         OTHER:         PUMP DATA (AFTER PRODUCTION BY OEM)         CUSTOMER/USER         LOCATION CUSTOMER P.O. NO	MFR BEARINGS SERV	VICE FACTOR	COMMENTS (OE	M & PURCHASER DEFINED)	
LUBE TEMP. RISE °C ENCL         ORIENTATION (REL. TO PUMP INLET)         FOR STEAM TURBINE DRIVER:         INLET PRESS EXH. PRESS STEAM TEMP WATER RATE         OTHER:         PUMP DATA (AFTER PRODUCTION BY OEM)         CUSTOMER/USER         LOCATION CUSTOMER P.O. NO					
ORIENTATION (REL. TO PUMP INLET)			_		
FOR STEAM TURBINE DRIVER:         INLET PRESS EXH. PRESS STEAM TEMP WATER RATE         OTHER: <b>PUMP DATA (AFTER PRODUCTION BY OEM)</b> CUSTOMER/USER         LOCATION CUSTOMER P.O. NO					
INLET PRESS EXH. PRESS STEAM TEMP WATER RATE OTHER: PUMP DATA (AFTER PRODUCTION BY OEM) CUSTOMER/USER LOCATION CUSTOMER P.O. NO ITEM NO (S) EQUIP. NO (S) FACTORY ORDER NO (S) PUMP SERIAL NO (S) ISSUED BY DATE REVISION DATE					
OTHER: <b>PUMP DATA (AFTER PRODUCTION BY OEM)</b> CUSTOMER/USER		A TEMP. WATER RATE			
PUMP DATA (AFTER PRODUCTION BY OEM)         CUSTOMER/USER         LOCATION       CUSTOMER P.O. NO.         ITEM NO (S).       EQUIP. NO (S)         FACTORY ORDER NO (S).       PUMP SERIAL NO (S)         ISSUED BY       DATE         REVISION       DATE					
CUSTOMER/USER					
LOCATION       CUSTOMER P.O. NO.         ITEM NO (S).       EQUIP. NO (S)         FACTORY ORDER NO (S).       PUMP SERIAL NO (S)         ISSUED BY       DATE         REVISION       DATE					
ITEM NO (S)       EQUIP. NO (S)         FACTORY ORDER NO (S).       PUMP SERIAL NO (S)         ISSUED BY       DATE         REVISION       DATE		MED BO NO			
FACTORY ORDER NO (S).       PUMP SERIAL NO (S)         ISSUED BY       DATE         REVISION       DATE		MER F.U. NU.			
FACTORY ORDER NO (S).       PUMP SERIAL NO (S)         ISSUED BY       DATE         REVISION       DATE	ITEM NO (S) EQUIP.	NO (8)			
ISSUED BY         DATE           REVISION         DATE	FACTORY ORDER NO (S) PUMP S	SERIAL NO (S)			
REVISION DATE					
	(WORD 6.0, DOCS/FCE/002)	· · · · · · · · · · · · · · · · · · ·			

FIG. 2 Centrifugal Pump Ordering Data (Metric)

Purchaser approval must be obtained for the use of nonmetallic materials.

**TABLE 1 Material Specifications** 

	Class 1 (Boiler Feedwater)	Class 2 (Condensate)	Class 3 (Fresh Water)	Class 4 (Seawater (< 50 psi/stage)	Class 5 (Seawater (> 50 psi/stage)	Class 6 (Hydrocarbon)
Casing	12 % chrome steel (Specification A 743/A 743M, Grade CA15)	copper-nickel (70-30) (Specification B 369, UNS C96400)	bronze (Specification B 584, Alloy 905 or 922)	copper-nickel (70-30) (Specification B 369, UNS C96400)	copper-nickel (70-30) (Specification B 369, UNS C96400)	bronze (Specification B 584, Alloy 905 or 922)
Shaft	12 % chrome steel (Specification A 276, Grade 410)	nickel-copper alloy (Specification B 164, Class A or B, UNS N04400 or N04405)	nickel-copper alloy (Specification B 164, Class A or B, UNS N04400 or N04405)	nickel-copper alloy (Monel) (Specification B 164, UNS N04400)	nickel-copper alloy (Monel) (Specification B 164, UNS N04400)	nickel-copper alloy (Specification B 164, Class A or B, UNS N04400 or N04405)
Impeller	12 % chrome steel (Specification A 743/A 743M, Grade CA15)	nickel-copper alloy (Specification A 494/A 494M, S22, Comp M30C with S22)	bronze (Specification B 584, Alloy 905 or 922)	nickel-aluminum bronze (Specification B 148, Alloy 955)	nickel-aluminum bronze (Specification B 148, Alloy 955)	bronze (Specification B 584, Alloy 905 or 922)
Shaft sleeves	12 % chrome steel (Specification A 276, Grade 410)	nickel-copper alloy (Specification B 164, Class A or B, UNS N04400 or N04405)	stainless steel (Specification A 276, Type 304 or 316)	nickel-copper alloy (Monel) (Specification B 164, N04400)	nickel-copper alloy (Monel) (Specification B 164, N04400)	stainless steel (Specification A 276, Type 304 or 316)
Wear rings	12 % chrome steel (Specification A 743/A 743M, Grade CA15 and CA6NM)	nickel-copper alloy (Specification A 494/A 494M, Comp M25S, with S10 and S21 or M30H)	bearing bronze III (Specification B 505, UNS C91000)	nickel-copper alloy (Specification A 494/A 494M, Comp M25S, with S10 and S21 or M30H)	nickel-copper alloy (Specification A 494/A 494M, Comp M25S, with S10 and S21 or M30H)	bearing bronze III (Specification B 505, UNS C91000)
Base	structural steel	structural steel	structural steel	carbon steel (Specification A 216/A 216M, Grade WCB)	carbon steel (Specification A 216/216M, Grade WCB)	structural steel
Casing bolts	corrosion-resisting steel (Specification A 193/A 193M)	Monel (Specification F 468, Alloy 400)	Monel (Specification F 468, Alloy 400)	Monel (Specification F 468, Alloy 400)	Monel (Specification F 468, Alloy 400)	Monel (Specification F 468, Alloy 400)

### 6. General Requirements

6.1 Pumps shall be designed to meet all operational requirements of the intended service and be constructed in such a manner as to allow for reliable operation and maintenance.

6.2 Pumps shall be selected to operate at or near the best efficiency point (BEP) on the head-capacity curve. The pumps shall have non-overloading power characteristics, and the driver-rated horsepower shall at least equal the maximum power requirements of the pump at the rated speed without allowances for a service factor.

6.3 Pumps shall be designed for a shipboard environment including both pitch and roll conditions specified by the purchaser in Fig. 1 and Fig. 2. Pumps shall also be capable of sustained operation at the maximum angles of list and trim specified in Fig. 1 and Fig. 2.

6.4 For horizontal pumps, the pump and driver shall be mounted on a common base of sufficient strength and stiffness to allow for proper alignment and operation. Where necessary to maintain proper alignment, dowels or fitted bolts shall be provided.

6.5 All vertical pumps shall be entirely supported by a horizontal foundation or a vertical ship structure, but not both. Where necessary, the upper portion of the pump unit may be bolted to a frame erected on the horizontal foundation.

6.6 Bedplates for Class 6 pumps shall be equipped with

#### driprims and drain connections.

6.7 Horizontal pumps of the coupled type shall be driven through a flexible coupling. Coupled vertical pumps may be connected to their drivers by a flexible or rigid coupling. Couplings between the pump and driver shall be keyed to both shafts.

6.8 All pump units shall incorporate guards over the couplings, belts, and other external rotating parts. The guards shall prevent personnel contact with the rotating elements. Guards shall be rigid enough to support a 200-lb (88-kg) person.

6.9 Pump and driver seating surfaces of mounting bedplates, bracket mounting plates, or other mounting arrangements shall be machined.

6.10 Sufficient means shall be provided for attaching conventional lifting gear for the installation, removal, and maintenance of both the pump and driver.

6.11 Pumps with face-mounted motors shall be arranged such that there are four possible orientations of the motor to pump.

6.12 Shaft alignment between the pump and driver will be specified by the OEM to allow the pump unit to operate within the vibration limits set in Section 8 over the expected service life of the pump.

6.13 Direction of rotation shall be indicated on the pump by either an arrow cast into the pump casing or by a direction

arrow plate permanently attached to the pump.

6.14 The driver type and requirements shall be specified in Fig. 1 and Fig. 2.

### 7. Pump Design

7.1 Pump inlet and outlet connections shall be flanged in accordance with ANSI B16.1, B16.5, B16.11, or B16.24.

7.2 Pump casings, except for small close-coupled pumps, shall be arranged so that the rotating components can be removed without disturbing the driver or the suction and discharge connections.

7.3 The pump casings shall be provided with bosses drilled and tapped or socket welded and flanged for suction, discharge pressure gage, and vent and drain connections if specified in Fig. 1 and Fig. 2 (refer to Fig. 1 and Fig. 2 for type and size). All connections shall be plugged or blank flanged using material suitable for design conditions.

7.4 Coupled pumps shall be equipped with radial and thrust bearings to support the rotor and counteract any unbalanced forces in the pump and ensure that the pump will operate satisfactorily over the pump's entire design range.

7.5 Close coupled pumps and rigidly coupled vertical pumps shall have radial and thrust bearings located in the driver that are capable of supporting the rotating assembly and counteracting any unbalanced forces in the pump unit.

7.6 Bearings shall be securely fitted by snap rings, shoulders, or other means to prevent axial movement within the bearing housing. Bearing housings shall be integral or bolted to the pump case to maintain internal alignment of components and external alignment between the pump and driver. Bolted connections require fitted bolts, dowels, or rabbet fit to ensure alignment of the bearing housing to the casing.

7.7 Journal and thrust bearings may be of the fluid film or rolling element (antifriction) type. The bearings may be sealed and self or externally lubricated or may be lubricated by the process fluid.

7.8 Rolling element bearings shall be selected in accordance with AFBMA Standards 9 or 11, or both, and shall have a calculated minimum L10 life of 15 000 h.

7.9 Unless otherwise specified in Fig. 1 and Fig. 2, all pumps shall be equipped with mechanical seals in accordance with Specification F 1511. The installation shall ensure that adequate circulation of liquid at the seal faces occurs to minimize deposits of foreign matter and to provide adequate lubrication of the seal faces.

7.10 Material selection shall be in accordance with Section 5.

7.11 Separate pressure boundary parts such as casing halves, suction heads, and end covers shall be attached to the pump casing using rabbet fits, dowel pins, or fitted bolts to ensure component alignment.

7.12 Screw threads shall conform to ANSI B1.1. Metric screw threads shall conform to ISO Metric Screw Threads (ANSI B1 Report.)

### 8. Performance Requirements

8.1 The operating conditions of the pump shall be as specified in Fig. 1 and Fig. 2.

8.2 The NPSHR of the pump as determined by the Hydrau-

lic Institute Standards (ANSI/HI 1.1-1.5) shall not exceed the NPSHA that is specified at the rated condition.

8.3 Pumps that handle liquids more viscous than water shall have their water performance corrected in accordance with the Hydraulic Institute Standard (ANSI/HI 1.1-1.5).

8.4 The internally excited vibration levels of the pump unit shall not exceed the requirements of the centrifugal pump test standards of the Hydraulic Institute (ANSI/HI 1.1-1.5).

8.5 The acoustic levels of the pump shall not exceed those specified in Table 1 when measured in accordance with the centrifugal pump test standards of the Hydraulic Institute (ANSI/HI 9.1-9.5).

8.6 Pressure containing parts shall be capable of withstanding a pressure of at least 1.5 times the maximum allowable design pressure.

### 9. Painting and Coatings

9.1 *Painting*—External unmachined and nonmating machined surfaces shall be thoroughly cleaned and painted with a hydrocarbon-resistant, anticorrosive (lead and chromate free) primer and topcoat. Heat-resistant paint requirements, if any, will be specified in Fig. 1 and Fig. 2.

9.2 Painting external surfaces of nonferrous parts and components is not required but is permissible to avoid excessive masking. Identification plates shall not be painted or oversprayed.

### **10. Equipment Identification Plates**

10.1 Identification plates shall be made of a corrosionresistant material that will last throughout the service life of the pump. The identification plate must be securely attached to each pump.

10.2 The pump identification plate shall contain, at a minimum, the following information:

10.2.1 Manufacturer's name, dc533c58/astm-1998-00

10.2.2 Manufacturer's model number and size,

10.2.3 Manufacturer's serial number,

10.2.4 ASTM F 998 Class \_\_\_\_\_, and

10.2.5 Design parameters (expressed in English or SI units):

10.2.5.1 Capacity (rated) (GPM or  $m^3/h$ ),

10.2.5.2 Suction requirements (ft or m),

10.2.5.3 Total developed head (rated) (ft or m),

10.2.5.4 Rated speed (RPM),

10.2.5.5 BHP, and

10.2.5.6 Hydrostatic test pressure (psi or bar).

10.3 Attached accessory units such as the driver, controller, and gearbox shall have an identification plate.

10.4 The manufacturer shall provide necessary safety information in the form of information plates.

#### **11. Testing Requirements**

11.1 Testing shall be in accordance with Fig. 1 and Fig. 2. 11.2 Hydrostatic tests shall be performed at a pressure of 1.5 times of design working pressure (or 50 psig minimum) for a minimum of 30 min. The pump shall exhibit no leakage through the pressure boundary material or joints during the hydro test. Mechanical seal leakage criteria shall be in accordance with Specification F 1511.

11.3 The mechanical run test shall consist of a short