STANDARD SPECIFICATION OF GEAR BOX FOR COMPRESSORS APPLICATION.

1. **Scope:** This specification describes the requirements of speed increasing gear boxes for compressor application

   1.1. **Applicable Specification:** In accordance with API 613 5th edition Feb. 2003.

2. **Applicable Specification**:

   The design, manufacture shall conform to API 613 5th edition Feb. 2003, with confirmation to all the relevant provisions applicable to flexible dry couplings. The optional and additional features are elaborated in this specification and vendor shall explicitly indicate deviations if any, to API and the present specification in the offer. In the absence of any such deviations, the supply is deemed to be in strict compliance with the above referred specifications

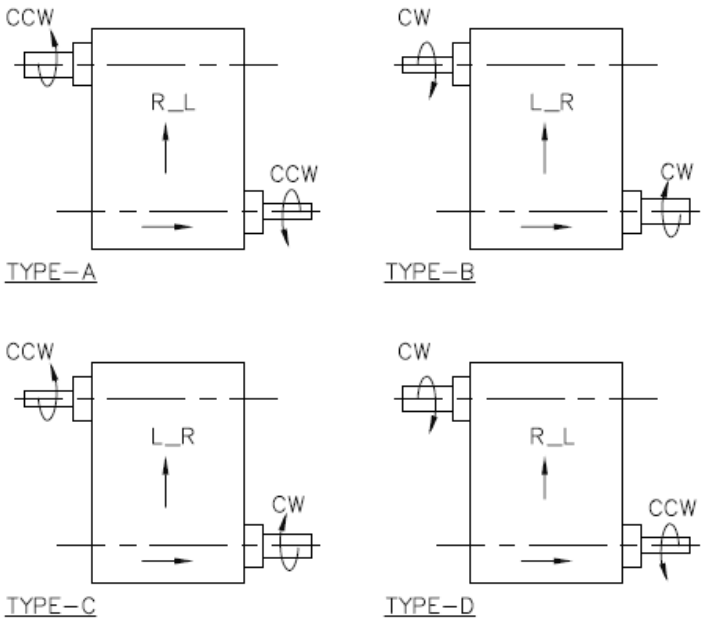
3. **Order of preference:**

   In case of contradiction between the job specification and this specification the job specification shall be final & binding.

4. Type **Of Gear Box** : Parallel shaft with horizontal off-set and with either single or double helical gearing. (Ref job specification for type of gearing).

Rev. No.	Revisions:	Prepared:	Approved:	Date:
10	Refer to record of revisions	U P K	B V S R	31.01.1998

5. **Layout Of Gear Box** : Plan views of typical layout of gearboxes are shown below with designations as Type A , Type B , Type C , and Type D. The required direction and shaft orientation will be indicated in job spec.



NOTES : a) L= left ; R= right

b) Letter preceding the hyphen refers to the direction of high speed shaft extension.

c) Letter following the hyphen refers to the direction of low speed shaft extension.

* d) Arrow indicates line of sight to determine direction of shaft extention.

6. **Gear Box Design** :

6.1. Gear casing shall be either cast or fabricated design and constructed to maintain rotor alignment under extreme load conditions.

6.2. Threading details of casing bolts within the gear box shall be in metric system or ANSI B 1.1

6.3. Gear teeth: The teeth of gear wheel and pinion are case carburised and ground.

6.4. As a minimum, the gear service factor shall be as per API 613, Table 3. It shall be minimum 1.4 for induction motors and shall be 1.6 for synchronous/ variable speed motors and steam/ gas turbine drives. The factor specified is over the driver rated power. The same shall be indicated in the supplier's offer.

6.5. Gear box mechanical rating will be as per clause 2.2.1 of API 613. For electric motor drivers the gear rated power will be the motor rating multiplied by motor service factor. Unless otherwise specified motor service factor shall be minimum 1.1.

6.6. The gear boxes offered shall be sized , designed, manufactured and tested in accordance with API 613 5th edition 2003 unless any deviations are explicitly accepted by BHEL in writing.

6.7. Short Circuit Torque: If the driver is electric motor, the gear unit shall be designed for short circuit torque of **minimum 3 times normal torque** for motor as driver. **10000 load changes** shall be considered.

6.8. **Noise Level: Sound level test shall be as per ANSI/AGMA 6025-D98 as specified in clause 4.3.3.5 of API 613, unless otherwise specified in job specification.** Any additional requirement will be mentioned in the job specification.

6.9. **Journal Bearings:**

6.9.1. Low speed side: Tilting pad/4 lobe /offset halves bearings shall be used on the Gear shaft. If any other types of journal bearings are proposed to be used, the same shall be supported with references in similar applications and is subject to BHEL approval.

6.9.2. High speed side: Tilting pad bearings only shall be used on the high speed shaft.

6.9.3. The journal bearings are to be procured from reputed bearing manufacturers and the same shall be specified for BHEL approval.

6.10. **Thrust Bearings:**

6.10.1. Unless otherwise specified, thrust bearings shall be provided on the low-speed shaft for all double-helical gears and shall be provided on each shaft for all single-helical gears.

6.10.2. Thrust bearings shall be of steel-backed, babbitted multiple-segment type, designed for equal thrust capacity speed side in both directions and arranged for continuous pressurized lubrication to each side. Both sides shall be of the tilting-pad type, incorporating a self-levelling feature that ensures that each pad carries an equal share of the thrust load.

6.10.3. The thrust bearing are to be procured from reputed bearing manufacturers and the same shall be specified for BHEL approval.

6.11. **Lubrication :**

6.11.1. Gear unit shall be designed for continuous operation on an oil of ISO VG 46 with an exception for G.T driven compressors where oil of ISO VG 32 is considered.

6.11.2. When alternative oil is requested, the vendor shall provide calculations and an experience list to support a request for an alternate oil selection. Alternate calculating methods can be used based on supplier experience. Please note that oil quantity required shall be provided in line with alternative oil used.

6.11.3. The gear unit shall be designed to limit the drain oil temperature as per API 613.

6.11.4. In order to avoid scuffing, unless otherwise specified, the gear unit shall be designed for use with an oil meeting ISO 14365-1 load stage 5.

6.12. **Lube oil connection flanges:**

6.12.1. Vendor shall provide blind flanges for all lube oil inlet & drain connections during transport for the standards ANSI connections.

6.12.2. If non-standard inlet/ drain connections are used, vendor shall provide the active connection flanges also.

6.12.3. Lube oil outlet/drain from gear box shall be provided side-wards.

6.12.4. Filter Breather: This shall be supplied as per API 613.

6.13. **Couplings:**

6.13.1. The shaft end details for couplings of low speed and high speed shaft shall be provided in the job specification. Vendor shall also check for adequacy from torque transmission aspect and shall confirm the same.

6.13.2. Details of the couplings shall be provided during detailed design. Vendor shall check the same from gearbox lateral analysis aspect. The adequacy check shall be informed to BHEL.

6.13.3. Half coupling weight shall be simulated during MRT of the Gear box rotors.

6.14. Lifting of upper part of gear box casing shall be possible without removing junction boxes.

6.15. Dynamic Loads coming onto the support points shall be clearly indicated.

6.16. Vendor to confirm that during detailed design, the distances from the gear centreline to gear and pinion driveshaft ends will not change with respect to the outline drawing provided in the offer stage.

7. **Scope of instrumentation or provisions for mounting instruments** :

The following instruments or provisions for mounting the instruments shall be strictly made. All the necessary instruments shall strictly be compatible to area classification indicated in the enquiry.

7.1. Thermo elements for journal bearing: To measure the bearing temperature thermo elements are to be supplied. The material of thermo elements with necessary calibration and no of elements shall be indicated in the enquiry.

7.2. Thermo elements for thrust bearing: Thermo elements shall be of embedded type. The embedding of thermo elements shall be made as shown below. Number of thermo elements to be provided on active and non active side will be specified in enquiry. The lead wires shall be taken out through two numbers of terminal heads, one consisting of thrust bearing active side leads and the other consisting of thrust bearing non active side leads.(See figure 3)

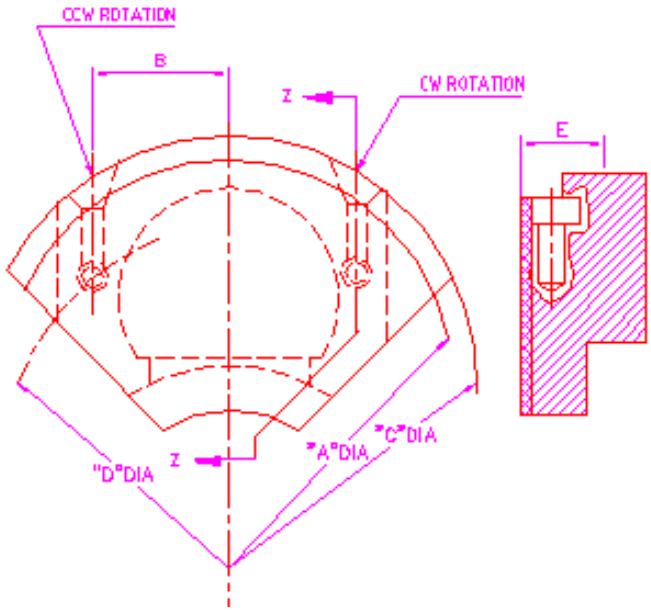


Figure 3 Typical details

Section Z-Z

7.3. The Journal and Thrust bearing thermo elements shall be of replaceable type to facilitate removal and assembly at site.

7.4. Thermo elements shall be procured from customer approved vendors and vendor list shall be indicated in the offer.

7.5. The drawings for thermo elements for both journal bearing and thrust bearing shall be submitted for review and records.

7.6. <u>Junction Boxes, Cables and Cable glands</u>

7.6.1. The thermo elements shall be assembled & properly routed through conduit and wired to flameproof junction box fixed on the GB assembly.

7.6.2. The thermo element wires shall be routed through protective (solid/Flexible) conduit up to junction box. The connecting glands, connector, conduit etc. shall be suitably selected by the vendor. The junction box outlet entries (1-1/2") NPT, 02 no's, along with any other unused inlet entries shall be plugged with Ex-d plugs.

7.6.3. Clause deleted.

7.6.4. The junction box shall be flameproof as per hazardous area classification and weather proof to IP 65 as minimum.

7.6.5. Junction box shall be painted in light blue shade or as per gear box colour shade.

7.6.6. Unused cable entries shall be plugged. The plugs & cable glands shall be flameproof to hazardous area classification.

7.7. Instrument hazardous area classification shall be indicated in the job specification.

8. Vibration And Axial Displacement Measurement:

8.1. The key phasor, vibration and axial probes shall be supplied by BHEL. The details of the probe shall be as per fig.-4.

8.2. Vendor shall provide all necessary arrangement (like support tube etc.) to mount the probes on the gear box.

8.3. The probe cable shall be routed through ¾" flexible conduit to junction box. Vendor shall provide ¾" NPT-F connection on the casing / support tube end for connecting this conduit.

8.4. The conduit & junction box for key phasor, vibration and axial probes shall be supplied by BHEL.

8.5. Any interference with casing or adjoining probes shall be studied by Gear manufacturer and suitable stand off adopters to clear interference and support tubes shall be provided. Plug the holes during dispatch.

8.6. Provide suitable burnished / ground zones on shaft collars, for vibration probe locations.

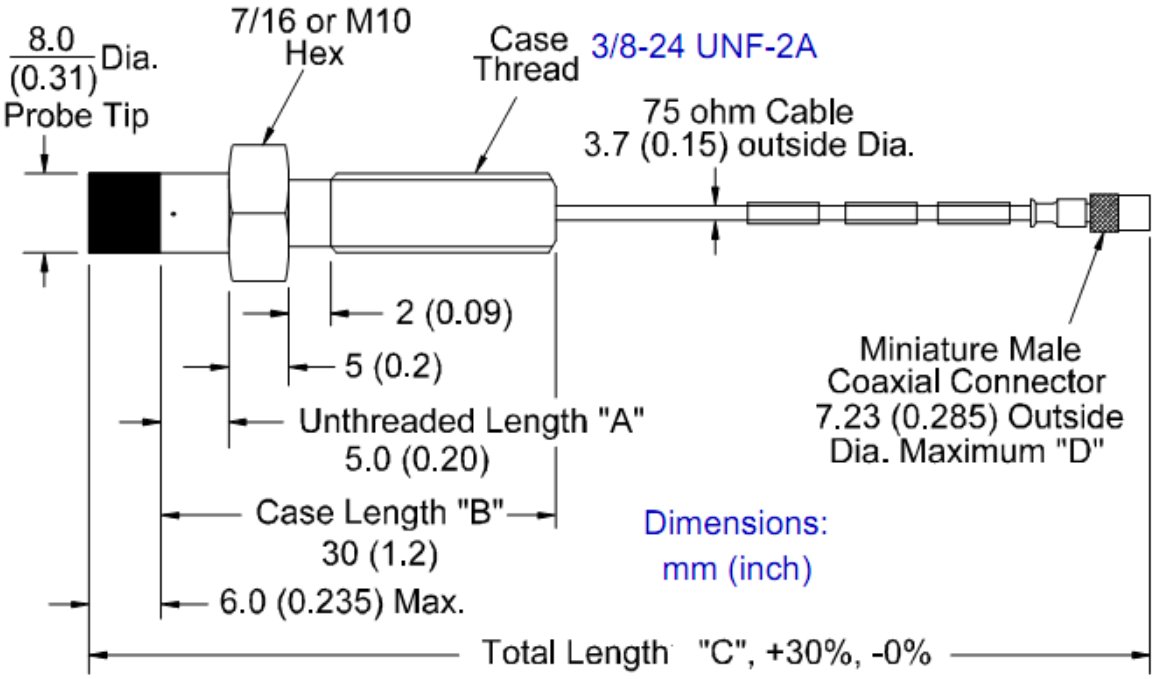
8.7. Number of provisions

Vibration probe:	2+2 nos for pinion side journal bearing
	2+2 nos for Gear side journal bearing
Axial probe:	1+1 no on pinion side
	1+1 on gear side
Key phasor:	1 no on pinion side
	1 no on gear side

KEY PHASOR, VIBRATION AND AXIAL PROBES DETAILS:

Sl.no	Description	Details
1	Probe Mounting	Reverse
2	Unthreaded Length (Inch)-A	0.2
3	Case Length (Inch)-B	1.2
4	Case Threading	3/8-24 UNF
5	Total Length including cable (meter)-C	1

FIG: 4



3300 XL 8 mm Proximity Probes, Reverse Mount

9. **Acceptance Criteria**:
   At least two numbers of the quoted model of gear box shall have been manufactured and supplied from the proposed shop of manufacture and at least one of them shall have successfully completed a minimum of 8000 hours of operation without any major overhaul for similar power rating, Gear ratio, Centre distances, bearing spans, pitch line velocities etc. Vendor shall fill up the experience record format for the offered model of the Gearbox & submit along with the offer.

10. **Quality plan**: Any requirements over and above standard quality plan shall be indicated in the job specification.

11. **Testing:**
    11.1. Gear box shall be tested in accordance with 4.3 of API 613-2003.
    11.2. Additional tests, if any, will be specified in the enquiry. Vendor shall confirm and include these tests in the offer.
    11.3. Gear boxes are required to be manufactured under third party inspection as mentioned in the job specification. Supplier shall include the same in their offer.
    11.4. Relevant certificates shall be furnished along with the supply. The certificates for chemical composition and mechanical properties for all torque transmitting parts shall be furnished along with the supply.

12. **Spares list for Gearbox:-**

The following spares shall be offered as a minimum with an offer validity of 12 months:-

12.1. High speed / Low speed gears and shaft assembly
12.2. Set of journal bearings
12.3. Set of thrust bearings
12.4. Set of Journal bearing pads
12.5. Set of Thrust bearing pads
12.6. RTDs for bearings
12.7. 'O' rings/ Gaskets as applicable
12.8. Set of Labyrinths, Oil seals for the gearbox

Required spares and their quantities will be mentioned in the job specification.

13. **Data to be provided along with the offer as a minimum** :

13.1. Filled in data sheets along with the offer as per API 613.
13.2. Supplier shall complete all missing data indicated in the job specification format and enclose along with the offer.
13.3. Experience record in customer format. (This will be provided along with job specification)
13.4. Noise datasheet
13.5. Test/Inspection procedure.
13.6. Exceptions to a) API 613/671
b) TC52203
c) Job specification TC62xxx
13.7. Overall General arrangement drawing shall be provided. Following information shall be provided in the drawing as a minimum-
13.7.1. Overall dimensions, shaft overhang, base plate fixing dimension, coupling guard fixing details, thermal growths etc.
13.7.2. Efficiency of gear box at 100% load
13.7.3. Oil quantity in lpm, oil pressure and temperature for lubrication.
13.7.4. Heat dissipation in Kcal/hr
13.7.5. Weight of gear box
13.7.6. GD2 value with reference to low speed.
13.8. Item wise price is to be given for the following with a validity of 12 months:
13.8.1. Gear box
13.8.2. Input coupling (if asked for, in the job spec)
13.8.3. Output coupling (if asked for, in the job spec)
13.8.4. Items as per Cl. 12

14. **Documents to be submitted after order placement:-**

14.1. Overall General arrangement (OGA) drawing of the gearbox showing all the major interface dimensions. This shall be submitted **within 15 days of order placement**.

14.2. Shaft modelisation diagram

14.3. Final cross sectional drawing assembly drawing indicating Bill of materials, instrument tag nos., clearances etc. of gear box in soft form.

14.4. Gear box datasheets in API 613/ customer supplied datasheets

14.5. Test procedure for the gearbox, **within 30 days of order placement**

14.6. Junction Wiring diagram, **within 15 days of order placement**

14.7. O&M Manual, at least **20 days before gearbox dispatch**

14.8. Lateral critical speed report **6 weeks after order placement.**

14.9. Drawings showing the details for vibration/axial displacement /key phasor mounting

14.10. The OGA drawings shall be submitted in *.dwg/ *.dxf format and datasheets in the native format *.doc/ *.xls, to enable BHEL for customer document submission.

14.11. Bearing RTD datasheet and catalogues.

15. **Guarantee and Warranty:**

Acceptance to provide a guarantee certificate for trouble free performance of the Gear box for a period of 18 months from the date of successful commissioning or 24 months from the date of despatch, whichever is earlier.

Vendor will guarantee that all materials and equipment's shall be repaired or replaced as the case may be at site, at its own expense, in case the same have been found to be defective in respect of material, workmanship or smooth and rated operation within a period of 18 months after the same have been commissioned or 24 months from the despatch whichever is earlier.

The guarantee period for the part that may be altered, repaired or replaced shall be 18 months from the date on which the same is commissioned.

16. **Certificates**: Test certificates for chemical composition and mechanical properties for all torque transmitting parts shall be furnished along with the supplies. Test reports for all the tests carried out on the gear box shall be furnished along with the supplies.

17. **Nameplates And Product Markings:**

Equipment supplied shall be identified by name-plate or other suitable product markings which shall include as a minimum the following information:

17.1. Gearbox nameplate rating, Gear ratio etc.

17.2. Serial Number

17.3. BHEL ordering specification number/code no.

17.4. Vendor's drawing and part number

18. Preservation, Packing and delivery:

18.1. Preservation shall be accomplished in accordance with acceptable commercial practices (for domestic or foreign shipments) unless otherwise indicated on the purchase order or quotation requirements.

18.2. Positive corrosion preservation of internal parts shall be carried out as per clause 4.4 of API613

18.3. Bolting for piping shall be coated by galvanised to prevent rusting.

18.4. Gear Box shall be suitable for outdoor storage up to 12 months.

18.5. The gear box shall be well packed suitable for shipment by sea or air as specified in P.O .The quality of packing shall be as per API 613 clause 4.4.

18.6. The vendor shall make shipment using the minimum number of shipping containers consistent with the requirements of safe transit, mutually agreed modes of transportation, and routing. It shall be the vendor's responsibility to determine that packaging as done is adequate to assure that all equipment shall arrive at destination in an undamaged condition and ready for the intended use. All shipping containers shall be identified with BHEL order no., suppliers' drawing number and packing list numbers.

PRODUCT STANDRARD
TURBINES & COMPRESSORS
HYDERABAD

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RECORD OF REVISIONS

Rev no	Date	Revision details	Revised	Approved
07	31.01.98	Std reissued under general revision.	UPK	BVSR
08	13.12.13	Standard revised in general in line with API 613 5th Edition	Suguna/ YVR	SDR/ PNR
09	15.11.14	Cl No's 6.8, 7.2, 7.6.2 and 7.6.5 are modified	Suguna	YVRL/SDR
10	21.08.15	Cl 7.6.2 modified and Cl 7.6.3 deleted.	Suguna	YVRL/SDR