INDIAN OIL CORPORATION LIMITED
GUJARAT REFINERY
ENGINEERING SERVICES

Tender Specifications for Screw Pump 742-P-06A/B

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TECHNICAL SPECIFICATION

FOR

SCREW PUMP

1.0 SCOPE

This Technical Specification defines the minimum requirements for screw pumps and their accessories/auxiliaries. The basic design of the screw pumps offered shall however be as per API-676, Specification for Positive Displacement Pump – Rotary – Latest Edition.

1.1 The scope of supply shall include the following as a minimum:

1.1.1 Pump, base frame, coupling, non-sparking coupling guard, anchor bolts, mechanical seal (unless specified otherwise), auxiliary piping, pressure relief valve, etc., strictly as per the enquiry requirements.

1.1.2 Matching squirrel cage induction motor, unless specified otherwise, as per enclosed data sheet. Local PUSH BUTTON station, FLP Cable Gland & FLP cable stopper plug.

1.1.3 Mandatory Spares for pumps and motors, as per list of spares.

1.1.4 All Deliverables listed in this Technical Specification for Screw Pumps.

2.0 VENDOR'S RESPONSIBILITIES

No Deviations or Exceptions from this specification are permitted without the written approval of the purchaser. Deviations, supported by adequate reasons, shall be listed by the bidder/vendor separately in Annexure-I and submitted along with the offer. Unless specifically mentioned in the designated format in Annexure-I, it shall be understood that the bidder is in complete agreement with all terms and specifications of this specification.

Compliance with this specification shall not relieve the bidder/vendor of the responsibility of furnishing equipment and auxiliaries of proper design, materials and workmanship to meet the conditions.

In case of conflict between the requirements of this specification and other documents, the following order shall govern:

i) Job Purchase Order/Enquiry
ii) Technical Specification
iii) Relevant API / ASTM / OISD codes as applicable

3.0 CODES & STANDARDS

Vendor shall follow the latest editions of the following codes & standards as applicable:

i) API 676
ii) OISD-STD-123

4.0 DESIGN CRITERIA

4.1 Maximum Allowable Working Pressure, indicated by the bidder/vendor on the data sheets shall correspond to the standard maximum allowable working pressure for the proposed model with proposed metallurgy at specified design and ambient temperatures.

4.2 The maximum permissible allowable working pressure, however, shall be at least equal to that of the specified relief valve accumulation setting pressure at rated capacity.

4.3 In case, of application involving varying viscosity, the running clearances shall be decided based on lower viscosity and driver shall be sized based on the higher viscosity.

4.4 The pump shall always be provided with replaceable inserts unless an exception to this requirement is permitted by the Purchaser. Inserts shall be interchangeable between identical pumps.

4.5 Inlet and outlet connections shall be flanged for nozzle sizes ½" and above, and shall be suitable for maximum allowable working pressure. Threaded pipe nipples shall be provided for sizes below ½". The flanges shall conform to ANSI B 16.5 rating.

4.6 In the event that nozzle size of 32, 65, 90, 125, 175 and 225 mm are offered, forged companion flanges (weld neck type) along with expander with bolts and gaskets shall be supplied along with pumps.

4.7 Rotors shall be interchangeable between identical pumps.

4.8 Complete rotating elements shall be statically and dynamically balanced at rated speed for higher speed. Certificate of balancing of rotor shall be furnished.

4.9 Rotor and shaft will not be separate items and will form an integral part.

4.10 When the quality of liquid and its operating condition does not permit use of internal self liquid lubricated bearings, bidder/vendor shall recommend externally housed bearings.

4.11 In case of drivers for vertical pumps, provision shall be made in pump to absorb thrust developed by the pump.

4.12 Anticipated process variations that may affect the sizing of the driver (such as pressure, temperature, or properties of the fluid handled and special plant star-up conditions) shall be specified by the purchaser

4.13 Pressure Relief Valves shall be Full flow, External, Line Mounted Type. The relief valve set pressure shall be 10% over the rated discharge pressure or 1 kg/cm2 over the rated discharge pressure whichever is lower. Relief valve shall be single coil type and shall have proven design for performance. Material of construction of wetted parts of relief

valve shall be equal to or better than that of main pump wetted parts. However, they shall not be less than AISI 316. End connection of relief valve shall be flanged type and flanges shall conform to ANSI B16.5.

4.14 Bidder/Vendor shall furnish standard performance curves of the proposed model with the offer. The curves shall be marked with Operating Points for all cases of operation.

4.15 Coupling shall be non-lubricated flexible metallic type with Spacer and non-sparking design.

4.16 Coupling Guard shall be Non-Sparking type capable of withstanding foreseeable impact.

4.17 Wherever pump vendor is not required to mount the driver, the coupling hub of driver shall be pilot bored.

4.18 Mechanical Seals: Pump will be generally provided with mechanical seals as per API-682 and IOCL Technical Specification IOC/M&I/MECH/E/R/06 (Revision-00) for Mechanical Seals.

4.19 If steam heating is contemplated from viscosity consideration, pump shall be provided with jackets on stuffing box and casing. If jacket is not feasible and if acceptance of such alternative is permitted in Pump Data sheet, coil may be offered as an alternative with flanged inlet and outlet connections, suitably located to prevent condensate settlement. Material of coil shall be corrosion resistant, suitable for pressure and temperature of the steam. Bidder/Vendor shall specify the consumption of steam in kg/hr and give specific confirmation on suitability of jacket for specified steam condition.

4.20 Recommended driver rating and speed shall be specified by bidder/vendor. In case of a complete set of pump along with motor being required by IOCL, the relevant IOCL Technical specifications for Electrical Motors and related codes shall be applicable.

4.21 For motor driven units the motor nameplate rating excluding service factor shall be minimum of 110% of the greatest horsepower (including gear and coupling losses) required for maximum capacity of pump. Motor nameplate rating including service factor shall include operation at the relief valve set pressure, including accumulation, at the maximum specified viscosity.

4.22 Bidder/Vendor shall furnish GD2 value of rotor assembly along with Torque v/s speed characteristic curve of each offered model. Bidder/Vendor, after finalization of P.O., will get the speed torque characteristic curve of selected motor super imposed on pump torque-speed characteristics curve and shall submit the same for purchaser's approval.

4.23 Bidder/Vendor has to select suitable motor model from existing product range of motor manufacturer. The responsibility of selection of motor meeting all purchasers' requirements will be solely on bidder/vendor. In case procurement of motor is in Purchaser's scope, then pump vendor has to furnish GD2 value of the pump and

Torque-Speed characteristic curve of the pump. Subsequent upon of selection of motor by Purchaser all drawings and all data will be forwarded to pump bidder/vendor for their concurrence.

4.24 Pump manufacturer has to supply common base frame as per API guidelines for pump and motor along with final drilling and tapping on motor pedestal-plates. Motor pads are to be provided with motor jacking facility.

4.25 Base plate shall be of fabricated steel, drain rim type. C.I. base plates will not be acceptable.

4.26 Adequate provision shall be made to lift the complete unit without distortion and damage to the machinery or base frame.

4.27 Anchor bolts will be supplied by the bidder/vendor.

4.28 Sufficient number of grout holes shall be provided in the base plate and they shall be easily accessible.

4.29 In case of vertical pump base plate and mounting stool shall be sized / designed to suit vessel flange, details of which will be furnished along with the data sheet.

4.30 Pressure Relief Valves shall be supplied by the bidder/vendor as loose items, unless specified otherwise by the Purchaser. Pressure Relief Valves shall be as per IOCL Technical Specification IOC/M&I/MECH/E/S/09 (Revision-00).

4.31 Relief valve shall be selected to pass 100% rated capacity of pump when fully open and to limit accumulation pressure to 10% of set pressure.

4.32 Design for the relief valve shall be submitted for IOCL approval.

4.33 Bidder/Vendor shall also furnish the standard curves to extrapolate the performance of the quoted pump to the actual operating conditions. Vendor shall furnish guaranteed performance at all operating conditions and test conditions.

4.34 Vendor should offer the best efficient model. Loading advantage will be given to efficient models on account of power-saving as per enclosed calculation sheet (CL. No. 6.0).

5.0 MATERIALS & CONSTRUCTION

5.1 Materials and construction of the screw pump shall be as per API-676 latest edition.

6.0 INSPECTION & TESTING:

6.1 Unless otherwise specified, the test shall be witnessed by the Purchaser or by their authorized representative or by both together.

6.2 The various tests carried out as described below shall be properly recorded, plotted and shall be extrapolated for speed, specific gravity, Viscosity, etc. Such documents duly signed by vendor's inspector and purchaser's Inspector shall be submitted to the Purchaser with requisite number of sets for their record.

6.3 Heating jackets and cooling coils shall be tested at applicable pressure.

6.4 Hydrostatic test shall be maintained for a minimum period of one hour.

6.5 Performance Test:

a) The test described in this clause, has to be carried out at rated speed with a liquid having viscosity equal to that of operating condition and such liquid shall be arranged by the vendor. Testing at reduced speed is not acceptable. During performance test, the relief valve shall be tested for its satisfactory performance and accumulation pressure.

b) The characteristics of the testing liquid for performance testing shall be as close as possible to the pumping liquid. Bidder/Vendor shall furnish details of the liquid proposed to be used for the performance test of the pump. The details of the testing liquid to be furnished by the bidder/vendor in his offer shall include viscosity, specific gravity, density etc. as a minimum.

c) Vendor shall furnish the details of the Extrapolation Procedures for interpreting the Test Results to the actual liquid along with the offer.

d) After the performance test, the pumps shall be aligned with the job driver and the job coupling at the vendor's shop and this shall be witnessed by the purchaser's inspector prior to dispatch.

e) The performance test shall continue as the mechanical run test for a period of 4 hours.

f) The actual power consumption at rated point shall be calculated by the Bidder/Vendor from the recorded results after considering all applicable corrections or extrapolations. This power calculation sheets shall be endorsed by the Purchaser's Inspector. The actual power figure shall also be recorded by the Purchaser's Inspector in his final release note and shall give categorical comment with regards to applicability of Penalty Clause (Cl. No. 10.4), in case the recorded figure exceeds the guaranteed figures that appear in the approved data sheet.

6.6 Rotors shall be Dynamically Balanced.

6.7 NPSH TEST**:** NPSH test shall be carried out when the difference between NPSHR and NPSHA is less than 1 M. and shall be done by the vacuum suppression or suction throttling methods. At rated speed and with NPSHA equal to quoted NPSHR, the pump capacity shall be within three (3) percent of the non-cavitational rated capacity.

6.8 STRIP TEST: After the performance test, the pump shall be stripped off to check for its wear and workmanship. Shaft under packing shall be checked for any abnormal rubbing and wear. Inspection of bearings and screws shall also be done.

6.9 Unless otherwise specified in the data sheet material test certificate (chemical and mechanical properties) shall be supplied for rotor, shaft, shaft sleeve and casings (inserts if applicable).

6.10 Unit Noise level shall be measured and shall be within the limit of 90 dBA when measured from a distance of 1 M from pump surface.

6.11 During performance test vibration shall be measured on the bearing an on the baseplate for the capacity range of ± 10% of rated capacity. On the test bed the vibration amplitude shall not exceed 75 micron.

6.12 Inspection shall also include dimensional check of pump and driver duly mounted on the baseplate in accordance with certified general assembly drawing.

6.13 PUMP

6.14 Test to be carried out in front of Purchaser's Inspector:

a. Performance Test with test bench motor at full speed.
b. Strip Test
c. Hydrostatic Pressure Test
d. Dimensional Check
e. NPSH Test (Optional)

6.15 Certificates to be furnished to Purchaser's Inspector for review:

a. Material test certificates for main components like casing, stuffing box, impeller, shaft, wear rings, shaft sleeve, impeller lock nut, etc.

b. Dynamic Balancing certificates for complete rotor assembly.

6.16 **MOTOR:** Manufacturer's routine test certificates and guarantee certificates to be furnished to Purchaser's Inspector for review as per attached specification.

7.0 PACKING & SHIPMENT

7.1 All accessory piping to be supplied loose. They shall be properly tagged with long lasting color paint and with proper marking in each end of loose piping so that it can be easily assembled together at site. However, please note that supply shall be made in such a fashion, so that no welding, cutting, etc., or any such modification will be required during assembly at site.

7.2 Constant oil leveler, breather valve, etc. to be supplied loose in a separate packet and same can be fitted at site.

8.0 DOCUMENTS

8.1 DOCUMENTS TO BE FURNISHED BY VENDOR WITHIN 30 DAYS OF RECEIPT OF P.O. FOR PURCHASER'S APPROVAL.

8.1.1 General arrangement drawing indicating overall dimensions; foundation details, anchor bolt locations, weight of pump, coupling and base frame, permissible forces, moments GD2 value of pump rotor assembly and Torque Vs Speed characteristic Curves along with final pump data sheet.

8.1.2 Sectional drawing of the pump, rotor, and the accessories, with complete part list indicating part number and metallurgy of each part.

8.1.3 Specification of the lubricants to be used in the pump as per SERVO GRADE marketed by Indian Oil Corporation Limited.

8.1.4 Mechanical Seal drawings.

8.1.5 Motor:

a. Torque-Speed Characteristics
b. Efficiency and Power Factor vs. O/P (Load) Curve.
c. Current vs. Acceleration Curve.
d. Current vs. Speed Characteristics Curve.
e. Thermal withstand Curve (Hot and cold)

8.2 DOCUMENTS TO BE FURNISHED AS PART OF DESPATCH DOCUMENT (IN SIX SETS) IN HARD BOUND FOLDER:

8.2.1 Operating and Maintenance Manual of Pump and Motor.

8.2.2 Performance Guarantee for 12 months from the date of commissioning of the pump and motor in accordance with the terms of purchaser.

8.2.3 Final Test Certificates and Characteristic curves accepted by Purchaser's Inspector.

8.2.4 Material Test Certificates for casing, shaft, rotor(screw), insert, timer, gear, sleeves, etc.
8.2.5 Final Data Sheet.

8.2.6 All approved documents listed under Sr. No. 4.

9.0 POWER LOADING & PENALTY CLAUSE

9.1 GENERAL

9.1.1 Power loading and penalty criteria shall be based on guaranteed performance of the pumping unit. The parameters for loading shall be guaranteed shaft power consumed (BKW) at the rated operating point specified in the Pump data sheet.

9.1.2 Loading shall be done individually for each pump item number. Loading shall be applied to the number of operating units only.

9.2 PERFORMANCE GUARANTEES

Vendor shall furnish the guaranteed values for the following:

9.2.1 PUMP:

BKW of pump with zero per cent positive tolerance including any allowances for errors in instruments and measurement at the rated point specified in the data sheets.

9.2.2 Loading Criteria

The total cost of pumping unit for evaluation purposes shall be computed as under.

Total cost = A + B + C, Where
A = Capital cost of the total number of pumping units (both operating as well as Standby) and auxiliaries including commissioning spares, if any.
B = Differential operating cost as defined here under,
C = Cost of mandatory spares.

Differential operating cost
Differential operating cost (B) is defined as under:
B (in Rupees) = N_{op} X (F_e – F_r) X C_p X 8000 X D_f

Where,
F_e = Guaranteed shaft power requirement in KW at rated operating condition as quoted by the vendor
F_r = Lowest guaranteed shaft power requirement in KW at rated operating condition amongst the vendor.
N_{op} = Number of operating units
C_p = Cost of electrical energy per KWH (prevailing rate to be taken)
D_f = Discount factor (at 16% annum interest rate - present value discount - factor, D_f works out to 2.8227 for 05 years of operating life of pumps). Discount factor shall vary and shall be as mentioned separately elsewhere or else to be calculated based on prevailing annual interest rate i.e. borrowing rate +1%.
8000 = Number of operating hours for one year.
Discounting Factor (D_F) is defined as under:-

$$D_F = \sum_{n=k+1} [\, 1 \div \{1 + (R/100)\}^n]$$

n=2

where

k = Number of operating years for which loading is to be done as specified i.e. 5 years

R = Percentage rate of interest (e.g.12%)

D_F = e.g. 3.2186

Note:

- In case of $F_e - F_r$ is 0.5 KW or less, No loading shall be adopted.
- The maximum loading to be applied however shall not exceed 10% of the total capital cost i.e. (A + C) as defined earlier.

Penalty Criteria

During shop performance tests, if the BKW consumed by the pump exceeds the stipulated guaranteed value, for every extra KW consumed over and above the guaranteed BKW, the vendor shall be penalized for extra power consumption as per following formula.

Penalty Computation

The penalty shall be worked out on the basis of differential operating cost (B) as under:

P_{1t} (in Rs.) = $(F_t - F_g)$ X C_p X 8000 X D_f

Where,

F_t = Shaft at rated operating condition (corrected to pumping fluid) during test run.

F_g = Guaranteed shaft power at rated operating condition as indicated in the purchase requisition

D_f = Discount factor (at 16% annum interest rate - present value discount - factor, D_f works out to 2.8227 for 05 years of operating life of pumps). Discount factor shall vary and shall be as mentioned separately elsewhere or else to be calculated based on prevailing annual interest rate i.e. borrowing rate +1%.

Note:

- In case $(F_t - F_g)$ is 0.5 or less, no penalty shall be applied.
- During performance tests, if the BKW consumed by a pump exceeds the stipulated guaranteed value at rated operating condition by more than 4%, the pump gets rejected.
- The maximum penalty to be charged for non-conformance to guaranteed values during the shop performance test of all pumps of an item number put together (i.e. all working & standby units) shall not exceed 10% of the total capital cost i.e. (A + C) as defined earlier.

10.0 SPARES

10.1 As a minimum vendor shall quote for all the spare parts as commissioning an two years operation spares as defined in the attached list, as applicable to the proposed design of equipment.

10.2 The cost of these mandatory spare parts shall be added to the total cost for bid evaluation purposes.

10.3 Vendor shall (apart from the mandatory spare parts) quote for any additional spares (mechanical, electrical and instrument spares), which by his experience may be required for normal maintenance of proposed equipment, indicating the quantity used per machine, quantity recommended and unit price against each item. The list of such recommended spares shall be furnished in a separate sheet..

10.4 Wherever the word "SET" has been used under Part Description it means quantity sufficient for full replacement of that part in one machine.

10.5 Minor parts like fastening screws for wear rings, springs, washers etc. for impeller nut, retaining rings, lock washers etc. for bearings, and similar other parts shall be considered to be included along with the main part and hence not listed separately.

10.6 Spare parts shall be identical in all respects to the parts fitted on the main equipment including dimensions, materials of construction and heat treatments.

10.7 Spare parts quotation shall list all the spares in the same manner and order as indicated in the attached list with applicable quantity, and parts not applicable to the proposed design of equipment shall be clearly highlighted.

SN	PART DESCRIPTION	QTY. REQUIRED BASED ON TOTAL NO. OF PUMPS BEING PROCURED	
	No. of pumps under procurement	1	2
A	**SPARE PARTS FOR PUMP**		
1.	Set of screws	1	1
2.	Insert	1	1
3.	Set of timing gears	1	1
4.	Set of coupling spares (Flexible Element)	2	2
5.	Set of NDE Bearings - Each Screw	2	2
6.	Set of DE Bearings - Each Screw	2	2
7.	Set of Mechanical Seal (Complete with Assembly)	1	1
8.	Set of Mechanical Seal Parts		
a.	Seal Faces (Stationary + Rotary)	3	3
b.	Gaskets/ O-Rings & Packings	6	6
c.	Bellows, Pins, Screws	3	3
d.	Seal Sleeve	1	1
9.	Set of Gland Packings (As Applicable)	3	3

10.	Set of Pump Gaskets / O-Rings	5	6
11.	Set of Labyrinths (As Applicable)	2	3
12.	Set of Oil Seals (As Applicable)	3	4
13.	PSV Springs	1	1
B	*SPARE PARTS FOR ELECTRIC MOTOR DRIVE*	As per attached Technical Specification for Electric Motors	

1	**GENERAL**				
2	Project :			Job No. :JR/ES/2016/6136	
3	Owner : **IOCL Gujarat Refinery**			Site : **Gujarat Refinery, Vadodara**	
4	Purchaser : **IOCL, Gujarat Refinery**			Unit : **OM&S Bitumen**	Unit No. :
5	Item No. : **742 - P-06 A/B (Two No.)**			Service :	**Bitumen**
6	No. Required : **....** Working : **2** Standby : **0**			Driver : **Elect. Motor**	
7	■ Scope Option & information specified by purchaser			☐ Information required from & options left to vendor.	
8	Manufacturer :			Type :**Ex-d**	Model :
9	**OPERATING CONDITIONS**				
10	■ Liquid : **Bitumen**			■ Capacity at PT: **M3/hr**	
11	■ Pumping Temperature (^{0}C) : **Norm-155 Max-175 Min-120**			Norm : **170**	Rated.: **190**
12	■ Specific Gravity at PT : kg/m3	**890-930@pumping temp**		■ Discharge Pressure (	**19**
13	■ Viscosity (Cp) :	**220-450@ pumping temp(135Deg C)**			
14	■ Corrosion / Erosion Caused by :			■ Suction pressure (kg/cm2-a) : **0.2**	
15					
16	■ NPSH available m :	**2.0m**			
17	**SITE/INSTALLATION DATA**				
18	Location :	☐ ~~Indoor~~	■ Out door ~~w~~/w/o roof		
19	☐ **PERFORMANCE**				
20	☐ Rated Capacity (l/hr/m3/hr) :			☐ Mechanical Eff. (%) :	
	@ Min Viscosity :	@ Max Viscosity :			
21	☐ NPSH required (m) :			☐ KW @ Max. Viscosity :	
22	☐ Rated Speed (RPM) :			☐ KW @ Relief setting :	
23	☐ Displacement (m3/hr) :			☐ Max. allowable speed (RPM) :	
24	☐ Volumetric efficiency (%):			☐ Min. allowable speed (RPM) :	
25	☐ Rated BKW :				
26	**APPLICABLE SPECIFICATIONS:**				
27	**API 676 Positive Displacement pumps - Rotary**				
28	☐ **CONSTRUCTION FEATURES**				
29	Nozzles	Size / ANSI Rating		Facing	Position
30	Pump section				
31	Pump discharge				
32	Gland Flush				
33	Drains				
34	Vents				
35	Jacket				
36	Pump Type : ☐ Internal gear	■ Twin-Screw	☐ Vane		
37	☐ External gear	☐ Three-Screw	☐ Progressing cavity		
38	Gear Type : ☐ Spur	☐ Helical	☐ Other		
39	Casing				
40	☐ Max. allowable pressure	@ ^{0}C :		☐ Steam jacket pressure	@ ^{0}C :
41	☐ Hydrostatic test pressure	@ ^{0}C :		Timing geras ☐ Yes	☐ No
42	Rotor mount ☐ Between bearings	☐ Overhung		Bearing type ☐ Radial	☐ Thrust
43	Lubrication type : ■ Constant level oilers				
44	Pumped fluid ☐ Ring oil	☐ Oil mist	☐ External	☐ flood	Grease
45	☐ Lubricant type :				
46	■ Mechanical seals	**As per API682**			
47	☐ Manufacturer and model :	**EAGLE BURGMANN / FLOSERVE SANMAR / JOHN CRANE**			
48	☐ Manufacturer code				
49	■ API 610 seal flush plan :				
50	☐ API 610 seal code				
51	**MATERIALS**				
52	■ Casing : **CARBON STEEL**			■ Rotor(S) :	**AISI 431**
53	☐ End plates :			■ Shaft :	**AISI 431**
54	☐ Sleeve(S)			☐ Gland(S)	
55	☐ Bearing housing :			☐ Timing gears :	
56	☐ Special material tests (2.9.1.3) :			☐ Low ambient temp. materials tests (2.9.5)	
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इंडियनऑयल	**INDIAN OIL CORPORATION LTD.** **GUJARAT REFINERY**	**ROTARY PUMP**	**DATA SHEET NO.** **JES/ML/DS/1/SP/6136**

60	**QA INSPECTION & TESTINGS (EACH PUMP)**			
61	■ Compliance with inspectors check list		■ Certificates of materials	
62	■ Final assembly clearances		■ Cleanliness prior to final assembly	
63	**Test**	**Required** **Witnessed**		
64	Hydrosatic	■ ■		
65	Mechanical run	■ ■		
66	Performance	■ ■		
67	NPSH	■ ■		
68	**DRIVER**			
69	■ Type of Driver:	■ Elec. Motor:	☐ Steam Driven: ☐ Air Motor:	
70	■ Driver Supplied & mounted by pump manufacturer		☐ Driver Supplied & mounted by others	
71	☐ Manufacturer:		☐ Type	
72	☐ Frame no:		☐ Constant speed ☐ Variable speed	
73	☐ KW RPM			
74	■ Volts Phase			
75	■ Hertz Service factor			
76	**PREPARATION FOR SHIPMENT**			
77	■ Domestic ☐ Export ☐ Export boxing reqd.:		☐ Outdoor storage more than 6 months:	
78	**WEIGHTS (KG)**			
79	☐ Pump ☐ Base ☐ Gear ☐ river		☐ Total weight (Kg.):	
80	**BASEPLATE**			
81	■ By pump manufacturer		☐ Suitable for epoxy grout	
82	**OTHER PURCHASE REQUIREMENTS**			
83	■ Relief valves by pump mfgr. ☐ Internal ☐ External			
84	Piping for seal flush furnished by : ■ Pump vendor ☐ Others			
85	Piping for cooling/heating furnished by : ■ Pump vendor ☐ Others:			
86	■ Provide technical data manual			
87	**Remarks**			
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TECHNICAL SPECIFICATION

FOR

MECHANICAL SEALS

1.0 SCOPE

This standard specifies requirements and gives recommendations for sealing systems and related auxiliary support systems for centrifugal and rotary pumps used in the petroleum, natural gas and chemical units. This standard is also applicable to seal spare parts and can be referred to for the upgradion of existing equipment.
This standard's objective is to achieve greater degree of reliability, improvement in equipment availability and the reduction of both emissions to the atmosphere while reducing life-cycle sealing costs.

Mechanical Seal and sealing systems conforming to this specification are intended to operate for 25,000 hrs without need for replacement.

2.0 REFERENCE STANDARDS

i) API 682 3rd edition
ii) API 610 8th edition
iii) API 610 10th edition
iv) OISD-STD-125, Revised Edition, August 2007
v) **DRAFT INTERNATIONAL STANDARD** ISO/DIS 21049

3.0 GENERAL:

This Technical Specification that is composed of all attachments mentioned below defines the minimum requirements for **Mechanical seals and their accessories/auxiliaries.** The basic design of the mechanical seals offered shall be in accordance with API 682, latest edition. It would at the same time be binding on the Bidder/Vendor to meet all the requirements of this Technical Specification. The bidder is, therefore, advised to read and understand the contents of all the annexures. It shall be construed that the bidder has considered all the points contained in the annexures prior to quoting and that the rates quoted by the bidder are inclusive of all the considerations.

1 LIST OF ATTACHMENTS AS GIVEN BELOW:

i) ANNEXURE-I: DATA SHEET FOR MECHANICAL SEALS (To be referred from Annexure-C, API 682 3RD EDITION and attached by purchaser)
ii) ANNEXURE-II: LIST OF SPARES

In case of conflict between any two sections/attachments of this specification, the following order of precedence shall govern:

1. Job Specification
2. Data Sheet (Annexure-I)
3. Standard Specification for Mechanical Seal and support system (this specification)
4. List of Spares (Annexure-II)
5. Other referred codes and standards

No Deviations or Exceptions from this specification are permitted without the written approval of the purchaser. Intended Deviations, supported by adequate reasons, shall be listed by the bidder/vendor separately and submitted along with the offer. Unless specific exceptions and extent thereof, is recorded by bidder/vendor, in his proposal, it shall be understood that the offer is in complete accordance with all terms and specifications to which reference is made and that Vendor / Bidder also guarantees to meet guarantee requirement as covered under relevant standards and this specification.

Compliance with this specification shall not relieve the bidder/vendor of the responsibility of furnishing equipment and auxiliaries of proper design, materials and workmanship to meet the conditions.

The Vendor/ Bidder shall not ask for any alteration/deviation once the Purchase Order is placed.

4.0 QUALIFICATION CRITERIA:

Offered seal models shall be of proven design and from the existing regular production range of the bidder/vendor. The quoted model, designed and manufactured earlier at the bidder/vendor's same works must have been operating successfully at the any site and must have completed individually, a minimum of 8000 hours of satisfactory operation in the specified operating range, without any major overhaul. The performance of the model shall have been established in the shop test.

Bidder/Vendor shall furnish Reference List for each offered seal model. Reference list preferably may contain following data: Name of Client, Liquid Handled, Capacity, Discharge Pressure, Temperature, Number of Units, seal model etc.

The Bidder/Vendor must not propose to effect any changes or modifications to his standard model(s) in order to meet Purchaser's requirements, as the same shall not be acceptable in any case.

It should be noted that further or differing requirements may be needed for individual applications. This Standard is not intended to inhibit a vendor from offering alternative equipment or engineering solutions for the individual application. This may be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this Standard and provide detailed justifications.

5.0 SCOPE OF SUPPLY:

a. Mechanical seal as specified otherwise, auxiliary piping, auxiliary system, auxiliary instruments etc. strictly as per the enquiry requirements.

b. Mandatory Spares as per list of spares- Annexure-II.

6.0 SUBMISSION OF OFFER:

a. The offer should be complete in all respects as per the enquiry and should include all requirements, drawing and schematics of all auxiliary systems as outlined in the section entitled "Proposal Data".
b. The data sheets as per API 682 (Annexure-C) should be properly filled in by the vendor without any ambiguity, cutting, use of white fluid etc. and duly signed and stamped on all pages as a token of acceptance, without which offer will be rejected.
c. Item wise unit prices are to be submitted for the Mandatory Spares as listed in Annexure-I.
d. Intended Deviations, supported by adequate reasons, shall be listed by the bidder/vendor separately entitled "Deviations" and submitted along with the offer.
e. General design and construction shall be as per API-682 latest edition including the following important points:
    i) Shaft-to-Sleeve O-ring at Impeller End as per API-682.
    ii) Gland has to be centered on seal chamber as per API-682.
    iii) Sleeve relief at set screw as per API-682.
    iv) Non-sparking Floating Throttle bushing (applicable for single seals only) as per API-682.
    v) Minimum sleeve thickness as per API-682.

7.0 TECHNICAL

7.1 All mechanical seals, regardless of type or arrangement, shall be of the cartridge design for all applications. However, if cartridge design is not feasible for pumps of API 610 sixth edition and earlier, non-cartridge seal shall be acceptable with proper justification.

7.2 For the cases in which single arrangement for Type-A seal as per API 682 is selected, the pusher seal shall be an inside-mounted, stationary, balanced cartridge seal with spring outside the product. Rotary seal will be considered only if stationary seal fitment is not possible.

Note: Stationary seals can take more misalignment and non perpendicularity between gland and shaft. The flexible element (spring/bellows) can deflect to a fixed position to match the rotating face. This recommendation is superior to API 682 3rd edition clause no. 4.1.3.
Also stationary flexible elements are preferred choice as it provides more reliable seal operation when:

a) Seals are installed in high temperature pumps where thermal distortion of the casing and/or gland plate will affect the alignment of the shaft to the seal chamber face. This is one reason API recommends stationary flexible elements as default selection above 176 °C.
b) Seals are installed in ASME B73.1 and B73.2 pumps or multistage pumps with high levels of shaft flexure may affect the alignment of the shaft and seal chamber face.
c) Seals are installed in high pressure pumps where the pressure results in excessive distortion of the seal chamber face and its alignment to the shaft axis.
d) Seals are installed in pumps with excessive pipe loads causing casing distortion affecting the alignment of the shaft and seal chamber face.
e) The seal balance diameter exceeds 115 mm (4,5 in).
f) The peripheral face velocity exceeds 23 m/s (4500 ft/min).

Rotating and stationary flexible elements are considered to be technically equivalent (by ISO working committee). The default for rotating or stationary elements for different seal types and their arrangements have been based on installed population and reliable operation.

7.3 For pusher type seals with multiple coil-springs material shall be Hastelloy C (Alloy C-276) only.Wherever single coil spring is used, material may be AISI Type 316 stainless steel.

Note: Hastelloy-C (Alloy C-276) has been standardized as per Clause 6.1.6.4 of API 682 3rd edition) due to better spring properties as compared to SS316 / Alloy 20.

7.4 O-rings shall be fluoroelastomer (FKM - Viton). If operating temperatures or chemical compatibility does not recommend the use of fluoroelastomers an O-rings compatible to the product shall be selected. For temperature limit following guideline shall be followed.

Material	Minimum temperature °C (°F)	Maximum temperature °C (°F)
Fluoroelastomer (FKM):		
Hydrocarbon service	– 7 (20)	175 (350)
Water-based service	– 7 (20)	120 (250)
Perfluoroelastomer (FFKM)	– 7 (20) [a]	290 (550)
Nitrile (NBR)	– 40 (– 40)	120 (250)
Flexible graphite	– 240 (– 400)	480 (900)
[a] Some FFKM grades are not suitable below 20 °C (70 °F).		

Source: API 682 3rd edition Table B.5 Typical temperature limitation guidelines for secondary seal materials

7.5 Unless otherwise specified, metal bellows for the type B seal shall be Hastelloy C.

7.6 For the type C seal, recommended bellow material shall be Inconel 718 for high temperature application(>176degC) and/or sulphur concentration>2% (for better corrosion resistance). For other applications, recommended bellow material is AM 350 (for cost advantage without sacrificing reliability).

7.7 The mating ring shall be Silicone Carbide. Suitable grade (reaction bonded or sintered) shall be decided by seal manufacturer.

7.8 One of the seal face rings shall be premium grade, blister resistant carbon graphite with suitable binders and impregnants to reduce wear and provide chemical resistance.

7.9 Abrasive service may require two hard materials. Unless otherwise specified for this service, the seal ring shall be reaction bonded silicone carbide and tungsten carbide (WC) with nickel binder or Silicon Carbide.

7.10 For temperature limit following guideline shall be followed:

Typical temperature limits for seal face materials	
Face Material	Maximum Temperature °C (°F) (Note a)
Tungsten carbide	1100 (2012)
Silicon carbide (sintered, SSiC	1650 (3002)
Silicon carbide (reaction bonded , RRBSiC	1400 (2552)
Silicon carbide – Graphite loaded (sintered,SSiCG)	550 (1022)
Silicon carbide – Graphite loaded (sintered,SSiCG)	550 (1022)
Carbon-graphite: Resin impregnated Antimony impregnated	 285(550) 500 (932)
a) With the exception of SSiC, chemical compatibility of face materials can vary with temperature and environment	

Source: DRAFT INTERNATIONAL STANDARD ISO/DIS 21049

Superior or alternative materials recommended for the service by the seal manufacturer shall be stated in the vendor's proposal.

7.11 **Default seal types and arrangements**

Single Seal: Unless otherwise specified the seal shall be inside-mounted, stationary, balanced cartridge seal with spring outside the product.

Double Seal: Unless otherwise specified, the configuration shall be face-to-face.

If specified separately, seals arranged in series (Tandem) or a back-to-back configuration may be provided as per guidelines of API 682 latest edition.

Note: Face to face seal arrangement requires minimum space. The heat removal of both the faces is more effective as compared to Tandem and Back-to-Back seals. Also, in face to face configuration flexible element becomes stationary.

Non contacting arrangement is preferred as in case of inboard seal failure within 8 hours normally the pump is not depressurized (after primary seal failure expected outboard seal life as per API 682 is 8h).

7.12 Gland plates and Sleeve for alloy pumps shall be of the same alloy as the casing, or one with superior corrosion resistance and mechanical properties. Unless otherwise specified, gland plates for other pumps shall be stainless steel.

7.13 The mating joint between the seal gland and the seal chamber face shall incorporate a confined gasket to prevent blowout. The gasket shall be of the controlled compression type (for example, an O-ring or a spiral wound gasket) with metal-to-metal joint contact. Where space or design limitations make this requirement impractical, an alternative seal gland design shall be submitted to the purchaser for approval.

7.14 The seal supplied shall be capable of handling normal and transient differential axial movement between the rotor and stator. The vendor shall obtain maximum design axial movement of the designated pump from the pump vendor, if necessary.

7.15 The minimum radial clearance between the rotating components of the seal and the stationary surfaces of the seal chamber and gland plate shall be 3 mm (1/8 in) for pumps conforming to API 610 7th Edition and after. For pumps of earlier edition, minimum radial clearance of 1.5 mm is acceptable (except for applications where API Plan 02 is selected, where more volume of the product is required for conduction of the heat).

7.16 For pumping ring (internal circulating device) minimum radial clearance shall be 1.5 mm.

7.17 Gland plates shall be provided with holes (not slots) for attachment studs. For horizontally split pumps, slotted glands are acceptable to make disassembly easier.

7.18 The seal chamber shall be provided with an internal passage or external connection to permit complete venting of the chamber before start-up.

7.19 A dual seal shall be selected in all applications as recommended as per relevant OISD standards referred.

7.20 In the cases where dual seal is selected, the standard, un-pressurized dual mechanical seal shall be an inside, balanced, cartridge mounted mechanical seal (with two stationary flexible elements and two mating rings in series). Outer seals shall be designed to the same operating pressure as the inner seal, but need not be balanced seal.

7.21 Unless otherwise specified, the inner seal shall be a contacting wet seal the inner seal shall have an internal (reverse) balance feature designed and constructed to withstand reverse pressure without opening or dislodging components.

7.22 Unless otherwise specified, a contacting containment seal shall be used with liquid buffer systems and a non-contacting containment seal shall be used if a liquid buffer system is not provided.

7.23 The standard pressurized dual mechanical seal shall be face to face, cartridge mounted mechanical seal. The inner and outer seals arranged in series (Tandem seal shall be standard option). The inner seal shall have an internal (reverse) balance feature designed and constructed to withstand reverse pressure differentials without opening. In other words , the primary seal should be able to hold the pumping liquid at its maximum suction pressure even when the pressure of the barrier fluid in the secondary chamber has fallen down to zero.

7.24 For single seals and when specified for dual seals, a non-sparking, floating-throttle bushing shall be installed in the seal gland or chamber and positively retained against blow-out to minimize leakage if the seal fails.

7.25 For dual mechanical seals, only mechanically forced seal flush and barrier/buffer fluid systems shall be provided. Systems that rely upon a thermo-siphon to maintain circulation during normal operation are not acceptable. .

7.26 **Internal circulating device:** shall be designed such that the maximum temperature differential between the barrier fluid inlet and outlet immediately adjacent to the seal chamber is:
8 °C (15 °F) for glycol/water or diesel barrier fluids; and
16 °C (30 °F) for mineral oil barrier fluids.

7.27 The seal manufacturer shall provide the performance curve for head versus flow for the internal circulating device based on actual test results.

7.28 External circulating device (Plan 54): If specified, or if an internal circulating device cannot meet desired flow rates, an external forced-circulation device may be proposed. Circulation device selection shall be mutually agreed upon by the purchaser and the seal manufacturer.

7.29 If a dual seal buffer/barrier fluid reservoir is specified, a separate barrier/buffer fluid reservoir shall be furnished for each mechanical seal / pair of mechanical seal in case of in-between bearing type of pump.

8.0 SEAL SUPPORT SYSTEMS

8.1 Orifices: All orifices shall have a minimum bore of 3 mm (1/8 in). Multiple orifices, installed in series, may be used if more pressure drop is required that can not be achieved in a single 3 mm (1/8 in) orifice.

8.2 For gas barrier orifice size will be 1.5 mm.

8.3 **Seal flush coolers:** Seal flush coolers shall generally be as per API 682 latest edition. However, air-cooled flush coolers may be considered in cases as per note c of the “Recommended seal selection procedure” in API 682 3rd edition for specified services, wherein it is mentioned that “However, the user may wish to reconsider using a Plan 21 due to added seal complexity imposed by Plan 23 (size and cost) and other factors such

as the use of an air cooler for Plan 21 in areas where water cannot be used or is not available. (An air cooler works better on Plan 21 due to higher temperature difference between the pumped fluid and the cooling medium)."

Note: Water related problem like scaling, gets eliminated (outage taken for scale removal is avoided) from Air cooler. Also water consumption becomes zero.

8.4 For all between-bearing pumps, a separate external seal flush cooler shall be provided for each mechanical seal. In case of Plan 21, the scope shall include auxiliary piping with restricted orifice, temperature indicator and coolers. Each cooler shall be sized for rated heat load.

8.5 **API Plan for seal**

Default plan for Single Seal at low temperature is API Plan 13 (where st. box pressure is more than suction pressure).

Note:

PLAN 11	PLAN 13
Impingement on seal face	**Liquid moves away from seal face**
St. box gets prssurised	**St. box gets de pressurised**

From the above, it can be concluded that seal life will be more with Plan 13.

Default plan for high temperature applications is API Plan 23 (Plan 21 to be used only if pumping ring is not capable of circulating the product).

Note:

PLAN 21	PLAN 23
Large cooler requirement – more initial cost	**Small size cooler required – less initial cost**
More heat loss – product to be cooled from pumping temperature to desired temperature.	**Only heat soaked plus heat added by seal needs to be removed**
Water requirement more	**Water requirement less**

Default API Plan for double seal shall be API Plan 53 C. In specific cases other plans may be specified with proper justification.

Note:
API Piping Plan 53 will avoid a pressure reversal at the inner seal and also avoid over pressurizing the seal or seal flush system components due to seasonal fluctuations in ambient temperature

With both Piping Plans 53A and 53B, as barrier fluid pressure increases seal face related drag also increases. It may become difficult or impossible to rotate some pumps prior to startup when the seal is pressurized. In small pumps, seal drag may also contribute significantly to the motor load and it is possible to experience an overload condition (high amps) causing shutdown of a marginally sized motor.

Advantages of Plan 53 C over Plan 52 is given below:

Design Features	Benefits	API Plan 52	API Plan 53 C
Barrier fluid is at a higher pressure and pump-age	Zero fugitive emission	No	Yes
Primary mechanical seal interface film is barrier fluid, not product	Increased mechanical seal life, especially on light hydrocarbon pump-age	No	Yes
Barrier fluid remains uncontaminated by pump-age through out its life	Increased mechanical seal life, especially the secondary seal face	No	Yes
No need for the seal system to be connected to plant flare systems	Increased mechanical seal life, especially the secondary seal face	No	Yes
Required only one channel of instrumentation	Reduced installation and maintenance cost	No	Yes
Barrier fluid can be refilled with the system pressurized and the pump running	Reduced pump shut down time and enables a pump with a leaking seal to continue running	No	Yes
Barrier fluid reservoir can be mounted off pump base plate/skid	Flexibility when retrofitting to existing pump assembly	No	Yes
Non-penetrating magnetic instrumentation	Able to service/ replace instrument with the system full of barrier fluid and pump operating	No	Yes

Advantages of API Plan 53 C over Plan 53 A and Plan 53 B:

Design Features	API Plan 53A	API Plan 53B	API Plan 53C
Barrier fluid pressure automatically changes with varying stuffing box pressure	No	No	Yes
Differential pressure between barrier fluid and stuffing box fixed	No	No	Partial
Suitable for use with low suction pressure	Yes	Yes	No
Nitrogen Gas required	Yes	Yes	No
Nitrogen absorption into barrier fluid	Yes	No	No
Barrier fluid pressure	Maximum stuffing box pressure + 2 kg/cm2	Maximum stuffing box pressure + 2 kg/cm2	stuffing box pressure + 1 - 2 kg/cm2
Instrumental requirement	Min. requirement Low pressure alarm and low level alarm	Min. requirement Low pressure alarm and low level alarm	Only low level alarm is required
Suitability for low variation in stuffing box pressure	Yes	Yes	No
Large amount of useable seal barrier fluid	Yes	No	No
Non-Penetrating magnetic instrument	No	No	Partial

8.6 External circulating device (Plan 54): If specified, or if an internal circulating device cannot meet desired flow rates, an external forced-circulation device may be proposed. Circulation device selection shall be mutually agreed upon by the purchaser and the seal manufacturer.

8.7 **Barrier/Buffer Fluid reservoirs:** If a barrier/buffer-fluid reservoir is required, the purchaser and the mechanical seal manufacturer shall mutually agree on the sizing, instrumentation requirements, fluid selection, general arrangement, etc.

8.8 A separate reservoir shall be furnished for each mechanical seal.

8.9 Unless otherwise specified, the reservoir shall be equipped with a low-level alarm (LLA) switch.

8.10 A nameplate, stamped with the MAWP, hydrostatic test pressure, and the minimum and maximum allowable temperatures, shall be permanently attached to the reservoir.

8.11 Unless otherwise specified, the barrier/buffer-fluid reservoir and any piping or components welded directly to the reservoir shall be AISI 316L stainless steel.

8.12 External seal flush systems: If an external source of seal flush is required, the seal manufacturer shall specify the volume, pressure and temperature required, where these are factors. The purchaser shall specify the fluid characteristics.

8.13 **Condensate collection reservoir:** If a condensate collection reservoir is required, the size and instrumentation required shall be mutually discussed and agreed with purchaser and seal manufacturer**.**

8.14 **Barrier/Buffer Gas supply systems:** If a barrier/buffer-gas system is specified, the purchaser and the mechanical seal manufacturer shall mutually agree on the instrumentation requirements and general arrangement.

8.15 Barrier/buffer-gas supply systems shall be provided by the seal supplier and include as a minimum a pressure regulator, coalescing filter, indicating flow meter, check valve, inlet and outlet isolation valves, low pressure switch and a pressure gauge.

9.0 INSTRUMENTATION

9.1 Unless otherwise specified, controls and instrumentation shall be designed for outdoor installation.

9.2 Instrumentation and controls shall be designed and manufactured for use in the specified area classification (class, group and division or zone).

9.3 All controls and instruments shall be located and arranged to permit easy visibility by the operators, as well as accessibility for tests, adjustments, and maintenance.

9.4 **Temperature gauges:** Dial temperature gauges shall be heavy duty and corrosion-resistant. They shall be bi-metallic or liquid filled with a rigid stem suitable for mounting as needed.

9.5 **Thermowells:** Temperature gauges shall be furnished with separable threaded solid-bar thermowells made of austenitic stainless steel or superior material.

9.6 **Pressure Gauges:** Dial Pressure gauges shall be furnished with AISI 316 stainless steel bourdon tube type or of other material compatible with the liquid.

9.7 **Alarm and Switches:** Each alarm switch, each shut-down switch and each control switch shall be furnished in a separate housing located to facilitate inspection and maintenance. Unless otherwise specified, double-pole, double-throw switches with a minimum rating of at least 5 A at 110 V a.c. and 1/2 ampere at 110 V D.C., suitable for the electrical hazard area classification, shall be used.

9.8 **Pressure switches:** Pressure switches shall have over-range protection to the maximum pressure to which the switch may be exposed. Switches exposed to vacuum shall have under-range protection to full vacuum.

9.9 The measuring element and all pressure-containing parts shall be AISI 316 stainless steel unless the pumped fluid requires the use of alternative materials.

9.10 If specified, pressure transmitters shall be furnished.

9.11 Level switches: Unless otherwise specified, level switches shall be hydrostatic, capacitance or ultrasonic type.

9.12 If specified, level transmitters shall be furnished.

9.13 Flow switches: Flow switches provided with buffer/barrier-gas systems shall be inline, mechanically actuated, that respond to gas motion within the line, independent of system pressures.

9.14 Level indicators: The specification level indicator shall be of the weld pad reflex design.

9.15 If required, an externally mounted, removable, reflex indicator can be furnished instead of the specification weld pad design.

9.16 Flow instruments

9.17 Flow indicators If used, flow indicators shall be of the non-restrictive bull's-eye type and shall have a steel body.

9.18 Flow meters Flow meters shall be armoured rotameter or internal magnetic float design.

9.19 Flow transmitters If specified, flow transmitters shall be furnished

9.20 Relief valves Unless otherwise specified, the manufacturer shall furnish the relief valves that are to be installed on equipment or in piping and tubing that the manufacturer is supplying.

9.21 Regulators: Regulators for gas buffer and barrier systems shall be supplied in accordance with the following.

9.22 Regulators shall be self-contained, spring-loaded with an internal pressure-sensing connection.

9.23 The regulators shall be designed such that the regulated pressure is applied directly to the diaphragm through the valve body.

9.24 An adjusting device shall be provided with a locking mechanism to ensure that the control point cannot shift or be changed (by mistake).

9.25 The regulator body shall be rated for the maximum upstream and downstream pressure and temperature to which it may be subjected.

9.26 Cast iron valve bodies are not permitted. Cast aluminum, if approved by the purchaser, is permitted only in air or nitrogen service; spring and diaphragm housings shall be steel or stainless steel.

9.27 Pressure amplifiers: A gas-pressure booster shall be provided if necessary to increase utility gas supply pressure.

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10.0 SHOP INSPECTION & TESTS:

10.1 Each mechanical seal shall be tested with air by the seal manufacturer after final assembly.

10.2 Each sealing section shall be independently pressurized with clean air to a gauge pressure of 0, 17 MPa (1,7 bar) (25 psi). The volume of each test set-up shall be a maximum of 28 l (1 ft3). After pressurization isolate the test set-up from the pressurizing source and maintain the pressure for at least five minutes. The maximum pressure drop during the test shall be 0,014 MPa (0,14 bar) (2 psi).

10.3 In general, commissioning, inspection testing and installation of the mechanical seal and auxiliary support systems shall be carried out as per relevant standards, particularly with API 682 3rd edition and OISD-STD-125 latest edition.

11.0 PROPOSAL DATA

11.1 The vendor shall provide six sets of documents in hardcopy and one softcopy in CD format for all the drawings as listed in tables for Proposal data and Contract data as below.

11.2 The seal cross-sectional drawing shall include the following information:

- Sufficient dimensional information to check the fitment of the seal in the equipment, including the seal chamber bore and depth, gland plate connections, and the distance to the nearest obstruction external to the seal chamber.
- Overall seal dimensions and any relevant seal setting dimensions.
- Seal axial tolerance to differential shaft/casing movement.
- Material specifications.
- Auxiliary system schematic.
- Exceptions to this Specification.
- Detailed bill of materials for seal and auxiliary system.
- Seal design performance parameters.
- Seal axial thrust force on shaft.
- Hydrostatic /Air test certification.
- A separate seal-chamber drawing clarifying any pump modifications required to fit the proposed seal. This drawing shall either show the seal assembly or include a cross-reference to it.

PROPOSAL DATA (TABLE 9 OF API 682 3RD EDITION)

Information required	Seal category		
	1	2	3
Cross-sectional drawing (typical)	X	X	X
Auxiliary system schematic			X
Appropriate completed data sheets	X	X	X
Alternatives proposed	X	X	X
Exceptions to this International Standard	X	X	X
Detailed bill of materials for seal and auxiliary system			X
Estimated seal leakage of 2NC-CS at rated seal-chamber pressure	X	X	X
Seal qualification test results and certification			X
Seal design performance parameters			X
Seal axial thrust force on shaft			X
Data requirements form	X[a]	X[a]	X[a]

[a] If specified.

CONTRACT DATA (TABLE 10 OF API 682 3RD EDITION)

Information required	Seal category		
	1	2	3
Cross-sectional drawing (typical)	X	X	
Cross-sectional drawing (specific)	[a]	[a]	X
Auxiliary system schematic	X	X	X
Detailed drawing of auxiliary system			X
Appropriate completed data sheets	X	X	X
Detailed bill of materials for seal and auxiliary system	X	X	X
Seal energy and heat-soak calculations			X
Seal axial thrust on shaft			X
Internal circulating device performance (test data)			X
Installation, operation and maintenance instructions (typical)	X	X	
Installation, operation and maintenance instructions (specific)			X
Hydrostatic test certification			X
Material safety data sheets	[b]	[b]	X
Data requirements form	X[c]	X[c]	X[c]

[a] Shall be supplied if significant pump modifications are required.
[b] If required by regulations.
[c] If specified.

Drawing of auxiliary system:

The detailed drawing of the auxiliary system shall include:

- All mounting overall dimensions and boundary limits.
- All external utility requirements and positions.
- All connecting pipe work locations, type and size.
- Appropriate labeling and reference to the bill of materials.
- Barrier or buffer-fluid specification.
- Equipment and alarm set points.
- Hydro test pressure, if applicable.
- Maximum design pressure and temperature.
- Orifice size.
- Size and set pressure of relief valves.
- Complete bill of materials for auxiliary systems.

12.0 PREPARATION FOR SHIPMENT

Unless otherwise specified, the equipment shall be prepared for the type of shipment as described below.

- The manufacturer shall provide the purchaser with the instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the job site and before start-up.
- The equipment shall be prepared for shipment after all testing and inspection have been completed and the equipment has been released by the purchaser. The preparation shall include the following.
- Exterior surfaces, except for machined surfaces, shall be given at least one coat of the manufacturer's specification paint. The paint shall not contain lead or chromates. Stainless steel parts shall not be painted.
- Carbon steel exterior machined surfaces shall be coated with suitable rust preventive.
- The interior of the equipment shall be clean and free from scale, welding spatter and foreign objects.
- Internal steel areas of carbon steel systems of any auxiliary equipment, such as reservoirs, shall be coated with suitable oil-soluble rust preventive.
- Flanged openings shall be provided with metal closures at least 4,8 mm (3/16 in) thick, with elastomer gaskets and at least four fully threaded bolts. For studded openings, all nuts needed for the intended service shall be installed.
- Threaded openings shall be plugged.
- Lifting points and the centre of gravity shall be clearly identified on the equipment package if the mass exceeds 23 kg (50 lb). The manufacturer shall provide the recommended lifting arrangement.
- For Double Seal, the equipment shall be identified with item and serial numbers. Material shipped separately shall be identified with securely affixed, corrosion-resistant metal tags indicating the item and serial number of the equipment, and

shall be shipped with duplicate lists, one inside and one on the outside of the shipping container.

- Auxiliary piping connections shall be die-stamped or permanently tagged to agree with the manufacturer's connection table or general arrangement drawing. Service and connection designations shall be indicated.
- Hydrostatic /Air test certification.
- Performance test of internal circulating device (if used).
- One copy of the seal manufacturer's installation instructions shall be packed and shipped with the equipment.
- All parts shall be supplied with clear marking of part nos. as per drawing.

Annexure-II

LIST OF SPARES

NOTES:

1. As a minimum vendor shall quote for all the spare parts as defined in the attached list, as applicable to the proposed design of equipment, indicating their unit prices.
2. The cost of these mandatory spare parts shall be added to the total cost for bid evaluation purposes.
3. The offers not including the quote for these mandatory spare parts shall be considered as incomplete offers, and shall be liable for rejection.
4. Vendor shall (apart from the mandatory spare parts) quote for any additional spares, which by his experience may be required for normal maintenance of proposed equipment, indicating the quantity used per machine, quantity recommended and unit price against each item. The list of such recommended spares shall be furnished separately along with the offer.
5. Wherever the word “SET” has been used under Part Description it means quantity sufficient for full replacement of that part in one machine.
6. Spare parts shall be identical in all respects to the parts fitted on the main equipment including dimensions, materials of construction and heat treatments.
7. Spare parts quotation shall list all the spares in the same manner and order as indicated in the attached list with applicable quantity, and parts not applicable to the proposed design of equipment shall be clearly highlighted.

SN	SPARE PART DESCRIPTION	UNIT	REQD. QTY.
1	Complete mechanical seal assembly (with sleeve and gland plate)	SET	01
2	Complete seal without gland and sleeve (for non-cartridge seal)	SET	01
MECHANICAL SEAL PARTS			
1	Seal faces*	SET	01
2	Gaskets/O-rings/packings (including gland & sleeve)	SET	02
3	Springs, pins, screws	SET	02

*For bellow seal design, seal faces shall include bellow.

TECHNICAL SPECIFICATION

FOR

SAFETY RELIEF VALVES

CONTENTS

1.0 SCOPE

1.1 This specification, together with the data sheets enclosed herewith covers the basic requirements for design, materials, construction, inspection, testing and performance of safety relief valves.

1.2 No deviations from these specifications and respective valve data sheets are allowed unless the vendor has taken prior approval from IOCL.

2.0 VENDOR'S RESPONSIBILITIES

2.1 Vendor shall be responsible for supplying right size and type of safety relief valves to suit the process conditions specified in the respective data sheets.

2.2 Along with offer:

2.2.1 Vendor shall furnish signed and stamped copy of this technical specification as a token of acceptance along with their techno-commercial offer failing which their offer shall be rejected Deviation, if any shall be clearly spelt out on separate sheet.

2.2.2 Along with the quotation, the bidder shall submit 2 sets of drawings, furnishing the cross-sectional details of the valves and the material list.

2.2.3 The bidder shall furnish documentary proof of capacity certification for PSV (in combination with Rupture Disc wherever applicable), issued by ASME certified body, along with the offer.

2.2.4 The bidder shall furnish the cross-sectional drawings of the offered PSVs and Rupture Discs (wherever applicable) along with the offer.

2.2.5 Bidder shall furnish the orifice sizing calculations for every individual PSV, consisting of the calculated discharge area, selected area, orifice designation, inlet and outlet calculations, actual relieving capacity and cold bench test pressure as minimum, along with the offer.

2.3 Approval of Design / Drawings:

The PSV/ TSV data sheet and drawings shall be submitted to IOCL for approval. However, IOCL approval will not absolve the party from the design responsibilities.

2.4 Deviations, if any, shall be listed /highlighted in a separate sheet (Annexure-I)

3.0 CODES & STANDARDS

Vendor shall follow the latest editions of the following codes & standards as applicable:

a) API RP - 520, 521, 526, 527
b) ASME Section I and VIII
c) API Standard 2000
d) ANSI B 16.5
e) ANSI B 16.20
f) ANSI B 1.20.1

4.0 DESIGN CRITERIA

4.1 The basis of design and selection of safety relief valves shall be in accordance with latest edition of API RP520 - sizing, selection and installation of pressure relieving devices in refineries, the latest revisions of ASME boilers and pressure vessels code and Indian Boiler Regulations.

4.2 Wherever it is specified in the data sheets, safety relief valves shall be marked and certified in accordance with the ASME boiler and pressure vessels code / IBR code.

4.3 The calculated orifice areas given in respective data sheets are indicative only. Vendor shall calculate the orifice areas as per the process data furnished and select the safety relief valves accordingly. Vendor shall furnish sizing calculations to IOCL for approval.

4.4 For two phase liquid / vapour relief application, the total orifice area shall be the sum of the orifice areas calculated individually for liquid and vapour.

4.5 Percentage of over pressures used in calculating the sizes area as under :

a)	Steam boilers (ASME code)	3%
b)	Steam boilers (IBR code)	5%
c)	Gas or vapour service and liquid except as noted below in (d)	10%
d)	Fire exposure on unfired pressure vessels with vapour	21%

4.6 Body drain with a plug shall be provided as a standard feature on every pressure relief valve.

4.7 Wherever stelliting of disc and nozzle has been specified, it stands for stelliting of the seat joint and the entire disc contour, unless otherwise specified.

4.8 Lifting levers shall b provided for valves used for steam service.

4.9 Bonnet shall be of the enclosed type in general. Open bonnet shall be used only for steam service.

4.10 Whenever the specified set pressure exceeds 70 kg /cm2g, vendor shall submit the leakage rate of valves for approval of purchaser.

4.11 Where bubble tightness is specified, there shall be no leakage or bubbles of air at the specified percentages of set pressure.

5.0 MATERIALS & CONSTRUCTION

5.1 In general the material of construction shall be cast carbon steel (ASTM A216 Gr WCB) for body, SS316 (forged) for trim and cadmium plated CS for spring, unless otherwise specified on the datasheets. Tungsten alloy steel springs shall be used for temperature above 230 deg. C.
Fasteners shall be according to A193 B7/A194 Gr. 2H

5.2 For safety relief valves in sour service

a) Carbon steel/Duplex SS /Incoloy 825 shall meet the requirements of NACE MR-01-75 latest edition and other job specific requirements as mentioned in datasheets.

b) Materials other than CS/Duplex SS / Incoloy 825 shall meet the requirements of NACE MR-01-75 latest edition and all the castings and weldings shall be 100% radiographed.

5.3 Normally full nozzle, full lift type valves shall be supplied for sizes 1" and larger. The nozzle bushing shall extend through and beyond the inlet flange base and shall form the gasket bearing surface for the inlet flange.

5.4 Flanged safety relief valves shall have enclosed spring bolted bonnet, screwed cap with a tapped and plugged vent for easy conversion to balanced bellows type valves.

5.5 Bellow type safety valve shall be considered wherever back pressure exceeds 10% of the set pressure. Bellows material shall be same as trim material as a minimum.

5.6 Open bonnet type safety valves along with lifting lever shall be used for water above 60 degC, air and steam services.

5.7 Flanged connections shall be Internal and as per ANSI B16.5 and the rating shall be as per the piping specifications as indicated in the data sheets. However, vendor shall confirm the flange ratings as per his sizing calculations.

5.8 Face to face dimensions shall be as per the latest edition of API Std 526.

5.9 Testing for seat tightness shall be accordance with the latest edition of API Std. 527. Soft seating (coring) shall be provided wherever tight shutoff is called for.

5.10 Safety relief valves for set pressure of 17.5 kg/sq.cm. (250 psig) or less shall have springs suitable for a range of adjustment of plus or minus 10% of the set pressure.

5.11 Safety relief valves set at pressures higher than 17. 5 Kg/Sq.cm.g(250 psig) shall have springs suitable for range of adjustment of plus or minus 5% of the set pressure. Range identification shall be provided on the spring.

5.12 The allowable tolerance in set pressures are as below :

a) $\pm$ 0.14 kg/cm2g for set pressure upto and including 5 kg/cm2g.
b) $\pm$ 3% for set pressure above 5 kg/cm2g.

5.13 Safety relief valves shall be provided with tamper proof seals after factory set calibration.

6.0 NAME PLATES

Each valve shall have SS name plate permanently fastened to the body. This name plate shall include the following :

a) Manufacturer's Name and trade mark
b) IOCL material SAP code .
c) Valve Tag No.
d) Serial number and type
e) Orifice designation
f) Valve inlet and outlet connection sizes and ratings
g) Valve body, spring and nozzle materials
h) Set pressure
i) Back pressure
j) Relieving temperature
k) Cold bench test set pressure
l) ASME Code stamp shall be furnished with the safety relief valve (Type test only) : If specified in datasheet.

7.0 INSPECTION & TESTING

7.1 Vendor shall provide all facilities free of cost to IOCL or their authorized representative to conduct following tests at vendor's works:

a)	Material	Body, trim etc.
b)	Physical	Visual and dimensional as per API/ASME/ASTM stds.
c)	Hydraulic	Leakage test at 1.5 times the maximum Working pressure for inlet flange and nozzle
d)	Seat tightness test	
e)	Set pressure test.	

The valve shall be tested for opening at specified set pressure and also for seat tightness.

7.2 Pressure relief value shall be tested in an apparatus as described in API B 21-00016. The valve shall be tested for opening at specified set pressure and also for seal tightness.

7.3 Whenever the specified set pressure is less than of equal to 70 kg/cm2g, the valve shall meet the seal tightness requirements specified in API RP - 527. The maximum permissible leakage rates for conventional and balanced bellows valve against various orifice sizes shall be as specified therein.

7.4 Whenever the specified set pressure exceeds 70 kg/cm2g, the vendor shall submit the leakage rates of valves for approval by the purchaser.

7.5 Where bubble tightness has been specified, there shall be no leakage of bubbles of air at the specified percentages of set pressure.

Third party inspection shall be done by IOCL approved third party inspection agencies as mentioned below and scope of inspection is as per the attached Annexure –I (Quality Assurance plan for safety relief valve /Thermal relief valve.)

8.0 PACKING AND SHIPMENT

8.1 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material during shipment.

8.2 Valves shall be supplied as a whole, complete with all accessories like cap, lifting lever, test gauge etc.

9.0 DOCUMENTATION

9.1 Final documentation.

Vendor shall supply six (6) bound copies and 2 (two) soft copy (in CD format) of data folder containing the following information:

a) Approved PSV/TSV data sheet
b) GA drawing
c) Test reports of set pressure, back pressure test, seat tightness pressure test etc.
d) Hydrostatic test reports.
e) Third party inspection certificates along with release note in original on their letter head.

TECHNICAL SPECIFICATION FOR COUPLINGS

CONTENTS

1.0 SCOPE

This specification covers the design, construction, materials, inspection & testing of general-purpose couplings for installation in pumps, gearboxes, fans & blowers. This specification does not cover couplings installed in special-purpose applications in steam turbines, compressors and gas turbines.

Couplings covered in this standard include flexible element couplings of selected types for torsional damping and torsional tuning in horizontal applications. All other couplings, including clutch, hydraulic, eddy-current are excluded from the scope of this standard. Additional requirements may be necessary if a coupling is to be used in a vertical position, or at any other angle significantly removed from the horizontal. In particular, adequate provisions may be necessary to support the mass of the spacer assembly.

In the process of manufacture, dimensions and tolerances not specified in specification shall be in accordance with the requirements of the equipment manufacturer.

2.0 CODES & STANDARDS

2.1 API-671 latest edition.

2.2. API 610 latest edition.

2.3 OISD-STD-123, OISD-RP-126 & relevant OISD standards for the equipment in which the coupling is to be selected and designed for (OISD-STD-119,122,171), latest editions, as applicable.

2.4 ISO Standard 1940, latest edition for “Balancing Quality of rotating rigid bodies”.

3.0 TECHNICAL REQUIREMENTS

3.1 In general, rotating equipment couplings vide this specification are to be designed and constructed for a minimum service life of 5 years of continuous operation in equipment.

3.2 These couplings are designed to accommodate misalignment and axial displacement of the shafts without imposing excessive mechanical loading on the coupled equipment.

3.3 DESIGN CRITERIA

3.3.1 The default design for couplings covered under this specification shall be dry flexible-element couplings. Any other design, if deemed necessary by the vendor due to any specific design criteria of the rotating equipment, shall require specific

approval of IOCL with adequate justification. However, in all such cases, the referenced standards vide this specification shall be applicable.

3.3.2 The coupling shall be selected based on the equipment loading, which consists of steady state and transient conditions of torque, angular misalignment, axial displacement, and speed.

3.3.3 All couplings shall be of the spacer type. The spacer shall be of sufficient length to allow removal of coupling hubs and to allow for maintenance of adjacent bearings and seals without removal of the shaft or disturbance of the equipment alignment. The minimum spacer length shall therefore correspond to distance between-shaft-ends (DBSE) dimension as per pump general arrangement drawing.

3.3.7 The coupling shall be of removable hub(s) type.

3.3.8 Flexible elements shall be metallic, unless specified otherwise.

3.3.9 Unless otherwise specified, the coupling shall be rated using a service factor of 1.5 for flexible-element couplings.

3.3.10 Unless otherwise specified, the coupling selection shall, as a minimum, be based on (1/5)° steady state angular misalignment capacity across each flexible element. The total minimum steady state axial deflection capacity shall be determined by the largest shaft diameter divided by 100.

3.3.11 Data related to material strength for coupling selection shall be as per API-671 latest edition or manufacturer's standard. The coupling manufacturer shall state the source. Construction materials shall be the manufacturer's standard for the specified operating conditions, except as required by the data sheets or this standard. The metallurgy of all major components shall be clearly stated in the vendor's proposal.

3.3.12 Materials shall be identified in the proposal with their applicable ASTM, AISI, ASME, SAE or UNS numbers, including the material grade. If the designation is unavailable, the vendor's material specification, showing physical properties, chemical composition, and test requirements, shall be stated in the proposal by the vendor.

3.3.16 Flexible elements shall be of corrosion-resistant material. Any corrosive agents present in the environment, including constituents that may cause stress corrosion cracking, shall be specified in the datasheet for the vendor's reference.

3.3.12 If the flexible elements of a coupling are combined in a factory assembled disc pack, the coupling spacer shall be removable without disturbance of the factory assembly of the elements (discs).

3.3.13 Unless otherwise agreed, the design of the metallic flexible element couplings shall be such that in the event of complete failure of the flexible element or elements in one plane of flexure, the spacer assembly is retained in approximately its normal position.

3.3.14 Removable coupling hubs shall be secured to the shaft by means of interference fit. The shaft end details and the degree of interference will be as specified in API-671 latest edition.

3.3.16 As the coupling must operate within a close-fitting enclosed coupling guard, the attached datasheet for details of the guard shall be referred by the vendor to inspect and conform.

4.0 INSPECTION & TESTING

4.1 After final machining, all metallic torque-transmitting components, bolts, and other major parts, with the exception of multiple membrane diaphragms and discs, manufactured from cold rolled strip, shall be inspected by wet magnetic particle, or liquid penetrant methods. Indications of cracks or other injurious defects shall be the basis for rejection of the affected part. Certification of conformance is required.

4.2 All welds shall receive 100% surface and subsurface inspection after final treatment. Magnetic particle or liquid penetrant methods shall be used for surface inspection. Ultrasonic or radiographic methods shall be used for subsurface inspection. All weld inspection procedures shall be mutually agreed upon by the purchaser and the vendor.

4.3 This balance method requires that all components be individually balanced as well as assembly balanced to the requirements of ISO 1940 balancing quality Grade 2.5 minimum for rigid rotors. For flexible rotors, tolerances as specified in ISO 5343 shall govern.

4.4 A residual unbalance check shall be performed on assembled couplings. The residual unbalance check shall be performed after assembly balancing or assembly check-balancing is complete and before the assembled coupling is removed from the balancing machine.

4.5 Balancing shall be performed on balance machines that are capable of achieving the specified level of residual unbalance.

4.6 Material for the purpose of balancing shall be removed from low-stress areas of the components.

4.7 Acceptance of shop tests inspection / tests as above, does not constitute a waiver of requirements to meet field performance standards under specified operating conditions, and inspection by the purchaser does not relieve the vendor of his responsibilities.

4.8 The tests as above shall be witnessed by IOCL / third party inspection, as specified in the datasheet / enquiry.

5.0 PACKING & SHIPMENT

5.1 Prior to assembly and shipment, all surfaces of the coupling shall be cleaned and coated to prevent corrosion. Adequate instructions covering preparation for operation shall be attached.

5.2 Each coupling shall be properly identified by make, model, type, item number and serial number stamped or etched on the coupling assembly. The container also shall be marked with the information as specified.

5.3 The vendor shall inscribe a serial number unique to the coupling on all of the coupling's major separable parts. The vendor shall inscribe the recommended bolt torques on each flange.

6.0 DOCUMENTATION

The vendor shall submit six sets of hardcopy and 2 sets of softcopy in CD format of the following:

6.1 Coupling drawing indicating the following:

i) IOCL P.O. number and equipment tag no.(on every drawing).
ii) The make, type, and size of the coupling.
iii) The weight and 1/2 weight of each part of the assembly and the weight of the entire assembly.
iv) All principal overall outline, interface, and other critical dimensions, including interface pilot diameters, lengths, hub-to-hub and shaft-end spacing, hub bore details including keyways, hub-to-shaft interference fits, hub advances, and axial float.
v) The distance from centerline to centerline of the flexing elements.
vi) When applicable, axial natural frequencies of flexible element couplings.

6.2 Test reports/ certificate of origin for materials of construction.

6.3 Maximum permissible values of the following:

i) Axial displacement and angular misalignment for continuous and transient operation.

ii) Continuous and peak torque rating and momentary torque limit.
iii) Flexible-element lateral stiffness
iv) Maximum axial force at maximum deflection or axial stiffness.
v) Maximum bending moment or bending stiffness.

6.3 For all hubs:

i) Hub-to-shaft interference range.
ii) Hub draw-up range (for taper-bored fits).
iii) Torque capacity of hub shaft interface (for keyless only).

6.4 SPARES

The vendor shall submit a list of recommended spare parts other than the above, which shall include recommended spare list with references to cross-sectional or assembly-type drawings, parts numbers, materials etc. Parts numbers shall identify each part for purposes of interchangeability.