



PRODUCT STANDARD
TURBINES AND COMPRESSORS
HYDERABAD

TC-5-2357REV No.: **04**

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STANDARD SPECIFICATION FOR DRY GAS SEALS

1. INTRODUCTION

This General Specification covers the requirement of Dry gas seals of following types used both in Low Pressure and High Pressure applications for Centrifugal Compressors

- a. Single / Double / Tandem / Triple
- b. Unidirectional / Bidirectional
- c. With / without intermediate Labyrinth

Dry gas seals shall be provided to restrict or prevent process gas leaks to the atmosphere or seal gas leaks in to the process gas stream over the range of specified operating conditions. Seal shall be suitable for specified variations in seal operating conditions that may prevail during start-up, shut down or settling out and during other specified conditions. When toxic or inflammable gases are used, an isolating seal is required to prevent uncontrolled leaks to the atmosphere or the bearing housing. This isolating seal shall be capable of acting as a backup seal if the primary seal fails during operation. Dry gas seal shall be provided with connections to inject filtered gas and to protect against reversal of differential pressure during sub atmospheric operation. Each dry gas seal assembly shall be cartridge mounted, located and attached to the compressor shaft. For unidirectional seals, cartridges shall be designed such that incorrect installation of the cartridges is impossible

2. SCOPE

Vendor shall offer for the dry gas seal as per this specification, job specification and the standards indicated elsewhere in the specifications. All test requirements as per this specification, international standards and special tests indicated in the job specification, if any, shall be considered in the offer. Special tools and Commissioning spares shall be included in the offer. The type of seal required, Gas Composition at different operating points and Shaft and housing dimensions are indicated in job specification. Scope of supply of supporting seal gas system (along with filter skid) is covered under a separate specification as indicated in Job Specification.

Rev. No.	Revisions	Prepared	Approved	Date
04	Refer to record of revisions	SDR	PNR	17.05.16

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3. BRIEF DESCRIPTION OF DRY GAS SEALING SYSTEM

Offered configuration for Dry Gas Seals shall be of type Single or Tandem or triple or double configuration as indicated in the Job Specification to prevent leakage of process gas. A barrier seal (separate cartridge) – Carbon Ring Tertiary / Labyrinth seal as per Job Specification shall be provided to prevent entry of lube oil from the bearings into the seal zone. Dry, filtered clean gas (Process gas / Nitrogen / Sweet Gas as indicated in job specification) shall be filtered and throttled with the help of DPCV in compressor to the corresponding primary seal gas pressure and routed to the primary seals. Primary seal leakage shall be routed to the flare. A restriction orifice in the flare–line shall maintain a backpressure of about 0.3–0.4 kg/cm²–g. **The leakages of the in-board seal & intermediate Labyrinth seal shall be estimated based on this back-pressure. Nitrogen shall be supplied** to the secondary seal with the secondary seal leakage routed to safe atmospheric height **or** it shall be **plugged** as indicated in the job specification. Both primary and secondary seals shall be capable of handling the entire pressure difference from clean (seal) gas pressure to flare pressure. **Nitrogen or Instrument Air** shall be supplied as barrier/separation gas as indicated in the job specification.

4. Applicable Standards / Codes

1. API 617
2. API 614
3. NACE Standard MR0175 (for Petroleum production, drilling, gathering and flow line equipment)
4. NACE Standard MR0103 (For sour Petroleum refining and related processes)

Please refer Job specification for applicable edition / NACE code

5. CHECKLIST

The offer will be considered complete in all respects and will be scrutinized only after the vendor confirms each of the requirements as per the checklist in **Page Nos. 4 to 8** of this specification.

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COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in any way detrimental to the interest of the company.		6. <u>Technical Data</u> Vendor shall furnish all the technical inputs / data in the specified format as per Page Nos. 9 and 10 of this specification. Any other data given elsewhere will not be considered for evaluation / scrutiny. 7. <u>Acceptance Criteria and Performance Track Record</u> As on the date of issue of this enquiry, at least TWO sets (validly similar in terms of specified process gas service, shaft diameter, speeds, sealing pressures and configuration etc.,) shall have been designed, manufactured, tested and supplied from the proposed manufacturing plant and at least ONE of these units shall have been successfully operated in the field for at least 8000 hours without any major overhaul. Vendor shall furnish the Performance Track Record as per Page No.11 of this specification. 8. <u>Comments and Deviations</u> Any comments or deviations with respect to this General Specification, Job Specification, API and NACE standards shall be provided separately clearly indicating the clause no, deviation sought for and the technical justification. Any deviation indicated elsewhere in the offer will not be considered during evaluation. All the deviations shall be discussed and settled upon before placement of the purchase order. If the Comments and Deviations are not provided separately, it will be presumed that the vendor is accepting for these specifications and standards without any deviations.		
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CHECK LIST

(To be completed by Vendor)

Sl.No	Detail	Y/N
1)	A typical Dry Gas Seal data sheet is furnished in Job Specification. It should be completely filled.	

Vendor to furnish the below inputs along with **offer for the seal**

2)	Geometrical and mechanical data of the dry gas seal	
3)	Dimensioned seal cross sectional drawing – with required connections – along with B.O.M	
4)	Acceptance to submit the seal cross sectional drawings (final) for approval – within a week after placement of order – in hard copy as well as in digital form (Auto Cad file)	
5)	Conformance to total requirements of BHEL specifications	

Dynamic performance of Primary and secondary seals at the specified operating conditions

The Leakage rates for the following shall be furnished at **Page No. 9 & 10** to facilitate validation.

6)	The guaranteed primary (in board) seal leakage;	
7)	The guaranteed secondary (out board) seal leakage (N ₂) for the specified pressure & temperature at inlet to secondary seal;	
8)	The guaranteed consumption to barrier seal (for N ₂ /Instrument Air) for the specified pressure & temperature at inlet to barrier seal	
9)	The guaranteed N ₂ leakage across intermediate labyrinth seal (for a specified ΔP between secondary inlet and flare line)	
10)	Mechanical loss per seal @ MCS	

11)	Experience record as per the ACCEPTANCE CRITERIA (to be furnished as per Page No. 11 of this specification)	
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12)	Acceptance to submit Quality plan & testing procedures within a week of placement of order.	
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MATERIAL

Vendor shall confirm conformance to the following criteria.

13)	The material of all the components exposed to process gas (viz. housing, ring faces, O rings/gaskets, springs, loose parts etc.) shall be NACE compliant	
14)	For High Pressure Applications, that is, above 80 kg/cm² , all gaskets shall be PTFE based, with circumferential spring backing	
15)	The sealing face shall be shrouded for containment	

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Sl.No	Detail	Y/N
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SPECIAL POINTS

16)	Dry gas seal shall be designed for Guarantee case as indicated in Job specification and the seal performance for this case shall be demonstrated during testing	
17)	Performance of seal shall be satisfactory for all the other operating conditions of job specification.	
18)	If the job gas is Hydrogen Rich, the seal shall be tested for performance with hydrogen or helium. Otherwise the gas shall be tested with Air / Nitrogen	
19)	a) For Low Pressure Applications (<80 kg/cm ²), the clean gas pressure of 0.3 ~ 0.5 kg/cm ² above equalizing line pressure is considered. b) For High Pressure Applications (>80 kg/cm ²), the clean gas pressure of 0.5 ~ 0.8 kg/cm ² above equalizing line pressure is considered. Vendor to provide recommendation for the same specific to the job	
20)	The sealing faces shall get separated with zero differential pressure above lift off speed (to be indicated in offer).	
21)	The dry gas seals shall be used during performance test of the compressor. (The performance test details will be furnished during detailed engineering)	
22)	Vendor to confirm suitability of the dry gas seals to operate during string test & MRT. (During string test & MRT, the machine performs under near vacuum conditions – 0.2 ata). Vendor to indicate the primary inlet pressure of filtered air	
Seal vendor to check for possible condensation of any components of clean gas, due to <u>throttling in the control valve</u> / <u>across the seal faces</u> and suggest suitable changes in system viz.,		
23)	Confirmation to incorporate chilling/ heating wherever required.	
24)	Confirmation on the requirement of drain in the primary leakage port.	
25)	To furnish a support document (if drain is recommended) for such requirement vide operational experiences/references for similar H ₂ service	

GUARANTEE CERTIFICATE

26)	Acceptance to provide a guarantee certificate – for trouble free performance of the dry gas seals – for a period of 12 months from the date of successful commissioning or 18 months from the date of last despatch, whichever is earlier.	
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FIXTURE FOR ASSEMBLY / DISASSEMBLY OF DRY GAS SEAL

Acceptance to provide a fixture for assembly & disassembly of the DRY GAS SEAL.

27)	Drawings of the fixture assembly, individual components and BOM	
28)	User instructions for assembly / disassembly of seal	



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Sl.No	Detail	Y/N
COMMISSIONING SPARES		
29)	One set of gaskets, 'O' Rings on the body of the seals and tolerance strips shall be offered along with mail seal	
IDENTIFICATION		
30)	Each seal shall be marked with details like drawing no, job number, PO No. Direction of Rotation etc., at a convenient location on seal stationary part.	
CHECK LIST FOR PRESERVATION, PACKING & DESPATCH OF DRY GAS SEALS		
31)	Dry Gas seal against each code shall be packed in two separate transportable permanent air tight metallic boxes and shall be suitably packed and protected/preserved from damage due to weather, transportation, and handling / storage at workplace.	
32)	Ensure that the metallic boxes contain the following:- a) In the first box- Dry gas Seal cartridge of primary and secondary seals along with locking mechanism to prevent relative movement between stator and rotor parts shall be packed.	
	b) In the second box- Barrier seal cartridge and the outer closing flange of the dry gas seal shall be packed. Barrier seal shall be positioned in the closing flange the way it is housed for normal assembly. Barrier seal stator and rotating parts shall be locked together with locking mechanism to prevent relative movement. The spare O- rings and fasteners, if any, pertaining to each dry gas seal shall be kept in the second box with sufficient independent packing to avoid mechanical damage to the barrier seal and loose components themselves.	
33)	The special tools shall be packed in a separate box. The machined surfaces of the tool components shall be suitably preserved and packed. The packing list of the tools shall be provided in the box.	
34)	Each Metallic Box shall be designed with the following features:	
	a) Each metallic Box shall be optimum in size in consideration to the seal size and weight. It shall be of air tight and reusable type suitable for transportation and storage built with a hinged lid and good locking arrangement.	
	b) The metallic sheet used for box making shall be of adequate thickness not to deform easily for mechanical loads/shocks during transportation and handling.	
	c) All the corners of the metallic box shall be sufficiently reinforced so that the box is sturdy enough to withstand the mechanical shocks during transportation.	
	d) The seals in the box shall be positioned centrally in the box and packed & covered with protective cushioning all around. The cushioning/packing material around the seal shall be dense enough and shall have good damping properties.	

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35)	Adequate amount of silica gel in the box shall be provided before closing for despatch.	
36)	Warnings/Cautions like "Fragile", "Handle with Care", "Upright positioning" and symbols indicating protection from rain / dust shall be marked on the boxes. Other markings for identification as per purchase order and seal identification particulars in line with packing list shall be provided on external surface of the box.	

INSPECTION & TESTING**Both** the **operating** & **spare** seals shall have the following shop tests.

Vendor to confirm acceptance to carry out each of these tests.

37)	<u>Cleanliness test (for the dry gas seal filter and control system)</u> No discoloration or hard particles found on 20mesh screen after module blown for 5 minutes with 100 psig (7 kg/cm ² -g) dry filtered gas.	
38)	Test Medium shall be as indicated against Point No. 18. Conversion factors from test gas to Job gas shall be provided (during offer stage) to evaluate the performance test results	
39)	Gas leak test at a pressure equal to settling out pressure with a gas of M.W equal or less than the seal gas	
40)	Functional run for minimum of one hour at operating pressure and speed. Following the test, seal elements shall be examined for wear and general condition	
41)	Other tests as per Appendix-ID of API 617	
42)	Acceptance to include Third Party Inspection by customer approved TPI.	

OFFER FOR SPARES

43)	Supplier shall include in his offer separate item-wise prices for the following spares for two years operation	
44)	'O' Rings/gaskets and Tolerance rings	
45)	Barrier Seal	

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Sl.No	Detail	Y/N
FINAL DELIVERABLES		
46)	The contents of each metallic box for the dry gas seal shall be as per clause 31), 32-a) & b). The metallic box shall be designed as per clause 34) to 36).	
47)	Commissioning spares (as per point no. 29)	
48)	Two year spares (if ordered)	
49)	Special tools and tackles packed in a separate box, along with relevant drawings/ instructions as per clause 33)	
50)	Each consignment shall accompany with the following for inwards goods inspection at BHEL works. a) set of approved drawings b) Packing list	
51)	Supplier to confirm to furnish 15 copies (hard) of Operation and Instruction Manual along with the seals and soft copy on a CD	
52)	Supplier to confirm to furnish 5 copies of Quality book including material test certificates, balancing and performance test reports	
53)	Supplier to confirm to provide assistance for assembly/disassembly - 2 visits for a period of 3 days each for each casing -at shop.	
54)	Supplier to confirm to provide assistance- 2 visits for a period of 3 days each for each casing at site during commissioning, till BHEL hands over the compressor train to customer.	

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TECHNICAL DATA / INFORMATION

Name of Vendor:

Sl.No	Parameters	Values	Remarks
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VENDOR SHALL NOT ALTER THIS FORMAT. JUST TO FILL & RETURN FOR VALIDATION.

1	Dry gas seal model		
2	Drawing No		
3	Shaft dia (mm)		
4	Unidirectional or Bi directional		
5	Sealing Pressure		
6	Seal design pressure		
7	Speed		
8	INBOARD SEAL (primary seal)		Considering a delta-P of 0.5 kg/cm² between seal gas & Ref Gas
A	Leakage (NI/min)		
i	Expected		
ii	Guaranteed		
B	Static Leakage (NI/min)		
i	Expected		
ii	Guaranteed		
9	OUTBOARD SEAL (secondary seal)		Considering a delta-P of 0.3 kg/cm² between inlet of sec seal & primary vent.
A	Leakage Outboard (NI/min)		
i	Expected		
ii	Guaranteed		
B	Static Leakage (NI/min)		
i	Expected		
ii	Guaranteed		
10	Intermediate Labyrinth (NI/min)		Expected Leakage for a delta-P of 0.3 kg/cm² between inlet of sec seal & primary vent (to flare)
i	Expected		
ii	Guaranteed		

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Sl.No	Parameters	Values	Remarks
11	Intermediate Labyrinth (NI/min)		Expected Leakage for a delta-P of 0.2 kg/cm² between inlet of sec seal & primary vent (to flare)
i	Expected		
ii	Guaranteed		
12	Intermediate Labyrinth (NI/min)		Considering controlled flow to the seal at recommended velocity.
i	Expected		
ii	Guaranteed		
ii	Velocity (m/sec)		
13	BARRIER SEAL		Differential pressure (delta P) between seal & secondary vent to atmosphere shall be indicated.
i	Leakage (NI/min)		
ii	Expected		
lii	Guaranteed		
iv	Delta P		
14	Axial movement (mm)	+/- ____	
15	Radial movement (mm)		
16	Balancing		
17	Lift off speed (rpm)		
18	Test Gas (of equivalent MW)	To specify	
19	Conversion factor		Conversion factor for test gas to real gas to be indicated
20	Deviation from Sketch Dimensions	To specify, if any	
21	Set of commissioning spares		To confirm "Included in the offer"
22	Mass of rotor parts (kg)		
23	MI (kgm ²)		
24	Power Loss (kw)		
25	Materials		
a	Face		
b	Seat		
c	rotor/stator		
d	Labyrinth		
e	Secondary seals		
f	Bolts		

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PERFORMANCE TRACK RECORD								
	PARAMETER AS PER THE ACCEPTANCE CRITERIA	OFFER ED SEAL	REFERENCE -1	REFERENCE-2	REFERENCE-3	REFERENCE-4		
1.	Seal Model No.							
2.	The specified process gas service							
3.	Shaft diameter							
4.	Speed							
5.	Sealing pressure							
6.	Configuration							
7.	Uni / Bi-Directional							
8.	Location of Manufacture*							
*Both the seals referred are designed, manufactured, tested and supplied from the same manufacturing plant as that of the offered seal.								
9.	Total number of hours the seal is under continuous operation.							
10.	End customer details							

