DME
402

CURATION GROUP
DRG. office

NEW
DME-402
(NEW)

DME SPECIFICATION 402

DESIGN, SELECTION & MANUFACTURE OF ROTODYNAMIC PUMPS

DME-402
(NEW)

Read wide letter No. EG/4001/Aux/04 dt 21/3/06

FOREWORD

1. This document is a comprehensive specification on Marine Rotodynamic Pumps, as a guidance document to pump manufacturers and those dealing with design and selection of pumps. For more details on installation requirements, General Marine Engineering Specifications and other relevant documents may be consulted.

2. Any user of this specification, within the Navy or in the outside industry may propose changes. Proposal for changes are to be forwarded to Director Marine Engineering, Integrated Headquarters, Ministry of Defence, New Delhi -110011.

3. No alteration to this specification is to be made, without formal approval of the Directorate of Marine Engineering.

(Gopal Bharti)
Commodore
Principal Director of Marine Engineering

28 Nov 05

CONTENTS

SCOPE

0101 This specification contains guidance information and mandatory requirements for rotodynamic pumps for installation onboard Indian Naval ships.

0102 This document defines Naval duties and details pertaining to evaluations and testing of pumps. Manufactures may be guided by this document to ensure that their products meet the standards of manufacture, in-process inspection, type and performance tests and installation on Naval Ships.

0103 Order specification and/or guidance drawings with details of type and performance of the pump for particular application will be separately issued along with tender enquiry or order. Order specification will be prepared by Naval Headquarters or ship builder.

GENERAL

0201 At present there is no standard range of roto-dynamic pumps for Naval Applications Naval Policy has been to restrict the types and models of pumps to achieve standardization.

0202 Pumps which will meet the following requirements of Naval standards of performance, environment, material, quality control, documentation, manufacture and testing at all stages of design developments, manufacture and testing would be classified as warship standard pumps.

0203 General Applications of roto-dynamic pumps in Naval ships are as follows.-

(a) Feed Pumps

(b) Extraction Pumps

(c) Seawater Pumps

(d) Fuel, Transfer and Supply Pumps

(e) Forced Lubrication Pumps

(f) Chilled and Fresh Water Cooling Pumps

(g) Domestic Hot and Cold Fresh Water Pumps

(h) Salvage Pumps

(j) Portable Pumps

Duty

0204 The duty of a pump in a particular application will be defined by the system designer. Following aspects should be considered while selecting the pump **(NES 327 refers)**.-

(a) Operation in all environmental conditions prescribed

(b) Rated flow at rated head /pressure

(c) Flow and head / pressure at specific duties

(d) NPSH required

(e) Requirement of self priming

0213 **Static Tilt of Equipment** Equipment is to be designed to withstand the following shipboard angles of permanent heel and trim. The angles at which equipment must remain capable of operation and survive without damage vary according to the type of ship and the orientation or function of the equipment. For new equipment and systems not covered by existing specifications the maximum conditions considered must be.-

(a) Operate at design performance with a permanent tilt of 15 degrees in any direction.

(b) Survive, without leakage of fluids or other degradation, a permanent tilt of 30 degrees in any direction and be capable of design performance when conditions return to (a) above or normal

(c) All pumps upon which reliance is placed for damage control and fire-fighting duties are to be capable of operating efficiently when the vessel is in a static damaged condition causing a heel of 30° and a trim of 15°.

0214 Equipment in all ships is normally to be designed for un-stabilised conditions Recommended figures for general design purposes are given in table below. Statistically 'significant values' are defined as the average of the third highest peaks and there is a 13% probability of exceeding these values. The rms values which have a numerical value equal to half the significant value, are exceeded 60% of the time.

Sea State	Roll (Unstabilised)		Pitch		Yaw	Heave	
	Period (s)	Amplitude (Degrees)	Period (s)	Amplitude (Degrees)	Acceleration under ship's motion (degrees/s^2)	Period (s)	Amplitude (m)
7	8	+30	6	+7	1.75	7	4.0

Table - Ship Motion Data for General Design (Significant Values)

0215 Pumps which are associated with the operation of diesel generating sets or such other equipments shall be capable of operating under the conditions specified for the main equipment.

Vibration Environment

0216 Pumps and their associated equipments are to operate efficiently in the vibration environment in ships. The vibration environment is specified in **NES 1004**. In general, if

(n) Location in ship relative to centre line and normal deep water line (in case of surface ships)

Commercial Issues

0207 In addition to the technical requirements of the Pump, there are commercial issues involved in the purchase and running of the equipment. The same may be specified in the procurement document. Some of these issues are as follows -

(a) Through life contractual repair.

(b) Warranty and performance guarantees.

(c) Quality Assurance Plan. The manufacturer shall submit a quality inspection and control plan, which meets the intent of ISO 9001 before commencing production

(d) Duration of spares availability

(e) Transfer of intellectual property rights

Operational Conditions

0208 The ambient conditions in which the pump and associated equipment has to operate will vary with the location of the equipment and the state of environment. These will be specified in the order specification **(NES 1004 relevant)**

0209 All pumps should be normally capable of operating continuously at full specified performance at ambient temperature 0 – 55 °C and relative humidity 30 to 100 %, but not more than 38 °C wet bulb temperature, without any undue effect on maintenance or life.

0210 In laid up conditions, the ambient temperature may vary from -10 °C to + 55 °C, RH 30 to 100%. The pump should be capable of operating at full specified performance when brought to normal operation from laid up condition

0211 At closed down conditions the ambient temperature may rise upto 70 °C, RH 30 to 100% but not more than 44 °C Wet bulb temperature and remain in so for a specified period of time. Generally, the pump shall be capable of operating at a specified performance for 72 hours cumulative including 48 hours continuous every three months without any undue effect on maintenance or life.

Ship Motion

0212 Equipment is to remain mechanically secure and operate at its design performance when the vessel is subjected to the action of the sea and weather in addition to the velocities and accelerations derived from deliberate manoeuvers.

the pump is mounted in the main region of the ship, the standard test levels are as follows:-

Type of Ship	Region	Standard Test Level Peak Values & Frequency Range
Mine Sweeper size & above	Protected Compartments, Hull	0.125 mm Range 5 to 33 Hz
Smaller than Mine Sweeper	Protected Compartments, Hull	Constant velocity 30 mm/s or 0.2 mm whichever is lesser Range 7 to 300Hz
Submarines	All	0.125 mm 5 to 33 Hz

0217 For general test purposes the low frequency limit of 05 Hz is acceptable However if the equipment has any low frequency resonance, then the test will be extended to 0.5 mm to 2 mm at 1 to 5 Hz as explained in **NES 1004**.

0218 It is not mandatory for all mechanical equipments to be vibration tested, particularly the more robust items. However, automatic control units or special linkage equipments are to be vibration tested.

Vibration

0219 Acceptable noise and vibration levels will depend upon the target noise level of the ship in which the pump is to be installed. In general an attempt should be made to reduce the noise and vibration level to minimum. In the selection and design of pumps, the following are to be considered to minimize noise and vibration:-

(a) Pump speed

(b) Number of impeller / diffuser vanes or cutwaters

(c) Number of lobes / vanes or gear teeth

(d) Number of cylinders

(e) Dynamic balance

(f) Type of bearings

(g) Liquid film whirl in hydrodynamic bearings

(h) Gear meshing frequencies of gearboxes

(j) Driver type and speed

Noise

0220 The sound pressure level for the pump or pump package shall not exceed the value indicated in the specification. This shall generally be taken from **NES 832**.

0221 Pump or pump package noise should be minimized using the techniques described in **NES 810**.

0222 If the pump manufacturer considers it necessary to fit an acoustic enclosure the effect on pump/pump package size and maintainability shall be fully described in the tender.

0223 Noise tests shall be conducted in accordance with **NES 813**.

Shock

0225 All pumps and associated equipments installed in ships will be subjected to shock acceleration in service. Therefore all pumps should have an inherent degree of shock resistance. Equipment is to withstand without damage or subsequent degradation in performance a peak acceleration of 300 m/s^2 associated with half-sine (acceleration) pulse duration of 18 milli-second. This requirement applies along each of the three major orthogonal axes of the equipment.-

(a) In both directions for equipment up to and including a mass of 75 Kg.

(b) In one direction for equipment over 75 Kg mass.

0226 The level of shock resistance the pump should have in any particular application will depend upon the type of ship, position of the pump in the ship, weight of the unit and type of mounting and these will be specified in the order specification in accordance with **BR 3021**, **BR 8470** and **NES 814**.

0227 When a pump is likely to be fitted in a number of types of ships, the most severe shock conditions will be specified

0228 Inherent shock strengths of the pump is to be ascertained by calculations in accordance with the Simplified Procedure 1 described in BR 3021 (1) and it is to be submitted to IHQ/MoD(N) for approval.

0229 All prototype or first production pumps for applications which are essential for the sea going and fighting capability of the ship are to be shock tested. Pumps and equipments mounted on the same base plate should be tested as a combined unit.

0230 Pumps with less inherent shock strength than the environmental shock specified are to be mounted on shock attenuating mounts. Deflection limitations, alignment

constraints and vibration attenuation requirements should also be taken into account while designing the shock mounts

0231 The pump manufacturer is to be responsible for the overall mounting system. The design of the mounting should be in accordance with statement of requirement and should be submitted to HQ/MoD(N) for approval. Details of mounting system are to be included in the supporting literature and drawings to be supplied.

Thermal Shock

0232 All pumps are to be capable of withstanding rapid temperature changes within the specified range of operation without adverse effect on the pump performance and reliability. The design is to minimize any tendency to misalignment of the equipment liable to arise from differential thermal expansion when starting from cold

Cavitation & NPSH

0233 Cavitation, i.e. the formation and sudden collapse of vapour cavities can occur whenever the local absolute pressure falls below the fluid vapour pressure. Cavitation causes loss of pump performance and can cause noise and vibration and damage to pump internals particularly impellers. Pumps shall operate satisfactorily over the whole of the operating flow range specified. Cavitation shall not shorten the overall life of components or incur shut-downs between scheduled maintenance activities.

0234 When specified in the SOTR the rotodynamic pump offered shall have an Net Positive Suction Head Required (NPSHR) 3% value not greater than 25% or 50% of the Net Positive Suction Head Available (NPSHA) at rated conditions.

0235 Positive displacement pumps for differential pressures up to 20 bar shall use an Net Positive Inlet Pressure Required (NPIPR) criterion of 3% flow loss. Positive displacement pumps for differential pressures over 20 bar shall use an NPIPR criterion of 0% flow loss Pumps that do not exhibit a well defined NPIPR characteristic shall use an agreed NPIPR criterion

0236 Manufacturers of positive displacement pumps handling liquids with indistinct vapour pressure properties shall define the suction performance of the pump by MIP

Self Priming

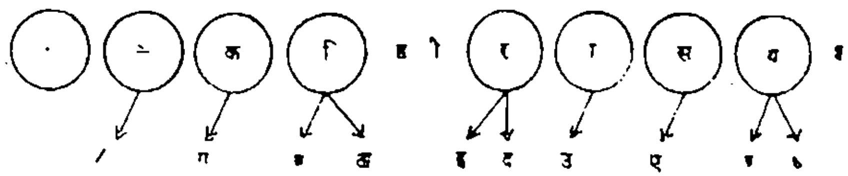
0237 A pump may be required to be of the self priming type when machinery arrangement aspects dictate that the pump / impeller is above the fluid level This requirement when applicable will be included in the order specification

0238 Self priming pumps generally fall into the following categories:-

(a) Self priming impeller, turbine type

ड्रिल 3

पहली पंक्ति



निर्देश—अंगुलियों का संचालन तीर-चिन्ह द्वारा दिखाया गया है। गाइड कीज से ुलियां प्रथम पंक्ति की कुंजियों को टकरायेंगी और गाइड कीज पर वापस आती गी।

बराबर याद रखें छोटी अंगुलियां अपनी जगह पर ही तो हैं।

पिछले अभ्यासों को बारबार शुद्ध टाइप कर दुहराएं।

अभ्यास

1. कगक बिं छिं सध्य यण्य सएस ला रदर रइर
2. प्रसाद क्रम प्रकार प्रचार कब्र ग्रह सत्र चक्र
3. गबन गगन काग बाहर असम इरादा
4. इलायची दमन दारा दाल उदार उस उन उजाला ऐन ऐसा
5. पुण्यक्र ध्यान साध्य ध्वनि ध्वंसक उपाद गण्य एकता

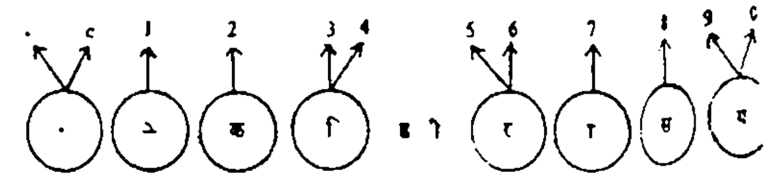
निर्देश—ो के लिए ा के पश्चात् े टाइप करें।

अभ्यास

एक दिन राजा ने बालक राम को गोद में लिया, रात हो गयी, चंद्रमा का उदय हुआ ने सुनहरे एवं गोल आकार वाले चंद्र को देखा चंद्र को लेने के लिए उसने अंगुलियों से त किया व गुल मचाया, राजा का ध्यान वहां गया किन्तु सोच नहीं पाए कि किस प्रकार को लाएं, बालक रोता रहा, अंत में पानी में राम का ध्यान चंद्रमा के प्रतिबिंब की ओर बालक चुप हो गया।

ड्रिल 4

चौथी पंक्ति



निर्देश—(1) कृ, नृ टाइप करने के लिए पहले क या ॒ टाइप करें, ि अंगुली से टाइप करें।

(2) ज़ टाइप करने के लिए पहले ज फिर छोटी अंगुली से, बिन्दु, . टाइप करें। . (बाद एक स्पेस द

अभ्यास

1. क2 क ि 3 ि ि 4 ि यि 0 य य, य स 8स ।7। र6र र5र
2. कृपा सुजन नृप साहस कृपालु, वृक मृदुल हृदय सुजन पुण्यमय
3. रोज़ आज़ाद अंग्रेज़ी मज़ाक
4. तुम नहीं आओगे पर चलो हम आएंगे

(कल सारणी) टेबुलेटर के प्रयोग को अवश्य सीखो—देखि पैरा(6)

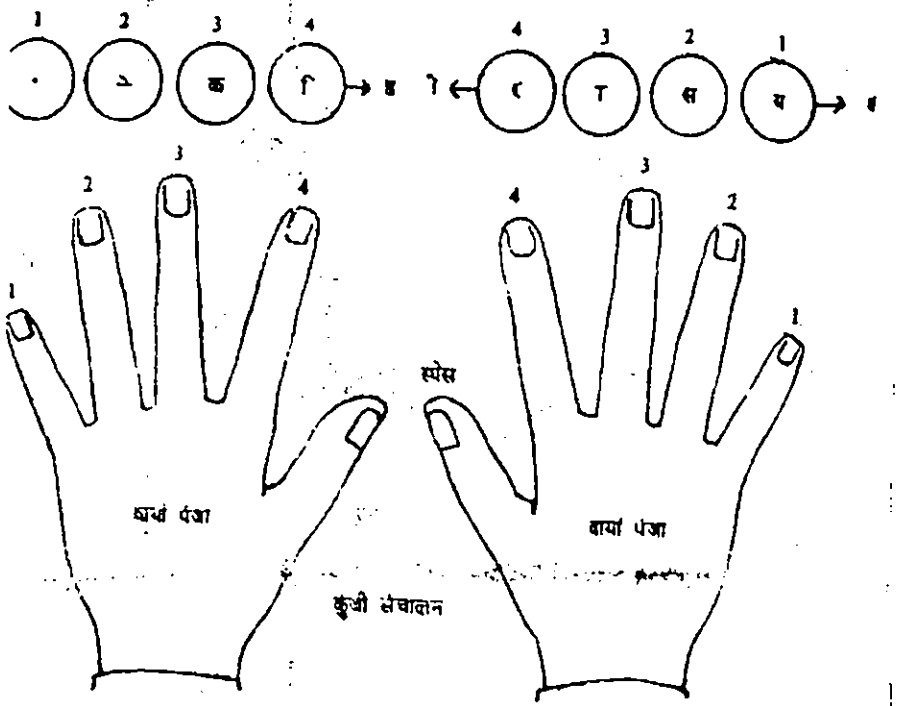
5\. 234 568 809 302 123 234 45 456
3790 2134 4578 789 301 4568

ड्रिल 5

निर्देश—(डाट) यह दूसरी पंक्ति की दाईं ओर की अंतिम कुंजी है। इसके प्रकार हैं :—

(1) दशमलव बिन्दु के लिए, जैसे 5.3
(2) संक्षिप्त शब्दों के लिये जैसे क. ग. आदि;
(3) लीडर डॉट्स के लिए जैसे ....
(4) विराम चिह्न के लिए।

होम-कीज (दूसरी पंक्ति)



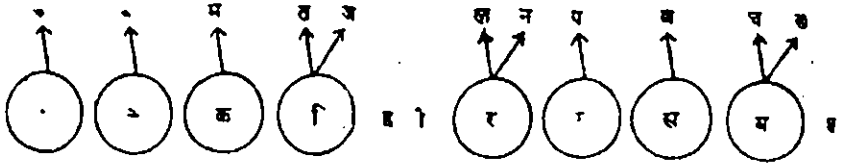
निर्देश—प्रत्येक पंजा की उंगुलियों और कुंजियों का सम्बन्ध सं० 1, 2, 3, और 4 से दिखाया गया है।

अभ्यास

1. कहिकि यसारीर कहिकि यसारीर कहिकि यसारीर
2. कही सकर सहारा किसी यह सिर हरी राय कर
3. कहि श्यसारीर कहि श्यसारीर कहि श्यसारीर
4. कश्क कह रहरश्क रसिक हारा यही
5. कस सिंह रंक संसार कस कहे हरे ये से साहस
6. किसके सहारे यह यहां रहा राही सही कहो कि किस की राय से यह हारा

द्वितीय पंक्ति

तीसरी पंक्ति



निर्देश—अंगुलियों का संचालन तीर चिन्ह द्वारा दिखाया गया है। अंगुलियां तीसरी पंक्ति की कुंजियों को अपने स्थान से उठकर टकरायेंगी और फिर तुरन्त अपने स्थान पर वापस आएंगी। याद रखें दूसरी पंक्ति की कुंजियों को गाइड कीज अथवा होम कीज कहते हैं और अंगुलियां हमेशा वहां वापस आती रहेंगी चाहे वे जिस कुंजी को भी टाइप करें। श के बाद । टाइप करने से श बनता है।

बराबर अभ्यास रखें छोटी अंगुलियां अपनी जगह पर ही सो हैं।

पिछले अभ्यास को बारबार शुद्ध टाइप करके दुहराते जाएं।

अभ्यास

1. कमक तिं जिं यश्य यश्य सदस पा रनर रलर
2. पाप नाम काम नीति रजनी वही चाल ख्याति लाली, माला
3. मनुज नूपुर माता जलज जलज पवन नापाक चमन ख्याल कश्मीर
4. मूल नूर पुकार कूप कुंज कुंती चमक कवच ख्वाहिश
5. कमल ने जलज से पूजा की रजनी व सीता नाची कुशल
6. काका मूली ला माला पहना हरीश नरेश

(b) Centrifugal pump provided with a suction reservoir, air separating chamber and means of re-circulation between the air chamber and the suction reservoir.

(c) Centrifugal pump with a separate air evacuating pump driven by the same motor.

Normally the arrangement at (c) above is preferred.

0239 Alternatively a group of centrifugal pumps can be primed by connecting them on the suction side to a separate motor driven air evacuating unit (i.e. a central priming system). This may not be acceptable in all surface ships as it involves more piping. But it may save on overall pump size and cost when a large number of pumps are to be self priming type.

Hydraulic Design

0240 Cavitation is to be avoided entirely at the design duty of the pump and to be minimized to the greatest practical extent over the remaining range of specified output. The selected speed of the operation of the pump, the area for the flow, and the form of the suction passages are to be designed in relation to the viscosity and vapour pressure of the pumped fluid and to the lowest specified manometric head at the pump suction to provide smooth flow to the impeller or rotor and so ensure freedom from cavitation. Sudden changes in the cross section area for flow and in the direction of flow of the fluid are not permitted. Design of the discharge passage is to minimize lose of head within the pump.

0241 The head flow rate characteristics of pumps specified to run in parallel with one another are to be stable throughout their complete ranges of output.

0242 The disposition of the impellers or rotors and the relative disposition of suction and discharge branches is to be arranged to minimize the liability of air locking under any specified attitude of operation, especially in pumps, which are liable to operate with a sub atmospheric condition at the pump suction branch. In addition, the disposition of the branches is to permit the arrangement of the associated pipe work to ensure that the pump impeller or rotor remains drowned when the pump is stopped.

Hydraulic Thrust

0243 Hydraulic thrust on the rotating element is to be minimized in the operating range and thrust bearings provided to take any unbalanced axial thrust that arises under starting and running conditions. All bearing surfaces are to be adequately sized to support the mechanical and un-balanced hydraulic loads imposed on them. Particular attention is to be given to unbalanced hydraulic thrusts arising during minimum and maximum net flow rate operating conditions. Changes in thrust characteristics when the pump is worn to its wear limits are to be allowed for in bearing design

Submersibility

0244 When it is specified that pump and motor assemblies are t be capable of submergence, a flooding level of 05 metres above the pump seating is to be specified unless a greater flooding level is required. Under these conditions, the pump is to be capable of starting and running for a period to be specified in the order specification.

0245 Submersible pumps with motors of the air bell configuration are to be provided with a means for routine testing of the air tightness of the air bell and motor arrangements. Any removable covers which break into the air bell formed by the motor and pump combination are to be provided with test facilities to permit checking that air tightness of the flange joints is maintained.

Motor Selection

0246 Electric motors shall be designed and manufactured in accordance with **EED-Q-071(R2)**

0247 Motors shall be suitable for 380 V 3-phase 50 Hz or other supplies as defined in the STR.

0248 All motors shall be suitable for direct-on-line starting. All motors shall be suitable for a minimum of four starts per hour when hot.

0249 All motors shall be suitable for restarting while rotating in the correct direction against residual magnetism and 180° out of phase.

0250 Motors shall be continuously rated for the appropriate conditions described below:-

(a) Motors for centrifugal pumps shall be rated for the maximum absorbed power when passing the maximum flow specified at the greatest liquid density specified and at the highest viscosity specified

(b) Motors for axial and mixed flow pumps shall be rated for the maximum absorbed power which occurs at any specified set of operating conditions.

(c) Motors for positive displacement pumps shall be rated for operation with the discharge isolating valve closed, at relief valve overpressure with the maximum specified viscosity.

0251 Motors shall be capable of starting pumps under any specified system condition considering the voltage drop encountered during starting inrush currents.

0252 Motors shall be capable of accelerating the pump up to operating speed in less than 10 seconds.

0253 In considering the actual pump performance, a load range tolerance of ±2 5 % on frequency is to be taken into account.

0254 Disconnected electric motors combined with air turbines or air motors shall be suitable for intermittent rotation at the turbine/motor maximum no load speed without sustaining mechanical damage.

0255 Liquid-cooled electric motors combined with air turbines or air motors shall be physically protected to **IP 68** for the maximum liquid depth specified.

0256 Terminals and terminal boxes shall be suitable for the connection of cables in accordance with **NES 502**. If the atmosphere is potentially hazardous the gland/plug/socket shall be independently certified for the zone, area and gas groups. Gland/plug/socket shall be protected to **IP56** or to **IEC 529** (See **BS EN 60529**).

0257 Submersible motors driving portable/mobile pumps shall be equipped with cable glands or suitable plug/socket rated for **IP68** at the maximum liquid depth specified. If the liquid or atmosphere is potentially hazardous the gland/plug/socket shall be independently certified for the zone, area and gas groups.

0258 Submersible pumps with motors of the airbell configuration shall be provided with suitable means to routinely verify the integrity of the airbell. Any removable covers/flanges that form a seal of the airbell shall be provided with suitable means to verify the integrity of gaskets.

0259 Motors shall have provision to accept an external earthing strip of at least 4 mm^2 attached by a 4 mm minimum diameter bolt.

0260 When specified, the pump manufacturer is to provide the following data to enable selection of motor:-

(a) Output power required, KW

(b) Period of output or duty cycle

(c) No load or synchronous speed

(d) Full load speed and speed tolerance

(e) Direction of rotation

(f) Particulars of shaft end and mounting details

(g) Starting torque

(h) Maximum permissible starting current

(j) Full characteristics of the pump and the fluid to be pumped

(k) Axial and radial thrust characteristics transmitted to the motor.

Lifting Arrangement

0261 All components weighing more than 40 kg are to be provided with eyebolts. Any components requiring special handling shall be so marked and shall be accompanied by the necessary handling instructions. One set of lifting gear is to be supplied along with the pump package.

Scope of Supply

0262 The pump manufacturer will be responsible for the supply of the pump together with its prime mover, starter, base plate, mountings, instrumentation and control. The pump manufacturer is to ensure that the associated equipments confirm to relevant Naval Standards.

0263 Scope of supply, applicable to the particular installation will be specified in the order specification. In general the installation boundaries are as follows:-

(a) Inlet and outlet materials

(b) Leak off connections

(c) Pump discharge chamber vent valve outlet where fitted

(d) Pump drain valve outlet where fitted

(e) Electrical terminals on motors, starters, controls and instrumentation where fitted. Wiring between the pump and its starter/Control panel will be supplied by the ship builder

(f) Coolant inlet and outlet connections to the water jackets of submersible airbell type motor driven pumps.

(g) Air drive supply and exhaust connections where a pump is air driven or has an alternative air drive.

(h) Air drive lubricating oil supply, seal and drain connections (from the main FL system) or FL pumps where the pump is air driven or has an alternative air drive

(j) Hydraulic motor supply, exhaust and drain connections of hydraulic motor driven pumps.

(k) Mountings arrangements. Shock/ vibration mounts where required are to be supplied with the pump. Tank mounted pumps supported on shock mounts are to be fitted with a sealing bellows between the pump and the tank by the pump manufacturer

(l) Thrust compensating unit pump end bracket/pad where fitted.

(m) Bearing coolant and lubricating water inlet and outlet connections from an external source where fitted.

(n) Seal coolant, sealing, drain and leak off fluid connections from an external source where fitted

(p) Instrumentation pipe connections where fitted.

Painting, Preservation and Packing

0264 Painting, preservation and packing of equipment must meet the following specifications:-

(a) Painting and preservation of equipment for dispatch shall be in accordance with **NES 737**.

(b) Packing and boxing of equipment for transportation shall be in accordance with **NES 724**.

(c) Equipment shall be provided with de-preservation procedures in order to prepare equipment for installation and subsequent commissioning and operation.

(d) The equipment supplier shall provide an assessment of the effect on service life of a period of five years in storage, indoors at tropical ambient temperature, before installation. The assessment shall include necessary routine activities to ensure preservation is maintained and the maximum number of parts shall be serviceable. A list of all parts that must be replaced shall be included.

0307 Materials positive displacement and roto-dynamic pumps shall be agreed with the manufacturer. Acceptable materials for roto-dynamic pumps are given in table below -

Pumped Fluid / Pumped Component	Feed (Main & Auxiliary Feed Pump)	Condensate (Main & De-aerator Extraction Pump)	Other Condensate Feed Fresh (Raw) Water	Lubricating Oil	Fuel Oil, FFO, Diesel & AVCAT	Main Circulating Seawater	Other Seawater Brine & Calcium Chloride Brine
Casing and Gland Housing	Cast Steel NES 817			Gunmetal NES 833 Part 4 Nickel Aluminium Bronze NES 747 Part [illegible] Aluminium Silicon Bronze NES 834 Part 3			Nickel Aluminium Bronze Cast NES 747 Part 5
Spindle (Excluding sleeves where fitted)	Stainless Steel BS EN [illegible] BS EN [illegible]			Nickel Aluminium Bronze NES 833 Part 2 Hiduron NES 835 Aluminium Silicon Bronze NES 834 Part 2			
Spindle Sleeves	BS [illegible]			Gun Metal NES 833 Part [illegible] or BS EN 1982			
Impeller	Stainless Steel BS 3100	Monel BS 3071 NA1		Gun Metal NES 833 Part 3 Nickel Aluminium Bronze NES 747 Aluminium Silicon Bronze NES 834 Part 2			Nickel Aluminium Bronze NES 747 Part 5 or Monel BS 3072 NA1
Clearance or Packing Rings	Leaded Bronze BS EN 1982			Leaded Bronze BS EN 1982 Phenolic Resin (non-asbestos)			
Bearings (If lubricated By Fluid Pumped)	PTFE Impregnated Leaded Bronze		Leaded Bronze BS EN 1982				Phenolic Resin (non-asbestos)
SEAL PARTS							
Packing	Cold Fluid Cotton packing NS Cat No. [illegible] Hot Fluid Lubricated Metal Foil NS Cat No. 0411-923-[illegible]			Hot Fluid NS Cat No. 0411-923-[illegible]		Cold Fluid NS Cat No. [illegible]	Cold Fluid NS Cat No. [illegible]
Bush lantern and Neck Rings				Leaded Bronze BS EN 1982			
Mechanical seals			Monel Metal Parts, Resin Loaded Carbon Rings, Solid Ceramic Seat				
'O' Ring				Fluorocarbon NES 337			

<u>Materials for Roto-Dynamic Pump Components</u>
<u>(Centrifugal, Axial Flow or Mixed Flow)</u>

DESIGN

0301 Pumps and their associated equipments should be designed to meet all service requirements. The major features which are desirable are:-

(a) Reliability

(b) Ease of maintenance

(c) Efficiency

(d) Economy of weight

(e) Economy of space

(f) Ease of operation

(g) Ease of manufacture

(h) Resistance to shock

(j) Silence of operation

(k) Safety of personnel

0302 Relative importance of these features depends upon the purpose of the ship for which machinery installation is designed. Order specification will indicate those features which are of over-riding importance in any particular application.

Materials

0304 All materials for the manufacturing of the pump are to be of approved Naval specifications and most suitable for the particular service. Special attention is to be given to the selection of materials with a view to reduce corrosion or erosion of components to the minimum. Consideration may be given to hardening or plating of wearing surfaces

0305 Any special / new material or design features introduced in the pump manufacture is to be highlighted to IHQ/MoD(N).

0306 Materials with an elongation of less than 12% or a Charpy impact value less than 13J at 20°C shall not be used. Spheroidal or nodular graphite iron, to BS EN 1563 Grade 370/17, may be used with the approval of IHQ/MoD(N).

General Mechanical Design

0308 The specifications to be adhered to are as follows:-

(a) Pumps and pump packages shall use metric fasteners. The minimum fastener diameter should not be less than 8 mm. The use of self tapping screws is prohibited except where no load or no requirement for removal is anticipated. Where self tapping screws are used the potential for corrosion must be eliminated.

(b) When a pump, gearbox, motor or similar machine includes dimensionally identical fasteners for different functions all fasteners shall be of the same material specification.

(c) Consideration shall be given during design to the handling of components and assemblies (including removal routes) when erecting, assembling and maintaining the pump/pump package. Facilities shall be provided, where necessary, for jacking bolts, extraction bolts, locating dowels, spigots and lifting eyes.

(d) Fabricated components shall be stress relieved before machining.

(e) The forces and moments applied to pump connections shall be agreed between the pump manufacturer and the system designer.

(f) When a drain connection is specified complete emptying of the casing shall be possible. Drains shall be plugged or valved as specified in the STR. Threaded connections shall not be used for hazardous liquids.

(g) When a vent connection is specified complete venting of the casing shall be possible. Vents shall be plugged or valved as specified in the STR. Threaded connections shall not be used for hazardous liquids.

(h) All pumps shall be self venting during all normal operating attitudes.

(j) When specified in the STR pump casings shall be provided with a filling connection. The connection shall be plugged or valved as specified in the STR. Threaded connections shall not be used for hazardous liquids.

(k) If it is impractical to fit drain, filling or venting connections the manufacturer shall describe the difficulties and propose alternative system solutions.

(l) Pumps mounted on tanks or extending into tanks shall be arranged for easy removal, with a minimum of dismantling and not disturbing other equipment, and without draining the tank.

(m) Pumps, supported by noise and/or shock mountings, mounted on or extending into tanks, shall have the base surrounded by a sealing bellows.

(n) Fixed pumps, which are specified to be suitable for intermittent submersion, shall be capable of operation when submerged to a minimum depth of **05 m** measured from the pump mounting bracket. A greater depth of submergence shall be specified in the STR if necessary. Pumps shall be capable of starting and running for at least eight hours under all normal attitudes. A longer running period shall be specified in the STR if necessary.

(p) Pumps shall be capable of normal operation during rapid temperature changes of the pumped liquid. A rapid change of liquid temperature from cold to normal operating temperature, exceeding 50°C occurring five times between scheduled major maintenance activities, shall not impair pump performance or reliability. The design of pumps shall minimise misalignment effects caused by differential thermal expansion while warming up.

(q) All pumps and drivers shall have the correct direction of rotation permanently indicated at a point that is clearly visible.

(r) After reviewing the requirements for thermal shock and deciding on appropriate acceptable nozzle forces and moments the manufacturer shall determine if major pressure containing parts may have an internal corrosion allowance and IHQ/MoD(N) is to be informed whether such an allowance is made.

Design of Pump Packages

0309 The specifications to be adhered to are as follows:-

(a) When pumps and drivers are specified to be mounted independently the necessary coupling(s) shall be selected to cope with the predicted misalignment specified in the STR.

(b) Pumps, drive train and motors mounted independently shall incorporate suitable lifting points to facilitate installation and removal.

(c) Pump packages shall not exceed the dimensions specified in the STR.

(d) If space constraints preclude the fitting of a spacer coupling of the required length and the pump or driver weight is less than 250 kg the bolting down arrangements shall be organised to allow easy repositioning of pump or driver to facilitate pump coupling hub, bearing if appropriate, and seal removal.

(e) The design of pump packages shall minimise misalignment effects caused by differential thermal growth while warming up. For pumps that are susceptible to misalignment, means are to be provided for checking alignment.

(f) Pump packages shall be supported by suitable vibration isolation mountings. Mountings shall be capable of absorbing hull movements given in the STR.

(g) Consideration shall be given to the forces and moments applied by connecting pipe work when selecting the location and number of vibration isolation mountings. When expansion bellows or flexible pipe connections are used the reactive thrust due to fluid pressure shall also be considered. If necessary, lateral or longitudinal restraints may be added to control the pump package movement.

(h) When lateral or longitudinal restraints are required the pump manufacturer shall supply complete assemblies.

(j) When expansion bellows or flexible pipe connections are used anchor points may be required adjacent to the pump or driver connections.

(k) Base Plate.

(i) The baseplate shall be made sufficiently rigid to avoid permanent distortion during transportation. The baseplate shall maintain alignment during operation and withstand appropriate shock loads. All welds shall be continuous. Wherever possible overhung masses are to be avoided.

(ii) Baseplates shall be equipped with four lifting points to allow the use of four equal length slings for installation/removal of the complete unit. For units with restricted access the STR may permit lifting of pump, drive-train and driver separately.

(iii) Baseplates shall be fabricated using steel conforming to BS EN 10025 Grade S355 J2 G3 or equivalent material with certified impact properties.

(l) If a drain pan or special facilities are required these shall be specified in the STR.

(m) **Vee Belts**. When a speed change between the pump and driver is necessary, preference shall be given to gearboxes. If a vee belt is used, provision shall be incorporated for tension adjustment and mounting/dismounting belts.

(i) Vee belts shall be selected from **DEF STAN 30-2**. The manufacturer shall indicate if a matched belt set is necessary. The material of pulleys is subject to approval.

(ii) Vee belt drives are to be protected by robust guards that allow adequate ventilation when considering the range of ambient conditions

Support

0310 All machinery is to be secured to the ship by an appropriate number and size of holding down bolts which are to be positioned so as to reduce the stresses likely to be caused by the large decelerations accompanying underwater explosion. Where packing chocks are required, they are to be made of one of the following materials:-

(a) Nodular cast iron BS 278g - SNG 24/17

(b) Cast or forged steel

(c) Cast aluminum to BS 1490 LM6-M

0311 Cast aluminum is to be used only where weight reduction is of the utmost importance.

0312 Where alignment might be adversely affected, a number of the holding down bolts for each machine are to be fitted to withstand the loads that may be caused by large accelerations in a horizontal direction accompanying under water explosion. The nuts to be used in conjunction with holding down bolts are to be of the self locking type.

0313 Shock and vibration mountings selected from Naval standard range are to be fitted where necessary and they are to be secured with self locking nuts of the nylon insert type.

0314 To facilitate routine inspection and removal of mountings by ship staff personnel, jacking or lifting devices are to be incorporated such that all mountings can be removed at the same time. The jacking or lifting devices are to be fitted with locking arrangements to ensure that in the locked clear position the correct shock clearances are maintained

Couplings and Guards

0315 The following specifications are to be adhered to:-

(a) Pumps driven by a separate driver should be close coupled or fitted with a spacer coupling. Where a pump is not close coupled the spacer should be of adequate length to permit removal of the pump coupling hub, the pump bearing if appropriate and the shaft seal. If the pump is of 'back pull out' construction or is fitted with a cartridge assembly the spacer should be of adequate length to permit normal maintenance tasks.

(b) Roto-dynamic pumps and screw pumps shall be supplied with torsionally rigid, flexible couplings. Diaphragms, where fitted, shall be of corrosion resistant non sparking material. The coupling design shall restrain any components in the

case of coupling failure. Spacers shall be dynamically balanced according to **ISO 1940 G1.0**.

(c) Positive displacement pumps, other than screw pumps, shall be supplied with torsionally flexible couplings appropriate for the degree of cyclic irregularity experienced in operation.

(d) Coupling selection shall be in accordance with the coupling manufacturers' recommendations.

(e) Guards shall be in accordance with **BS EN 953**. See also **BS EN 809**.

Pipe Connections

0316 The following specifications are to be adhered to:-

(a) Connections that rely on the sealing of a threaded component shall not be used on piping for hazardous liquids.

(b) Piping shall be supplied with sufficient connections, strategically located, to permit efficient maintenance of the equipment.

(c) Compression fittings are prohibited

(d) Pipe connections shall be made by any of the methods listed below at the discretion of the pump manufacturer or as specified in the STR.

(e) Threaded connections using BSPP or BSPT threads.

(f) Flanges complying with **BR 3013(2)**.

(g) Screwed unions with capillary brazed ends complying with **BR 3013(2)**.

(h) Capillary brazed connectors complying with **BR 3013(2)**.

(j) Socket weld fittings in non corrosive services.

(k) Taper hub connectors with socket weld or butt weld hubs appropriate for the service.

(l) Butt weld pipe-to-pipe.

Tally and Diagram Plates

0317 All major components, switches, valves, cocks, levers, gauges, alarms, indications etc , are to have identification tallies located on them Tally plates shall be in English

language and in SI units. All tallies and diagram plates shall be of anodised aluminium alloy. Caution/ warning tallies should be in bold black letters on a fluorescent orange background. A diagram plate indicating details of connection is to be provided/affixed near to the terminal box of the motor. Size of tally plate and their letters shall be conformed to specification **NES-723**.

0318 Arrow marking for direction of rotation of motor is to be provided by supplier. This tally is to be made of Naval Brass and properly secured on the motor.

0319 Motor details such as HP (KW), Starting Current, Full Load Current, rpm, Insulation, Weight, Maker's Name, Sr. No. of Machine, Year of Manufacturing etc. are to be given in the motor tally plate.

0320 Motor winding terminals ending at Connection Box should have engraved tally number as per the anodised aluminium tally affixed at the rear side of motor connection box.

0321 The diagram plate which is fixed on the rear side of the front door should have complete wiring diagram of the starter with sub-component identification number. The same identification number should be engraved on the components fitted on the starter

0322 Internal Cable-Cores terminating at the connection terminal strip should have the same corresponding terminal ferrule no. Fixed / fitted on it.

Instruction Plates

0323 Instruction plates of metallic / fire safe material, listing the start/stop procedure and precautions in brief are to be prominently displayed for every equipment at the required place.

Pressure Test Marking

0324 Each component subjected to pressure testing is to bear the test pressure and the date of the test to the requirements of **GMES 25**.

Screw Threads and Fasteners

0325 All screw threads, fits, thread identification and fasteners are to confirm to **GMES 2** All screw threads are t be ISO metric to **BS 3643 Part I**

0326 For all general purpose, fasteners are to be of ISO metric hexagon bolts, screws and nuts to **BS 3692**. Fasteners required for particular applications are to be selected from the preferred ranges given in **DGS 326** All nuts or screws liable to work lose are to be fitted with split pins or other approved securities

0327 The use of bolts or stud bolts is preferred to the use of studs. Bolts, stud bolts, nuts and washers, used for securing flanges of pipes, valves and fittings etc are to confirm to **BR 3013 (2)**.

0328 Bolts and stud bolts used for securing other flanged joint subject to pressure are to be not less than M 10 diameter, unless otherwise specified.

0329 Bolts used in connection with reciprocating parts, and shock and vibration mountings and as safety and tension stays are to be made of strength not exceeding that at the bottom of the thread over an approved stretching length.

Materials of Screwed Fasteners

0330 Materials of fasteners used for securing flanges of pipes, valves and fittings are to confirm to **BR 3013 (2).**

0331 Screwed fasteners for general purposes are to be of HT carbon or alloy steel, strength grade 8.8 for bolts and 8 for nuts to **BS 3692**, selected from the appropriate ranges in **DGS 326** as follows. -

(a) For use in temperature -50°C to 60°C - zinc plated

(b) For use in temperature 60°C to 300°C - un-plated

0332 Whenever non-ferrous fasteners are required, they are to be of aluminum silicon bronze to **DGS specification 8453**, selected from the range in **DGS 326**.

Casings

0333 Pump casings are to be designed to withstand the loads and bending moments which might be imposed by the attached fluid piping. For feed pumps and any other pumps directly attached to piping requiring stress analysis as laid down in **NES 348**, the casing structure is to be capable of withstanding the bending moments which correspond with the maximum permitted nominal axial bending stress in any flanged joints as specified in **NES 348**.

0334 Drain connections where provided are to be at the lowest point of each pump casing.

0335 The required direction of rotation of the pump must be indicated on the pump, adjacent to the coupling.

0336 The material for main and auxiliary feed pump casing and gland housing may be cast steel to **DGS 8081**. Material, for all other condensate pumps, fresh water pump, lub oil pump, fuel pump etc should be gunmetal to **DGS 203**. Materials for casings of

(iv) A pump driven by internal combustion engine of 150 kW or larger.

(d) The following information is to be submitted for approval: -

(i) The first critical speed of each rotor, together with normal full speed and the speed corresponding with the trip speed of the associated driving equipment.

(ii) Physical characteristics of the materials proposed for impellers and shafts.

Wearing Parts

0339 Renewable impeller clearance rings and inter-stage bushes are to be fitted. The arrangements for fixing the clearance rings and inter-stage bushes in the pump casing and diaphragms respectively are to preclude the possibility of any leakage between the mating surfaces which would be liable to erode them.

Bearings

0340 The specifications to be adhered to are as follows:-

(a) Sliding bearings shall conform to **BS 4480**. Finished precision shells shall be used. The shell manufacturer shall be specified by the manufacturer in the tender document.

(b) The bore of bearing shells to be white metaled shall be fully machined before tinning.

(c) Sliding bearings shall be constructed to maintain accurate alignment without requiring adjustment.

(d) Sliding bearings shall be clamped in position by a separate bearing cap spigoted into the bearing housing. Provision shall be made to prevent shell rotation. Bearing caps shall be secured with measures taken to prevent loosening by vibration.

(e) Provision shall be made, and special tools provided if necessary, to allow the lower bearing shell to be rolled out without removing the shaft.

(f) Rolling element bearings shall be clamped in position by a separate bearing cap spigoted into the bearing housing. Bearing caps shall be secured by bolts or nuts restrained by locking wires or tab washers.

seawater pump, brine pump etc are to be either gunmetal to **DGS 203** or Aluminum bronze to **DGS 8520**.

Rotating Assembly

0337 The specifications to be adhered to are as follows:-

(a) Keys and keyways shall be in accordance with **BS 4235**.

(b) Taper shaft ends are preferred to parallel shaft ends.

(c) Consideration should be given to oil injection mounting. Removable couplings shall be locked in position by a retaining nut or bolts.

(d) The surface texture and dimensional accuracy of surfaces of spindles and shafts in way of ball and roller bearings, when the use of such bearings is approved are to be in accordance with the bearing maker's recommendation as specified in **GMES 2**.

Critical Speeds

0338 The specifications to be adhered to are as follows:-

(a) The first wet lateral critical speed of the rotor assembly, at operating temperature, minimum liquid density and viscosity, shall not be less than 30% higher than the speed required for the maximum duty and not less than 15% higher than the maximum speed or trip speed of the associated driver.

(b) Approval to operate above the first critical speed will be considered only for units governed to operate at a normally constant speed. In those approved cases, the first critical speed of each rotor assembly when at the operating temperature and when considered to be simply supported on rigid bearings is to be not less than 30% below the nominal constant operating speed of the rotor assembly.

(c) A torsional analysis shall be performed when any of the conditions identified below are fulfilled:-

(i) A pump driven by electric motor or turbine of 1 MW or larger through a gearbox.

(ii) A pump driven by electric motor of 500 kW or larger with speed control by a variable frequency invertor.

(iii) Any pump where two rotating masses are connected by a shaft longer than 25 times the diameter

(g) The loads on rolling element bearings shall be checked for all specified operating conditions to ensure correct operation of the bearings.

(h) Special attention shall be given to the loading and lubrication of stationary rolling element bearings to reduce the occurrence of 'False Brinelling'. Any special maintenance requirements, on stationary equipment, shall be clearly described in the tender.

(j) All rolling element bearings shall be mounted in accordance with the bearing manufacturers' instructions.

(k) The surface finish and tolerances of shafts/crankshafts supported by rolling element bearings shall be in accordance with the bearing manufacturers' instructions. The Sponsor will assess this against the requirements of **BR 3026**.

(l) When ball and roller bearings are subjected to marine conditions, seals are to be incorporated to protect the bearings against corrosion.

(m) The design of bearings is to be such as to preclude damage from over-lubrication or greasing.

Lubrication System

0341 The specifications to be adhered to are as follows.-

(a) The grades of oil to be used shall be selected from the approved **Naval type / DEF STAN 01-5** and will be specified in the order specification.

(b) Equipment that requires a supply of oil from an external source shall be fitted with nipples conforming to **DEF STAN 47-7**. Orifices may be fitted to regulate oil supply. Oil requirements shall be indicated in the Pump Operating Manual.

(c) Lubricating oil pipes shall be of sufficient diameter to ensure adequate oil supply under all operating conditions. If necessary, oil pipes shall be fitted with a nameplate indicating the pipe destination. Oil pipes shall be attached to equipment by suitable connections to permit efficient maintenance functions.

(d) Lubricating oil temperatures shall not exceed 65°C unless specifically identified in the STR

(e) **Forced lubrication**

(i) Routine maintenance shall not be required more frequently than the specified "Minimum time between adjustments for the pump/pump package".

(ii) The lubrication pump shall have a flooded suction.

(iii) The lubrication system shall be self venting.

(iv) Oil filters and coolers shall not drain or siphon when the pump is stationary.

(v) The oil pressure in the oil cooler shall always be greater than the cooling water pressure. Provision shall be included in the cooling water circuit to reduce the water pressure when the pump is stationary.

(vi) Any malfunction shall be readily observable. Indication shall be provided for low oil supply pressure, high filter differential pressure, high oil temperature, low cooling water pressure and low sump/tank oil level

(f) **Oil Bath Lubrication Reservoirs**

(i) Reservoirs shall have sufficient volume to permit cooling by natural convection and radiation.

(ii) Reservoirs shall have sufficient depth to promote settling of solid contamination

(iii) If reservoir volume is restricted a cooling coil may be fitted. The coil shall be constructed from seamless solid drawn tube suitable for sea water

(iv) Reservoirs shall be fitted with suitably sized drains and filling connections to permit efficient oil changes.

(v) Reservoirs shall be fitted with oil level indication that shows the normal oil level when stationary and running. The same indicator shall show the minimum oil level when stationary and running.

(vi) Reservoirs shall be fitted with a high temperature alarm

(g) **Oil Bath Lubricated Gears**

(i) They are to be totally enclosed. Oil reservoirs shall comply with requirements at para 0341 (f) above.

(ii) Gearboxes shall be designed to minimise the pumping action of the gears and to stabilise variations in the oil level

(iii) Spur, helical and bevel gears shall be arranged so that immersion does not exceed six times the addendum

(iv) The pitch line velocity of spur, helical or bevel gears designed for continuous operation shall not exceed 15 m/s without approval.

(v) If worms are mounted above the oil level, the wheel immersion shall not exceed 33% of the wheel diameter.

(vi) If worms are mounted below the wheel, the worm immersion shall not exceed 50% the worm diameter.

(vii) If both worm and wheel are partially immersed, the worm immersion shall not be greater than 1/2 the length or the wheel immersed greater than 33% of the diameter.

(viii) The pitch line velocity of worms designed for continuous operation shall not exceed 10 m/s without approval.

(h) **Oil Bath Lubricated Chain Drives**.

(i) Oil reservoirs shall comply with para 0341 (f) above.

(ii) The lower strand of chain shall be immersed up to the centre of the chain.

(iii) The pitch line velocity of chain drives designed for continuous operation shall not be greater than 15 m/s.

(j) **Oil Bath Lubricated Rolling Element Bearings**

(i) Oil reservoirs shall comply with para 0341 (f) above.

(ii) The static oil level for rolling element bearings shall correspond to the centre of the lowest ball/roller.

(k) **Friction Oil Ring Lubrication**.

(i) Friction oil ring lubrication may be considered for sliding and rolling element bearings on horizontal shafts when the shaft surface velocity is less than 12 m/s for uncoiled bearings and less than 18 m/s for cooled bearings

(ii) Friction oil rings shall deliver sufficient oil quantity to ensure adequate lubrication under all specified operating conditions and restrict the maximum oil temperature to acceptable values.

(iii) Reservoirs for friction oil ring lubrication shall comply with the requirements of para 0341 (f).

shall be provided with a spring loaded pressure relief by-pass valve to ensure that pump flow always exceeds the minimum continuous flow even when the discharge isolating valve is closed. The connection shall be taken from the pump discharge branch. The position of the bypass low pressure return connection shall be selected to provide adequate heat dissipation. Suitable liquids may be dumped overboard if most convenient. The pump manufacturer shall provide a suitable terminal point for bypass pipe-work. The bypass valve shall be of the diaphragm style for hazardous liquids.

Design Features of Portable / Mobile Pumps

0351 The following specifications are to be adhered to:-

(a) The weight and size of pump packages shall be kept to a minimum to facilitate handling, transport and storage

(b) Fire fighting and salvage pumps shall conform to the requirements below:-

(i) Salvage pumps shall be capable of dry running for 20 minutes in any two hour period. Pumps shall not wear excessively or tend to seize

(ii) Portable pumps shall have a Kamlock type suction connection unless specified otherwise

(iii) Portable pumps shall have a 2.5" single lug instantaneous female hose coupling to BS 336 discharge connection.

(iv) Suction and discharge connections shall have blank caps attached by keeper chains.

(v) All compartments used during normal operation shall be sealed by easily removable gasketed covers.

(vi) Portable pump packages should be restricted to an operational weight of 70 kg whenever possible in accordance with STANAG 1169.

(c) Motor driven pumps are to be provided with water proof cable glands or plugs, kellum sleeved, where submersible operation is specified.

(d) Gas turbine and diesel driven pumps are to be provided with light weight exhaust trunking for the discharge of exhaust fumes to atmosphere. An adequate source of ventilation is to be provided where the air intake of a gas turbine or diesel engine is direct to the engine

(iv) Oil rings with internal grooves shall have at least two grooves.

(v) The depth of ring immersion shall be between 10% and 20% of the outside diameter with the normal working oil level.

(vi) The minimum oil level shall be selected to ensure the bore of the ring is immersed under all normal conditions of list and trim.

(vii) Oil rings mounted in the centre of sliding bearings shall be adequately guided to ensure the location of the ring is maintained

(viii) Oil rings for rolling element bearings shall be restrained by a suitable guide ring, scraper or flinger, positioned to cope with the intended speed range of the equipment.

(ix) Oil rings shall be circular within 0.25 mm.

(x) Friction oil rings shall be made from brass or phosphor bronze

(xi) Chains or belts shall not be used as oil ring substitutes.

(l) Fixed oil ring lubrication may be considered for oil lubrication when a friction oil ring is deemed to be inadequate. Reservoirs for fixed oil ring lubrication shall comply with the requirements of para 0341 (f) above.

(m) **Grease Lubrication Systems**.

(i) Grease lubrication may be used provided the time between re-greasing is not shorter than the specified "Minimum time between adjustments".

(ii) The grades of grease to be used shall be selected from the approved Naval List.

(iii) Automatic grease dispensers or approved grease nipples, specified in **DEF STAN 47-7**, shall be fitted to each lubrication point.

(iv) When direct lubrication at the point of use is impractical grease piping shall be grouped and adequately supported to prevent vibration. Pipe bores shall ensure an adequate flow of grease is easily supplied under all operating conditions.

(v) Grease pipes shall be attached to equipment by suitable connections to permit efficient maintenance functions.

(vi) Grease pipes shall be identified for function, grade of grease and re-greasing interval. Each pump package shall be fitted with an instruction plate, which identifies the position of all lubricating units and to each lubricating unit to indicate the destination of each grease pipe and the quality of the grease

(vii) Assemblies designed for grease lubrication shall ensure the retention of the grease between re-greasing intervals even if the equipment is stationary.

(viii) Assemblies designed for grease lubrication shall be fitted with grease relief facilities.

(n) **Water Lubrication**

Pumps fitted with water lubricated bearings are to be provided with independent source of water for starting and emergency use. Material used in water lubricated bearings is to:-

(i) Be readily wetted with water.

(ii) Have a high resistance to corrosion with water.

(iii) Be compatible with the material of the journal or thrust collar.

(iv) Have a high resistance to wear under conditions of boundary lubrication.

(v) Be able to take a high surface finish.

(vi) Have good resistance to shock.

(p) **Process Liquid Lubrication Systems**

(i) The pump manufacturer shall specify if an external process liquid supply is necessary for any specified operating conditions or start up/shut down. Requirements shall be included on the STR.

(ii) If the process liquid specification includes undesirable solids suitable provision shall be made to ensure the cleanliness of liquid supplied to bearings.

(iii) The requirements, if any, for the disposal of waste solids shall be fully described in the tender.

'O' Ring Seals

0342 'O' ring seals are to confirm to approved Naval specifications. The dimensions of 'O'ring housing recesses are to confirm to **BS 4518**.

Seals

0343 The specifications to be adhered to are as follows:-

(a) **General Design**

(i) The seal arrangement fitted to any pump shall be suitable for all specified operating conditions and be capable of preserving the designed leakage rate between scheduled maintenance activities.

(ii) All seals shall prevent the impingement of leakage on bearings or other adjacent components.

(iii) The manufacturer shall specify in the operating instructions the method of achieving the designed leakage rate.

(iv) External seals shall prevent the ingress of any foreign solids/fluids into the equipment.

(v) When appropriate, sealing, cooling or quench liquid shall be taken from a suitable connection on the pump and returned to the pump suction. If the process liquid specification includes undesirable solids suitable provision shall be made to ensure the cleanliness of liquid directed through tight clearances between moving and stationary components. Piping shall include an orifice for flow control. All water pumps fitted with such liquid injection shall include a suitable solids separator and an automatic air release valve.

(vi) If an external supply of cooling, flush or quench liquid, or steam, is required the details shall be included on the Utilities Requirement sheet of the pump manufacturer.

(vii) If an external support system is required for the seal a full description shall be provided with the tender.

(b) **Mechanical Seals**

(i) When necessary, shafts shall be provided with cartridge mechanical seals. For the purposes of this specification a cartridge mechanical seal shall consist of the seal sleeve, primary seal, secondary

seal or back up seal if required, and gland plate with all external connections necessary.

(ii) Temporary setting tabs shall be slotted to allow radial movement and clamping on the gland plate without removal.

(iii) The type of mechanical seal configuration (single, single and back up, tandem or double) shall be as specified in the STR. When back-up seals are specified the predicted maximum running time shall be stated in the tender.

(iv) Single seals shall incorporate an atmospheric throttle bush to limit leakage flow.

(v) Sleeves shall be clamped to the pump shaft. The use of radial screws through the sleeve is prohibited. Hook type sleeves are not permitted.

(vi) If an appropriate length spacer coupling cannot be fitted and the pump or driver is deemed too heavy to move easily, consideration shall be given to the use of split mechanical seals. Split mechanical seals shall not be used for hazardous liquids or vapours/gases.

(c) **Soft Packed Seals**.

(i) Stuffing boxes shall be of adequate depth considering the operating conditions and the nature of the liquid. The seal ring cross section selected shall be appropriated for the shaft/rod/plunger diameter and the maximum operating pressure.

(ii) Preference shall be given to self energised or pressure energised seals that do not require adjustment. Seals loaded by internal springs may be considered. Internal springs shall be suitable for a minimum life of 10000 hours of on-line or standby operation. Any essential maintenance requirements to be performed during extended standby periods shall be fully described. The sealing arrangement shall be fully described with suitable sketches and is subject to approval.

(iii) Throat bushes shall always be fitted. Throat bushes may be flushed with clean liquid when the process liquid contains solids.

(iv) Lantern rings shall be fitted when necessary to provide admission for lubricating or quench liquids. Lantern rings may be fitted with two connections to facilitate circulation of cooling liquid.

(v) Gland rings or seal ring followers shall always be fitted. Split rings are prohibited

(vi) Glands for seals that do not require adjustment shall tighten up to a positive stop. Gland nuts shall be of the all metal self locking variety.

(vii) Glands shall be of adequate proportions to prevent distortion Studded glands may be split if suitable provision is made for alignment and bolting the halves together Slotted holes for gland studs are not permitted.

(viii) Swing bolts or T-headed bolts for glands are prohibited. The use of springs on the atmospheric side of glands is prohibited.

(ix) Adequate clearance for the gland to the closest obstruction shall permit routine maintenance of the seals to be performed efficiently.

(x) When maintenance access is restricted consideration may be given to a threaded gland. The mating component for the threaded gland shall be a small replaceable component Threaded glands shall be positively locked.

Valves

0344 Valves supplied with the pump are to be selected from the standard range given in **NES 360**.

Fixing Points

0345 All components weighing more than 40 kg are to be provided with eyebolts. Any components requiring special handling shall be so marked and shall be accompanied by the necessary handling instructions. One set of lifting gear is to be supplied along with the pump package

By-Pass Connection

0346 Constant speed roto-dynamic pumps of the centrifugal or mixed flow type with centrifugal bias are to be provided with a by-pass connection from the pump discharge to the pump suction or elsewhere in order to prevent overheating or excessive pressure during periods of low demand. Operation against a closed discharge can only be catered for a by-pass connection taken from the pump discharge branch stream upstream of any valve. Where the bypass is returned to the pump suction, it is to be checked that the length provided in the bypass ensures adequate heat dissipation (**NES 320 refers**).

General Details

0347 The following specifications are to be adhered to:-

(a) Keys and keyways shall be in accordance with **BS 4235**.

(b) Taper shaft ends are preferred to parallel shaft ends. Consideration should be given to oil injection mounting. Removable couplings shall be locked in position by a retaining nut or bolts

Balancing

0348 The following specifications are to be adhered to:-

(a) The purpose of dynamically balancing equipment is to reduce the transmission of vibration to the hull.

(b) The rotating assemblies of equipment, excluding gear pumps, lobe pumps, progressive cavity pumps and reciprocating pumps, shall be dynamically balanced in accordance with **BS 6861** and **BS ISO 11342**. Balancing proposals are to be submitted for approval for all rotating assemblies of new equipment designs. In addition each component is to be certified as having been balanced by an approved method by the manufacturer. Proposals and certificates are to cover the following:-

(i) Type of balancing machine.

(ii) Balancing machine range and sensitivity.

(iii) Detailed assembly drawing and whether the assembly has to be stripped and rebuilt for fitting into the equipment.

(iv) Number and type of bearings and how much of bearing is included in assembly for balancing.

(v) Weight of the assembly to be balanced.

(vi) Service speed of the rotating assembly.

(vii) Mandrel and adaptor details and balance limits.

(viii) Formula to be used to limit permissible unbalance.

(ix) Values of permissible and anticipated unbalance

(x) Method of correction of unbalance.

$U = 6.35\ W/N$ Equation 1

$U = 2.14\ W/N$ Equation 2

Where U = maximum unbalance kg mm
W = rotating assembly weight (excluding mandrel) kg
N = maximum speed rpm

Design Features for Roto-dynamic Pumps

0349 The following specifications are to be adhered to:-

(a) Pumps specified for parallel operation shall have rising head flow characteristics up to closed valve. The head rise from the rated duty point to closed valve shall be at least 10% of the rated head.

(b) Centrifugal pumps shall not be fitted with impellers larger than 95% of the maximum diameter possible for a standard casing.

(c) Impellers not integral with the shaft shall be driven by keys, which are completely shrouded by the impeller hub.

(d) Impellers, impeller wear rings, balance devices and shaft sleeves shall be physically restrained such that hydraulic forces and/or temperature gradients do not alter the angular or axial position.

(e) Shafts shall be protected locally, when running through throttle bushes or centre bushes, by replaceable sleeves.

(f) If a heavy duty shaft is available for the pump it shall be fitted irrespective of the pump power requirement or speed.

Design Features for Centrifugal & Mixed Flow Pumps

0350 The following specifications are to be adhered to:-

(a) Cast impellers with an as cast surface finish of rougher than 4.5 µm shall have the front and back shrouds machined to 3.2 µm, Roughness Number N8.

(b) Replaceable impeller and casing wear rings shall be fitted. Mounting details shall preclude the possibility of process liquid flow between the ring and the mating surface.

(c) When necessary to prevent overheating, excessive pressure, rapid wear, noise and possible cavitation, constant speed centrifugal and mixed flow pumps

(e) Air driven pumps are to be provided with a wet or oily air supply to prevent jerky travel or shuddering of pistons. Where such a supply is not available, lubricators are to be fitted in the air supply line.

Design Features for Special Drivers

0352 The following specifications are to be adhered to:-

(a) Air Turbine and Air Motor drivers.

(i) Air turbines and air motors shall be capable of running at the maximum no-load speed, irrespective of whether a governor is fitted, without sustaining mechanical damage or impairing reliability.

(ii) Air turbines and air motors shall have burst proof casings or additional physical containment to confine all fragments resulting from blade or disc failure.

(iii) Air turbines and air motors shall be suitable for submersion in sea water to a depth specified in the STR. Shaft seals and pipe connections shall prevent the ingress of sea water. The efficiency and reliability of the turbine / motor shall not be impaired by submersion.

(iv) Air turbines and air motors shall be suitable for connection to exhaust pipe-work, including a suitable silencer, to enable discharge to atmosphere outside the machinery space. The preliminary pressure drop of the exhaust system shall be specified in the STR.

(b) Gas Turbine and Diesel Engine Drivers Gas turbines and diesel engines shall be suitable for connection to lightweight exhaust trunking to convey fumes to atmosphere outside the machinery space.

PUMPS FOR SPECIFIC DUTIES

Seawater Pumps

0401 Centrifugal pumps are preferred for sea water duties due to the stability of head /flow characteristic. However, where the duty equates with a high specific speed, a mixed flow or axial flow pumps may be required (In centrifugal pumps, the specific speed is usually limited to a maximum of about 6500. Mixed flow designs cover the range 5000 to 9000 and axial flow designs from 6500 to 15000). From maintenance and space points of view vertical back pull out design may be preferred for fire pump duties, where space does not permit horizontal installations.

0402 Each self priming pump is to be provided with a connection for initial filling of the pump

0403 Each non-self priming pump except axial flow main condenser circulating pumps is to be provided with an air vent cock or an automatic air releases device (provided suction pressure is greater than atmospheric). An air pump is to be provided when suction pressure is less than atmospheric.

0404 Where main condenser circulating pump flanges are connected to flexible bellows expansion pieces, they are to be conform to the flange particulars specified for the expansion pieces of approved naval range.

Bilge Pumps

0405 Centrifugal pumps are not commonly used in bilge systems, where the requirement of pumping out directly bilges without causing emulsification of oil under high lift conditions exist. Bilge pumps are to be capable of handling solids passing through a strainer having 3 mm diameter holes. Generally vane or rotary diaphragm reciprocating type pumps are used for dirty bilge duties. A filling plug and air vent cock are to be provided.

Pumps for Distilling Plants

0406 Sea water, brine and distillate pumps are to be of the single speed centrifugal type. Single speed, centrifugal, turbine or vane pumps may be used for drain and air removal duties

0407 The out put of each of the above pumps is to be 10% in excess of its calculated duties and is to be maintained at the rated head for at least 2000 hours continuous operation **(NES 328 refers)**.

0408 The pumps are to be fitted with separate motors with a flexible coupling between each pump and motor. Each pump and associated motor is to be mounted on a common

0419 The design is to minimize any tendency to misalignment of the combined unit liable to arise when starting rapidly from cold.

0420 Each pump is to be provided with a discharge leak off to prevent over heating during periods of low feed demand, and pressure dissipating flow limiters of approval type.

0421 Turbo-water lubricated feed pumps are to be self lubricating at all operating speeds using water pumps from the pump discharge. A connection is to be provided for an external supply of lubricating water for starting and standby purposes.

0422 A differential pressure switch with an enclosure watertight to 1 kg/cm^2 is to be provided for water lubricated feed pumps to sense the difference between the bearing lubricating water supply and turbine exhaust pressures. The design is to be capable of operating warning lamps when the differential pressure falls below the minimum necessary to ensure adequate lubrication.

0423 A drain valve is to be provided at the lowest point of each pump casing.

Fuel Transfer, Fuel Boost and Centrifuge Supply Pumps

0424 Positive displacement type pumps are preferably selected for transfer purposes in order to meet the suction conditions imposed by double bottom tanks. However screw or centrifugal pumps with self priming feature may be considered for fuel transfer duties. The latter type of pumps avoids the needs for such fine filtration at pump suction as that required by a screw type pump when the pump normally supplies a centrifuge, a strainer, normally of the duplex type is to be fitted upstream of the centrifuge.

Fuel Stripping Pumps

0425 Fuel stripping pumps are to be self priming type and are generally vane or rotory diaphragm reciprocating type. Stripping pumps may be sliding vane, positive displacement type with provision for manual adjustment of output by controlling the position of the rotor relative to the vaned driving shaft through a sliding inner body determining the working chamber volume

0426 Balancing planes are to be provided for in-place dynamic balancing.

0427 Each pump is to incorporate in-place means of measuring axial wear which are to be easily accessible to the operator. Measurement and visual inspection of axial wear should be a built in facility, without re-course to special tools and gauges or major stripping of the unit.

Extraction Pumps

0428 Extraction pumps are to be of the vertical (i.e. nearly vertical) spindle, flange mounted open suction, centrifugal type, driven by single speed AC motor or turbines. Running speed and number of stages will normally be recommended by the pump manufacturer with respect to NPSH available and the target noise and vibration levels specified. Obtaining the necessary margin between NPSH available and NPSH required is often critical due to the low suction pressure and the temperature of the water being close to its saturation temperature.

0429 The downward projection of the pump casing below the impeller must be kept to a minimum.

0430 Each pump must be capable of clearing vapour from within it and a facing is to be provided for the release of vapour from its suction chamber.

0431 Each pump spindle glad is to be provided with an efficient mechanical seal suppled with water from the extraction pump discharge line to prevent entry of air

0432 A facing is to be provided for the release of vapour from each pump suction chamber.

0433 A connection is to be provided on each pump discharge branch to permit samples of water to be drawn off for salinity and dissolved oxygen tests.

0434 Glands subject to vacuum are to be provided with water sealing from the discharge side of the pump.

0435 A drain plug is to be provided at the lowest point of each pump casing.

0436 The turbines of the turbodriven main extraction and deaerator extraction pumps are to be fitted with a speed governor to restrict the speed of the pump to that required for the specified duty and to not more than 5% greater speed at no load.

0437 Where two or more extraction pumps are fitted in one system, they are to be capable of discharging in parallel.

Chilled & Fresh Water Cooling Pumps

0438 Centrifugal pumps are normally specified for chilled and fresh water cooling, re-circulating duties. Drive is normally by electric motor. Vertical, back pullout design may be preferred from maintenance point of view where space does not permit horizontal installations.

Domestic Hot and Cold Freshwater Pumps

0439 Pumps for domestic hot and cold fresh water systems are to be self priming Horizontal designs with power unit on one side and pump on other are preferred

Chemical Dosing Pumps

0440 Variable stroke reciprocating or diaphragm pumps are normally specified for chemical dosing duties. Drive is normally by an electric motor with a reduction gear box where required.

MANUFACTURE

0501 The working stresses and speeds coupled with the high pressures and temperature of operation and the degree of interchangeability required, necessitate meticulous attention to materials and details of design and call for highest standards of workmanship, precision finish, cleanliness and inspection throughout. General requirements for manufacturing naval machinery are given in **GMES 21**.

Interchangeability of Equipments

0502 A complete piece of machinery capable of performing a specific function on its own is defined as an Equipment.

0503 Equipments are to be interchangeable with equipments to the same design which are fitted in the same ship, or any other ship or depot spares or replacements, ordered during the life of the ship.

0504 For equipment, the critical dimensions with permissible tolerances which must be maintained to effect interchangeability are to be shown in the drawings. This drawing is to show the terminal points for assembly and disconnecting purposes. Jigs are to be provided and used during manufacture of equipment to ensure that the positions of critical interfaces are within the agreed tolerances as shown in the above mentioned drawings, and that all similar equipments will be interchangeable. Before installation, these critical features are to be properly inspected to ensure interchangeability in accordance with the drawings.

Interchangeability of Assemblies

0506 An assembly is any part of an equipment which can be replaced as a unit, but does not perform a compete function on its own.

0507 In the replacement of assemblies, the use of shims or liners will be permitted to obtain alignment except when assemblies appear in spare gear lists, in which case they are to comply with the requirements for interchangeability of subassemblies.

0508 The design is not to necessitate reaming of bolts holes where alignment of the assemblies is maintained by spigotted joints, the faces, spigots and faucets are to be made to such tolerances as will ensure maintenance of alignment without hand fitting.

Interchangeability of Sub-Assemblies

0509 Any part of an assembly which can be replaced as a unit is called a sub-assembly.

0510 Subassemblies are to be replaced without any machining or hand fitting whatsoever, except where machining or fitting allowances are specified. This requirement applies to all sub-assemblies specified as spare gear.

Interchangeability of Components

0511 Any individual part of a sub-assembly is called a component. Parts subject to normal wear, including but not limited to; impeller wear rings, casing wear rings, bushes, lantern rings, balance disc, shaft sleeves, mechanical seal sleeves, piston rods, pistons, plungers; oil seals, sliding bearing shells; shall be supplied as completely finished components ready to fit.

Alignment

0512 The design of the pump together with the driven equipment is to be such that alignment is preserved under all operating conditions including those specified for shock.

0513 Alignment of the component parts is to be preserved by the use of spigots, a proportion of fitted bolts or dowels. Alignment is to be preserved independently of the ships structure care being taken that working of the hull in seaway does not cause misalignment. The method of obtaining the alignment is to be such that it is preserved after removal of the equipment, assemblies, subassemblies or components without the need for fitting or machining.

0514 Procedure for alignment of the unit, supplied with the driven equipment on a common base plate, the alignment procedure is to be devised by the supplier. The alignment procedure is to be approved by Naval Headquarters and it should be detailed in the drawing/ hand book.

0515 Alignment procedure may involve the use of jigs, gauges and mandrels Adjustment outfits used by the equipment supplier are to be supplied to the ship builder and retained with those used by the ship builder to enable the alignment procedures to be repeated or confirmed on installation of the equipment in the ship. A complete set of all necessary alignment jigs, gauges and mandrels is to be supplied to each ship.

Casting

0516 Ferrous and non-ferrous castings are to conform to **DG ships process specification 9010**.

0517 To facilitate production of sound castings, careful consideration is to be given to design for ease of casting. Such consideration is to include the use of simple casting or cast/ wrought items joined by welding, rather than a single complex casting.

0518 Any significant increase in the thickness of castings beyond the approved drawing dimensions will render them liable to rejection The use of casting chaplets of material differing from that of the castings is to be avoided if practicable, but where the use is essential such chaplets are to be drilled out and the holes plugged with the metal of the same composition as the parent casting.

Welding

0519 Welding requirements for machinery purposes other than nuclear reactor plant are to conform to **DG ships process specification 9023**.

0520 Structural welding is to conform to the requirements of the General Hull specification.

Limits and Fits

0521 All parts of machinery are to be manufactured to tolerances specified in the appropriate drawings for the following purposes:-

(a) To ensure design requirements are met

(b) To reduce the work and cost of assembly by the elimination of selective assembly and of hand fitting

(c) To reduce the time and man power for maintenance by the elimination of fitting work on spare gear.

(d) To ensure interchangeability at component, subassembly, assembly and equipment level as required.

(e) To enable dispersed production of subassemblies, assemblies and equipment to be undertaken in emergency without subsequently.

0522 All relevant tolerances in accordance with **BS 1916** are to be shown on the drawings. The hole basis is to be used with unilateral tolerance. The selection of preferred fits is to be taken from **Def-Stan 05-19**.

Finish

0523 Great emphasis is placed on the external appearances and finish of machinery. All exposed fittings and surfaces are to be designed to avoid the harbouring of dirt and water and are to be polished or treated in such a way as to give a neat appearance and to require a minimum of attention. To this end, the edges of all external flanges are to be machined and the edges of mating flanges faired.

0524 All bright parts of the machinery are to be made from corrosion resisting material or suitably proofed.

0525 The surfaces of bearings, teeth etc and rubbing surfaces generally, are to be finished to the standard indicated in the Approved Drawing. Surface finish is to be specified in accordance with the requirements of **BS 1134**.

CONTROLS & INSTRUMENTATION

0601 Pumps packaged on base-plates shall be equipped with a local instrument panel incorporating sufficient instrumentation to indicate the correct operation of the pump. The instrument panel shall be fitted as to be easily observed from the local start/stop/emergency stop push button station.

0602 Extra instruments, as specified in the STR, may be fitted to the local panel to indicate operating conditions at remote locations. These instruments shall be clearly marked to show precise function.

0603 Each equipment is to be arranged for local starting and control by a single watch-keeper in addition to any remote/automatic starting or control specified. Suitable provision for integration with IPMS is to be provided.

0604 The pump starter or a start/stop facility remote from the starter is to be located adjacent to the pump's local instrumentation so that the operator is immediately aware of whether or not the pump has picked up suction.

0605 Roto-dynamic pumps shall be fitted with a differential head gauge which is marked with the readings normally expected during starting, rated duty and run out. If the pump is started with a closed or partially closed discharge valve the instrument panel must be easily observed when adjusting the discharge valve.

0606 Pumps shall be fitted with suction and discharge pressure or head indicators connected to the pump branches or process pipe close to the pump connection. Each indicator shall be fitted with a suitable isolating valve. If the instrument line is long, over 3 m, an isolating valve shall be fitted at each end. If the pressure/head to be measured includes a significant pulsation a suitable throttling device shall be included. Threaded fittings shall not be used with hazardous liquids.

0607 Suction and discharge head/pressure indicators shall be marked with minimum, rated and maximum values.

0608 Bourdon tube type pressure indicators shall comply with **DEF STAN 66-2**. All pressure indicators shall be glycerin filled and incorporate a pressure relief vent. Installation of pressure gauges is to confirm to **BS 1780**.

0609 Roto-dynamic pump head indicators shall be calibrated in metres. An auxiliary scale may indicate the pressure in bars calculated for a suitable liquid density.

0610 Positive displacement pump pressure indicators shall be calibrated in bars.

0611 Head/pressure indicators should be mounted within 1.5 m above or below their pressure sensing point on the pump. If the indicator cannot be mounted within 1.5 m the indicator nameplate shall include "ADD" or "SUBTRACT" as appropriate with the correction value.

0612 When pressure indicators require a correction value the amount shall be derived from Equation:-

$$P = \rho * h * g / 100000$$

where:- P – correction value in bar
ρ – process liquid density in kg/m^3
h = elevation between sensing point and indicator centre in m
g = gravitational acceleration 9.81 m/s^2

0613 Instrument pipe-work shall be 18-12-2 low carbon austenitic stainless steel or other material suitably resistance to the process liquid and the environment. Instrument pipe-work shall be adequately supported and protected to prevent vibration and damage

0614 Thermometer pockets fitted in pipe-work conveying hazardous liquids and pipe-work attached to submarine sea water pumps subject to external sea water pressure shall be machined from the solid and flanged

0615 Thermometers are to be graduated in degree centigrade and thermocouples and electric resistance pyrometers are to be of approved designs and make.

0616 Pumps not fitted with vibration detectors shall have dimples machined in the bearing housing for precise location of portable instruments.

0617 Where a gauge board is specified, it is normally to be mounted directly on the unit, but where convenient, the maker may seek approval to dispense with the gauge board and mount the group of instruments directly on the unit. In cases where the gauge board is to be mounted separately from the unit, the make is to provide the gauge board suitable for separate mounting.

0618 When specified it may be required to provide means / instrumentation for endoscopic inspection and vibration measurement with a view to health monitoring

REPAIR AND MAINTENANCE

0701 Pumps and their associated equipments are to be designed for overhaul or repair by replacement of assembly, subassembly or components. Reconditioning of worn out components will be considered where applicable and manufactures are to indicate such components and recommend the appropriate reconditioning process / procedure.

0702 All pumps are generally repaired by replacement or major overhaul in the repair shop after removing the complete pump as a unit. Naval policy is to reduce maintenance repairs on board. Pumps design should carefully studied for ease of maintenance and access for examination and repair. The working and withdrawal space required for maintenance and for the repair of assemblies, sub assemblies and components are to be shown in general arrangement drawings.

0703 Size and weight of the major assembly /sub assembly which are required to be replaced are to be shown to facilitate providing for lifting eye bolts, lugs etc. and for the access hatches and portable plates

0704 Lifting gear and hand appliance are to be provided for handling weights exceeding 25 Kg or when on account of shape or bulk, they would be difficult or dangerous for one man to handle.

0705 Tools and maintenance gear such as a special tools, jigs, lifting gear, testing gear, cleaning gear and such other special appliances required for adjustment and maintenance of the engines are to be supplied by the equipment supplier.

Maintenance Schedule

0707 The manufacture should recommend the preventive maintenance schedules based on the duty cycle on a running hour/calendar time basis. The manufacturer should also provide information on the man power time, skill and spares, and facilities required to carry out each of the maintenance routines. The job formation as above shall also be a basis for ranging and scaling of spares.

Spares

0708 Manufacturers should ascertain the upkeep policy, duty cycle, preventive maintenance schedule, probable modes of failure and their frequencies and recommend ranging and scaling of each category of spares for the pump or a group of number of pumps of the same type.

0709 The categories of spares are generally defined as follows:-

(a) **First Category (Onboard Spares)**. Spares required for onboard maintenance and rectification of common defects which if not immediately available might impair the operational efficiency of the ship and which are capable of being fitted by ship's staff within a reasonable period (approximately 72 hours) with the facilities provided in the ship . These are first line support spares and are based on the estimated needs over an arbitrary 90 days period. These are carried onboard wherever practicable Top overhaul spares for pumps are to be included in the first category.

(b) **Second Category (Base & Depot Spares)**. Spares additional to those in the first category which may be required for normal maintenance or replacement of worn or defective parts between refits (normally a 5 years period), but which cannot be fitted by ship's staff without outside assistance from Maintenance ship or base.

(c) **Third Category (Long Term Exploitation Spares)**. Spares required to replace items that are always to be replaced when equipment is reconditioned to 'as new' standard when the efficiency of the equipment has deteriorated. The list may include spares which are already included in category one and two.

0710 All spare is to be manufactured to meet the interchangeability requirements of **GMES 21, Section 6** and is to be gauged and inspected by the makers as specified to ensure that it complies with these requirements. Any item at the discretion of the naval overseer is to be tried in place and will be rejected should the fit be unsatisfactory.

0711 Minor items such as fasteners and washers if required to be replaced in equipment's maintenance and repair routines are to be shown.

0712 Assemblies and sub assemblies in first and second category are to be chosen for direct exchange to facilitate speedy repair without resorting to component changes. The interface joint fittings and strip access items are to be shown and their relationship to the replacement assembly shall be clearly defined.

0713 Spares are to be listed in logical family tree break down.

0714 The manufacturers recommendation of spares will be ranged and scaled by IHQ/MoD(N)/DME. For this purpose following additional information is to be supplied by the manufacturer:-

(a) Comprehensive part list and part identification list giving details of assemblies and subassemblies with details of nomenclature and part number.

0720 Drawings are classified as:-

(a) **Tender Drawings.** Tender drawings may be less detailed than approval drawings. They are to enable tender to be assessed and compared for like features and to check that the equipment meets the technical specification, as far as possible

(b) **Approval Drawings.** Approval drawings are required after the tender stage to enlarge on the bare essentials of the tender drawings. Approval drawings are not intended to provide all the information needed for manufacturing purposes. They are to be regarded as preliminary with alphabetical issue status A, B etc up to the date when approval is given by the Design Authority. The drawings become final approved drawings when noted as approved at Issue 01 quoting the letter of approval.

(c) **Manufacturing Drawings.** Manufacturing drawings should be submitted and approval obtained (prior commencement of manufacture) from statutory and regulatory agencies. Where inspection by Naval Agencies or shipbuilder is specified, drawings should be submitted to the relevant agency and their approval obtained, prior to commencement of production.

0721 The technical drawings and documents shall be prepared and supplied to include (but not limited to):-

(a) General information on the equipment
(b) Operating Instructions
(c) Technical Specifications
(d) Commissioning procedures
(e) Functional details of major components
(f) Design specifications
(g) Details of associated systems with schematics, if any.
(h) List of special tools / instruments /equipments / Jigs & Fixtures.
(j) Dimensions of each unit for shipping in / unshipping and procedures.
(k) Performance curves and design calculations
(l) Desired clearances and wear limits of all wearing components
(m) Maintenance requirements
(n) Torque values for bolts which are to be tightened in situ
(p) Factory tests and Inspection plan
(q) Factory test reports, material certification & Calibration certificates of the instruments fitted
(r) Certification of Shock Grade 'A' for all components mounted on SV mounts and for equipments mounted directly on Hull.
(s) Installation Specifications and Alignment Values indicating their tolerance limits for each.

(t) Operation Maintenance, repairs and trouble shooting for levels up to second level maintenance. Component level maintenance procedures shall be offered as an option

(u) Part Identification List, indicating Part No., Quantity, Makers name, materials, etc

(v) List of special tools, facilities and equipment required to lift, transport and install the equipment

(w) Radius of gyration of the equipment

(x) Complete details of SV mounts

(y) Noise and Vibration data detailing the maximum expected noise and vibration levels on a frequency base

(z) List of recommended on board spares

(aa) List of recommended B&D Spares

(ab) Log Books/Forms/Documents for entering installation inspection/alignment values or other important data, if any

Modifications

0722 Pumps when supplied to the Indian Navy are to have no outstanding modifications to be incorporated.

0723 Modification to the pump may be identified by IHQ/MoD(N) based on feedback from the fleet , or any engine maker. Incorporation of modification to pumps will be only with the approval of the IHQ/MoD(N)/DME. Procedure for incorporation of modification is to comply with Naval requirements.

case basis according to the considered equipment. For equipment being resiliently mounted, the mounting system shall be capable of attenuating the shock impact below the inherent shock resistance characteristics of the concerned equipment. The installation and connections of the relevant equipment shall account for the extreme displacements that may occur under shock conditions. Where necessary, suitable stops/snubbers shall be provided to prevent excessive motion. Brittle materials, such as grey cast iron, or any material having an elongation capability of less than 10% shall not be used unless the stresses can be proved acceptable by shock testing the equipment. The shock calculations should be supplied to ensure that the equipment as designed can meet these Shock Standards. This should include calculations for selection of mounting. The S & V mounts are to be supplied along with the equipment indicating the following data: -

(a) Type
(b) Quantity
(c) Dynamic stiffness of mounts -1/3rd Octave band level 10Hz to 10 kHz
(d) Transmissibility -1/3rd Octave band level (10Hz to 10 kHz)
(e) Footprint indicating position of mounts
(f) Characteristic dimensions of the mounts
(g) Rated load, deflection in 3 - axes and the natural frequency
(h) Shock acceleration

Submersion Tests

0830 When the pump is specified to be capable of operation under submerged conditions, tests are to be carried out to demonstrate its capability to meet the specified requirements. **NES 1004** also refers.

Inclined Test

0831 Depending upon the design of the pump unit, inclined tests may be required to be carried out to prove the ability of the pump unit to start, stop and operate at the specified duty point at the inclinations specified in the order specification. The tests are normally to be conducted at the specified inclination or inclinations in that direction which imposes the most severe operating conditions from lubrication or other aspects, and is to operate for not less than 08 hours. **NES 1004** also refers.

Endurance Test

0832 Endurance test for not less than 100 hours and not more than 1000 hours is specified to assess the mechanical robustness of the engine to run continuously without loss of performance. The running time will be determined having regard to experience of similar units, operational requirements of the unit and the test facilities available. The total running time is to be completed without mechanical defects or undue wear. The running time if applicable may comprise of a series of operation cycles, each cycle simulating the actual service at sea.

(b) Establish the performance characteristic of the unit.

(c) Establish the principal performance figures for checking production tests on later units.

0808 Pump for type testing is to be selected by the Naval Inspector from a batch of pumps that have been manufactured in the normal course of production. The complete type testing is to be completed on the same pump unless otherwise authorized.

0809 Type testing is to be carried out to measure all factors concerning operation, performance, life expectancy and maintenance. All units except those driven by main propulsion engines are to be type tested together with their associated prime movers.

0810 Type testing may be carried out at the manufacturers works or at the Naval Test Facility, as may be approved. When the pump is to be tested at Naval Test Facility, the pump is to be delivered, set to work and collected back by the pump manufacturer.

0811 Drawings and instructions sufficient to enable engineers not familiar with the pump to install, operate, strip and re-assemble it are to be supplied along with the pump for type test. One complete set of all accessories and tools for stripping, re-assembling and erecting, together with any special lifting gear are to be supplied with the pump.

Proposals for Type Tests

0812 The equipment manufacturer is to prepare the proposal for the type test that should include the following: -

(a) Date of commencement and completion of type test.

(b) Delivery date of equipment.

(c) Place of Test

(d) Name and telephone number of persons responsible for test.

(e) List of tests and duration of each test

(f) Specified duties.

(g) Estimates of performance.

(h) Details of holding down arrangement.

(j) Details of each test including measurements to be taken

(k) Sketch of the test rig showing the points at which measurements are to be taken

(l) Details of measuring equipment and standard of accuracy.

(m) Methods of ensuring that fluids used confirm to specification, together with details of test fluids that will be used

0813 The proposal for type test is to be made in conjunction with the Naval Inspector and the main contractor/ship builder, where applicable. One copy is to be forwarded to HQ/MoD(N) in advance to permit perusal and amendments if desired, before commencement of trials.

0814 Type test shall comprise any or all of the following. -

(a) Physical data

(b) Wear

(c) Operation of Turning Mechanism

(d) Safety Tests

(e) Control equipment tests

(f) Over-speed tests

(g) Performance tests

(h) Start / Stop tests

(j) Cooling tests

(k) Noise and vibration measurement

→ (l) Environmental shock and vibration test

(m) Submersion tests

(n) Inclined test

(p) Endurance test

(q) Special ambient test

(r) Examination for wear

(s) Maintenance evaluation

(t) Life determination tests

Physical Data

0815 The physical data for the equipment will include the following:-

(a) Assembled weight of equipment dry

(b) Assembled weights of equipment with fluids at normal working levels

(c) Weights of individual assemblies

(d) Weight of spare gear including separate weights of each assembly, sub-assembly and component.

(e) Determination of center of gravity, radius of gyration etc.

(f) Maintenance Envelope. Minimum space required around the equipment for maintenance, repair and unshipping/shipping activities.

Wear

0816 Before a pump is type tested, a record is to be made by direct measurement of the relevant dimensions of wearing parts and clearances, unless these dimensions are available from the manufacturing records of the unit for comparison with the measured dimensions of the same components on completion of the endurance test.

Safety Devices

0817 All protection devices are to be tested to establish satisfactory operation. Such tests are to be repeated **at least five times** and each result recorded where appropriate. Rapid variations of speed or pressure are to be imposed to determine the time response of the system. Relief valves, if fitted are to be tested to establish the pressure at which it lifts, is fully open and reseats. The flow through the relief valve when fully open is also to be established. Further the relief valve is to be tight at design working pressure before lifting and after reseating.

Over-speed Test

0818 Pumps driven by steam turbine, gas turbine or diesel engine are to be run at various speeds up to 20% above the specified speed required for the maximum specified duty or 5% above the approved over-speed emergency trip speed, which ever is greater. Each running speed is to be maintained for not less than 05 minutes and it is to be shown that the equipment is free from unacceptable vibration.

Performance Test

0819 Pumps are to be tested to establish its performance over the full specified duty range, generally in accordance with **BS 5316 Part 1 /ISO 2548 /ISO 9906:1999**. Feed and extraction pumps are to be tested in accordance with BS 5316 Part 2 and the pump characteristic curves should be obtained.

0820 The fluid for which the pump is specified is to be used in performance tests of pumps, except that fresh water may be used in lieu of seawater. Exceptionally, where a fire hazard may result from this requirement, an alternative fluid may be used provided that it has similar viscosity ans specific gravity at the specified operating temperature and does not provide improvement in lubricity.

0821 The guarantee points tolerances on performance are to be agreed with the pump manufacturer. The suggested tolerance on the guaranteed flow rate for the guarantee points specified total head and speed is +4 - 4 75 %.

0822 Important parameters that should be measured during the performance test include: -

(a) Suction head

(b) Discharge head

(c) Output

(d) RPM

(e) Current, voltage and power consumption

(f) Motor temperature

(g) Bearing temperature

(h) Cooling water inlet and outlet temperature

(j) Ambient temperature and pressure

0823 Performance test should comprise the continuous running of at least 08 hours. Pump should be stooped immediately if any overheating, over heating, undue vibration or noise is observed. The cause is to be fully investigated and rectified and approval of the Naval Inspector be obtained before re-commencing the trials.

Start/Stop Tests

0824 A minimum of 30 start/stops are to be carried out. Once the pump has been started, it should run for at least 15 minutes and then stopped. Starting current, time to reach full performance, any noise, vibration and difficulty to start are to be recorded.

Cooling Test

0825 When specified cooling tests are to be carried out to establish the minimum cooling water flow required by the equipment when operating at its maximum specified duty. Test should also be carried out, if specified, with the discharge valve shut and the pump discharging through zero flow valve to ensure that no overheating takes place

Noise and Vibration Measurement

0826 Unless otherwise specified in the relevant procurement specification, the mechanical vibration requirements for all machinery and equipment shall be in accordance with **MIL-STD-167** and, accordingly, all limitations, calculations, and analyses for vibration and balancing shall comply with this standard.

0827 When specified self induced noise and vibration levels at the specified duty will be measured. The air borne sound power level radiated by the equipment should comply with the levels set out in **MIL-STD-1474D** Airborne noise measurements taken as sound pressure level reference of 20 μ Pa at a distance of 1 meter from the equipment in $1/3^{rd}$ Octave band over a frequency range of 10 Hz to 10 kHz are to be provided in graphical and digital format. Noise levels will be measured at 25%, 50%, 80% and 100% rated output at six positions around the plant. The instrumentation, measurement and analysis of structure borne noise should comply with **MIL-STD-740-2**. Above and below the mounts vibration data (under the standard and optional mounting arrangement) is to be recorded as velocity dB reference 10^{-6} cm/sec (RMS). This data shall be in both 1/3 octave band and narrow band spectra within a frequency range of 10 Hz to 10 kHz at 25%, 50 %, 80 % and 100% rated output.

Environmental shock and vibration test

0828 The equipment shall withstand, without any reduction of reliability and performance, the effects of environment vibration defined by **MIL-STD-167 Type 1**.

Shock Test

0829 The equipment shall meet the shock requirements as specified in the procurement specification. Design shall be suitable to withstand shock loading without significant effect on performance and without any portion of the equipment coming adrift or creating a hazard to personnel or to other equipment. Shock qualification methods such as testing for component / assembly of less than 500 kg, dynamic design analysis, existing certification of similar equipment or to equivalent shock standard for combatant vessels, will be decided on a case to

Special Ambient Test

0833 When the pump is to operate under ambient conditions, tests are to demonstrate its capability to meet the requirements. **NES 1004** refers

Examination for Wear

0834 On completion of type test, the unit is to be stripped and examined. All important dimensions are to be recorded and divergence from the original noted. Any wear, corrosion or erosion observed is to be described and recorded and photographic records of unusual wear or defects are to be provided. Special mention should be made on the condition and efficiency of the seal.

Maintenance Evaluation

0835 Maintenance evaluation is to be carried out by Naval personnel if possible, under simulated space restrictions to assess the work content of each maintenance routine in terms of time, skill, power, spares and special tools. It also evaluates accessibility and interchangeability of components.

Result of Type Test

0836 On completion of testing the equipment manufacturer is to prepare four copies of the test results in a form agreed by IHQ/MoD(N). The report is on ISO A4 size sheets and is to include following information:-

(a) Date of Report

(b) Date of Tests

(c) Description of Unit

(d) Comparison of estimated and actual weights

(e) A statement of specified duties and requirements of the unit.

(f) A sketch and brief description of the testing actually used and description of each test procedure, its duration and purpose, the date and results of calibration tests of all instruments and the degree of accuracy of measurements recorded.

(g) Tabular statements of all test results and the provision of curves in all cases where graphical presentation can assist in the interpretation of results. All measurements taken are to be recorded and plotted.

(b) Control equipment tests

(c) Overspeed test

(d) Performance test

(e) Noise and vibration test

0844 All pumps except those being driven by propulsion engines are to be tested together with their prime movers.

0845 Safety tests are to be conducted as required for the Type Test excepting that the time response of the system need not be established and relief valve flow need not be measured.

Examination on Completion of Production Test

0846 The equipment manufacturer is to prepare a report on the production test generally in accordance with the requirements of the type test results. The results are to be countersigned by the Naval Inspector. Unless otherwise specified, the report is to be disposed of as follows -

(a) Two copies to the Ordering Authority.

(b) One copy to IHQ/MoD(N).

(c) One copy to the Naval Inspector

0847 The ordering authority is to ensure that one copy is retained with the ship/spare depot to which the unit is supplied.

Shipboard Trials

0848 The scope of shipboard trials are given in **GMES 27**. Shipboard trials are carried out to prove the installation and to ensure that the pump and associated systems meet the design requirements. Pumps will be operated during harbour and sea trials, independently or in association with the system in which the pump is fitted, where the pump will be operated under service conditions of duty, ambient temperature, humidity, ship motion, vibration and NPSH. The performance of the pump under actual conditions will be measured depending upon the duty of the installation. Each pump designed for continuous duty onboard is run for at least 12 hours continuously and 60 cumulative hours before the completion of Contractors Sea Trial.

0849 Pumps for intermittent or emergency duty are to be run for 06 hours continuously and 24 hours cumulative before the completion of Contractor Sea Trials.

0850 Noise and vibration measurements of pumps also may be measured in conjunction with shipboard trials

(h) A tabular statement of all important dimensions and clearances before and after type testing, together with a detailed description of the condition of the unit on completion of the tests.

(j) Modification state of the unit during the type test

(k) Certification by the maker, endorsed by the Naval Inspector that the test has been conducted in accordance with the type test requirements.

0837 Complete test reports are to be indexed and bound in Manila folders to suit ISO A4 size One copy is to be retained by the Naval Inspector.

0838 After consideration of the complete type test, IHQ/MoD(N) will either issue instructions for necessary modifications or further testing or will approve the testing and indicate acceptance of the unit. On receipt of final approval the manufacturer may proceed with the delivery of units

0839 Unless otherwise requested, the equipment manufacturer is to supply the following copies of approved test results within 02 months of receipt of approval, but in any event, in advance of the Contractors Sea Trial of the first ship of the Class.

(a) One copy to Main Machinery Contract.

(b) One copy to Naval Overseer concerned

(c) One copy to Naval Inspector concerned.

(d) Four copies to IHQ/MoD(N).

0840 Summaries of the approved test results are to be incorporated into the relevant equipment handbook.

Production Test

0841 Each unit completed after the type tested unit, including those being supplied as spare gear is to be production tested before delivery.

0842 The aim of the production test is to confirm that the performance characteristics of each equipment confirms to those established during the type tests. The equipment manufacturer is to prepare the proposals of the programme and conduct of the production test and submit them to IHQ/MoD(N) through the Naval Inspector. The proposal should include the information as in the case of Type Tests details at para 0812.

0843 The scope of production test will be indicated in the order specification. It may include any or all of the following -

(a) Safety tests

Inspection after Contractor's Sea Trials

0851 The scope of examination of machinery is given in **GMES 27**. The aim is to reduce opening up to a minimum consistent with ensuring a satisfactory installation. This can only be achieved by experience and cannot apply to any class or batch unless they are fitted with proven machinery/equipment. The opening up is subject to the authority of the trials officer who at his discretion, may reduce or waive altogether the work to be done on any item. Or general guidance for opening up of pumps, the following clause in **GMES 27** shall apply:-

(a) Where provision is made for measurement to be taken without major dismantling and without opening up the forced lubrication system or breaking joints therein, measure wear down of bearings, axial clearances and/or position of rotors.

(b) On impellers of axial flow and centrifugal pumps, examine and check tightness on shaft, in one pump of every size or type fitted.

(c) In case of new design auxiliaries not previously installed in any IN ships, examine all working parts of one equipment of each new type, measure and record as above.

INSTALLATION

0901 GMES details the general requirements for location and seating of pumps for ease of maintenance. These requirements should be met in all naval installations

Lifting

0902 Pumps and their prime movers are only to be moved using the appropriate lifting gear on the lifting points. It is to be noted that lifting points on electric motors are normally only suitable for lifting the motor.

0903 Proper lifting arrangements are to be provided to avoid danger to the machinery and personnel. Where there is any danger of transit damage due to freedom of a dry rotor to move within its casing, a suitable jacking screw or rotor locking device is to be provided.

0904 All components weighing more than 40 kg are to be provided with eyebolts. Any components requiring special handling shall be so marked and shall be accompanied by the necessary handling instructions. One set of lifting gear is to be supplied along with the pump package.

Cleanliness

0905 Preservation material is not to be removed until connection to the system is about to be undertaken. The compartment is to be clean during this assembly.

Pipes and Fittings

0906 Pipe work is to be manufactured such that misalignment is minimised in order to reduce bending loading on pump casing and flexibles.

Connections

0907 The arrangement of pipe work connecting to any pump is to ensure that the pump rotor remains drowned when the pump is stopped. Special arrangement of pipe work may not be necessary where the liquid level is normally above the pump rotor.

0909 Suction strainers are to be provided to safeguard the pump from the ingress of fluid borne debris. The strainer aperture size is to be such that adequate protection is afforded to the pump internal clearances while ensuring that frequent blockage does not occur to the detriment of the pump. General requirement of strainers is given in **GMES 72**

0910 Where vent cocks or valves are provided on pumps handling oils, a drain pipe with a constant downward slope leading to the pumps saveall or to the system drain or recovery tank, depending on the fluid, is to be fitted by the shipbuilder. If the drain pipe

outlet is not visible from the vent position, a tundish is to be fitted in the pipe such that any flow is visible from the vent operating position.

0911 Oil pumps fitted with drain plugs are to be fitted with savealls draining to the appropriate drain or recovery tank for the system.

0912 The requirements for operating gear, extended spindles and rod gearing to valves are given in **GMES 3**.

Flexible Connections

0913 When a pump is set on shock mounts, the shipbuilder is to fit a flexible connection in each of its pipeline. These flexibles are to be fitted at the terminal points of the equipment, except where an elbow is required as part of the thrust balancing arrangement

0914 Where an elbow is to be provided the supply of the elbow is, preferably to be made the responsibility of the pump maker. The pump maker is to take the weight of the elbow into account in determining the point of the assembly's centre of gravity and the location and selection of pump mounts.

0915 Noise shorts are to be avoided The general means of avoiding noise shorts are given in **DGS 591**

0916 To ensure true pipe alignment, pipe systems are to be set up with rigid pieces before the rubber elbows and flexible elbows pieces are fitted into place.

0917 Sufficient flexibility and clearance are to be provided to meet relative deflections caused by shock, thermal expansion, seaway movements, hydraulic trust and severe vibration.

0918 Where pumps are mounted on resilient mountings, the following methods are used for achieving flexibility in the associated pipe systems:

(a) 15 mm to 40 mm nominal bore – Hose assemblies to **DGS 340**.

(b) 50 mm to 100 mm nominal bore – Flexible pipe assemblies to **DGS 340**.

(c) 125 mm to 300 mm nominal bore – Bellows expansion pieces to **DGS 339**.

0919 Where space limitations preclude the fitting of the assemblies specified in (a) and (b) above, bellows expansion pieces from 32 mm to 100 mm bore to **DGS 339** may be used.

(c) Performance curves

(d) Whether the design of the pump is approved and certificates may be provided.

(e) Inherent shock strength and method of evaluation.

(f) Details of shock/ vibration mountings and expected attenuation and displacement under shock.

(g) Guaranteed noise and vibration signature

(h) Details of motor, starting arrangement and control.

(j) Dimensions and weight –dry and wet of complete unit and major assembly/ sub assemblies.

(k) Reference list, results of type test. Productions test, special tests, if any, earlier carried out.

(l) Budgetary cost per unit and cost of on-board spares and validity of offer.

(m) Cost of service engineers, installation engineers and extent of involvement recommended for trials and setting to work.

(n) Delivery schedule of complete unit indicating any component which needs more than six months lead time.

(p) Specification for oils and greases used.

(q) Recommended maintenance schedule, and scale of on-board and base and depot spares.

(r) A statement that the copy of the Naval specification has been received and that the Naval requirement of design, manufacturing, control instrumentation, inspection, tests, repair maintenance drawings, documentation, spares modifications etc will be met.

(s) A statement on the continued production of the model being offered and the availability of spares in future.

0920 Where bellows expansion pieces are fitted careful consideration is to be given to the reactive forces due to internal fluid pressure in the bellows, acting on the pump and pipe system. Measures are to be taken to ensure that noise/ shock/ vibration mounting systems are not over loading due to such forces.

0921 Any pump which will experience a relative trust in excess of 4.5 KN, due to a system bellow, based on the maximum system pressure and the nominal bore of the bellows, is to have this reaction balanced by a second identical bellows. This second bellow is to be fitted to the following principles -

(a) Fitted in a position axially opposite the system bellows

(b) Pressurised by the system

(c) Fixed to a rigid bulkhead or other part of the ship structure.

0922 Any pump which will experience a reactive thrust of less than 3.5 KN due to a system bellows, where the overall force cannot be accommodated by the mounts, is to be fitted with a compensating unit

0923 Each thrust compensating unit is to employ the spring force of suitable standard shock mounting fitted for this purpose.

0924 Each thrust compensating unit is to be fixed to a rigid bulkhead or other part of the ship structure. Brackets/ pads required to be fitted/ drilled on the equipment are to be shown on the equipment drawing. Alterations to equipments which effect differences from approved drawings are not permitted

Power Supplies

0925 Electric cables are to be connected to the equipment in accordance with the relevant electrical specifications

0926 An earthing strip is to be fitted on each pump. Pumps are to be checked for correct direction of rotation on first start up

Flushing

0927 Installations and flushing procedures particular to each system are specified in the relevant GMES.

Tank Mounted Pumps

0928 Pumps mounted upon or extending into tanks are to be capable of being lifted readily for examination and repair without draining the tank and without disturbing other equipment.

0929 Pumps flexibly mounted on tanks are to be provided with a sealing bellows fitted between the pump stool and the mounting flange on the tank.

Air turbine mounts

0930 An anti-flash gauze is to be provided in the exhaust trunking of each air turbine

GUIDANCE PROFORMA FOR PREPARATION OF SOR FOR ROTODYNAMIC PUMPS

I General

Ser	Property	Description	To be filled in By	Remarks
(a)	Duty	State duty and application (Para 0204)		
(b)	Ambient Conditions	Range of ambient conditions to which full specified performance is required State performance required at extreme conditions (Para 0208 - 0211)		
(c)	Ship Motions	Steady state and transient conditions of ship motion at which efficient operations is required (Para 0212-0214)		
(d)	Noise and Vibration	State levels to be withstood (Para 0219 - 0223)		
(e)	Shock	State levels to be withstood in all three directions, requirement of theoretical evaluations and practical tests Requirement of shock mounts (Para 0225)		
(f)	NPSH	State NPSH available (Para 0234-0235)		
(g)	Self Priming	State requirement and means of self priming (Para 0237)		
(h)	Submersibility	State depth		
(j)	Motor	State motor specification preferred type, make design etc (para 0246)		
(k)	Scope of Supply	Define scope of supply and terminal points (Para 0263)		

2 **Normal Operating Parameters**

	Units	Rated Conditions	Outlet Pressure Maximum	Outlet Pressure Minimum	Inlet Pressure Maximum	Inlet Pressure Minimum	Max Diff Press
Inlet Temp							
Viscosity							
Vapour Pressure							
Inlet Pressure							
NPIPA							
Flow							
Outlet Pressure							
Compressibility							

3 **Duty**

Duty	Continuous	Light	Intermittent	Cyclic	Irregular
Definitions	8-24 Hrs day	3-8 Hrs day	0-3 Hrs day	Describe	Describe

4 **Design**

Ser	Property	Description	To be filled in By	Remarks
(a)	Features	State over riding service features preferred type make, model, configuration etc (Para 0204)		
(b)	Material	To be generally in accordance with DMF 402 specific requirements to be stated (Para 0307)		
(c)	General Design	To be in accordance with DMF 402, state specific requirements (ref chapter 03)		

5 **Control & Monitoring** State scope of controls and instrumentation (chapter 06)

6 **Repair & Maintenance**

Ser	Property	Description	To be filled in By	Remarks
(a)	Repair Policy	State repair policy, maintainability, requirement of maintenance schedule (Para 0707)		
(b)	Spares	State policy of spare gear stocking requirement of ranging and scaling (Para 0708-0709)		
(c)	Drawings & Documentation	State requirement of drawings, handbooks Their quality and quantity, upkeep facilities and training facilities (Para 0715)		
(d)	Modification Procedure	State modification procedure (Para 0722-0723)		

7 **Other Contractual Requirements (if applicable)**

(a) Guarantee State guarantee requirement

(b) Installation and Service Engineers State requirement

(c) Delivery State delivery schedule, port of embarkation, transport, packing, preservation, mode of payment etc

(d) Cost State procurement cost applicable, escalation rate, liability clause etc

8 **Information Required along with Initial Proposal**

(a) General description, showing construction, design material specification manufacturing process and operational features

(b) Drawings plan elevation and end view of all complete unit and major components and pipe work to scale 1-20 The drawings are to show installation requirement maintenance envelope, seating details, ships builders connections and system diagrammatic and external system required