

TD-106-1  
Rev. 5  
Form No.



**PRODUCT STANDARD**  
**TURBINES AND COMPRESSORS**  
**HYDERABAD**

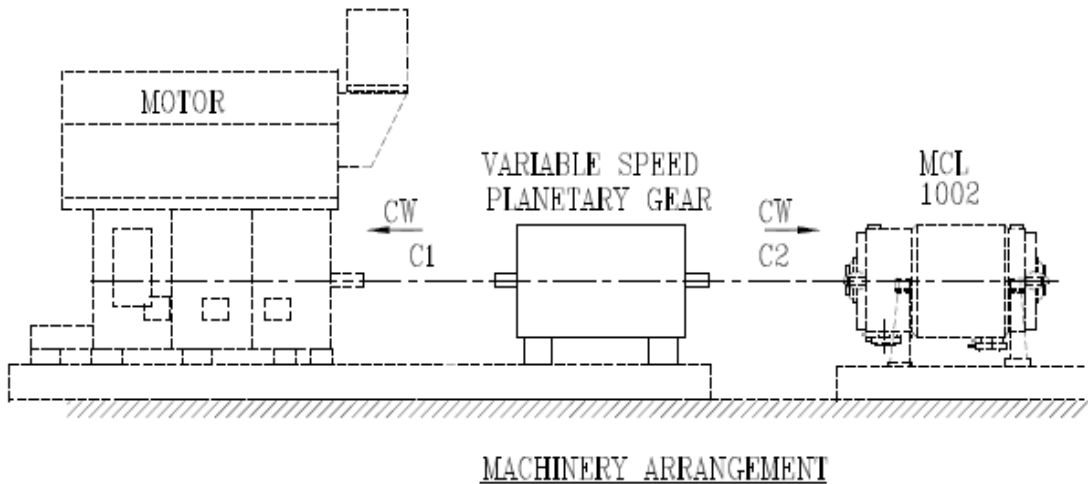
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**VARIABLE SPEED PLANETARY GEAR FOR THE DRIVE OF COMPRESSOR TRAIN FOR IOCL PANIPAT  
HEAT PUMP COMPRESSOR PROJECT**

**1. INTRODUCTION**

This specification covers requirement of Variable speed planetary gear to couple the electric motor driver with the compressor for IOCL Panipat Heat Pump Compressor project. The coupling shall serve dual-purpose viz. stepping up the speed to meet required maximum continuous compressor speed and speed variation from the MCS (Max Continuous Speed) to a minimum speed based on process load variation.



**2. PROCUREMENT DETAILS**

Var. No.	Description
01	Variable speed planetary gear to couple the electric motor driver with the compressor.
02	Mandatory Spares as per Clause 8

Please refer scope of supply Clause 5 for further details

**3. TECHNICAL REQUIREMENTS OF THE VARIABLE SPEED PLANETARY GEAR (VSPG)**

- 3.1 Variable speed planetary gear mechanism shall be designed for power rating at least equal to driver rating and all speeds required to achieve various operating cases as per sizing input, shall be achieved through this mechanism/system. The response time of the mechanism shall be fast enough to ensure that the process flow stabilizes within shortest possible time. Vendor shall confirm system response time for all operating cases.
- 3.2 Variable speed planetary gear mechanism and motor shall be mounted on a common base plate. Hence VSPG vendor shall provide base plate accordingly. In

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case same is not feasible due to transportation limitation, same shall be clearly indicated in the offer.

- 3.3 The lube oil system shall be common for compressor, VSPG and motor. VSPG vendor shall provide the lubrication requirement details.
- 3.4 The working oil system shall be separate closed loop and integral to the VSPG, complete with sump of adequate retention capacity, filler-breather, input shaft driven working oil pump, working oil cooler and duplex type filters. Reservoir shall be fitted with personnel protection if the operating temperature exceeds 70 deg C.
- 3.5 Working oil circuit shall be as per vendor standard practice with proven references.
- 3.6 The gear unit of Variable speed planetary gear mechanism shall be designed as per API613 to the maximum extent possible.
- 3.7 Vendor shall provide the performance of Variable speed planetary gear mechanism over its full operating range. Vendor shall furnish efficiency curves, torque curves & power curves during detailed engineering stage.
- 3.8 Vendor shall provide all required instrumentation & controls for monitoring & safeguarding of Variable speed planetary gear mechanism.
- 3.9 Variable speed planetary gear mechanism shall include a speed control facility by means of an electro hydraulic actuator by which the mechanism shall provide stepless speed control over its entire operating range from purchaser's 4-20mA signal.
- 3.10 Couplings shall be of metallic (Stainless steel), non- lubricated, flexible element (i.e. either Diaphragm or Disc) type with spacer. Couplings shall confirm to API Std. 671, 4th edition.
- 3.11 All Coupling models shall be selected for a minimum service factor of 1.5 over driver rating.
- 3.12 The coupling shall have spacer of adequate length to enable maintenance of packing/ seal/bearings without dismantling any equipment of the train. DBSE shall be more than seal cartridge length.
- 3.13 Removable coupling guard shall be provided which shall be fabricated from non-sparking material, and shall be open at the bottom to permit manual shaft rotation. The guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 kgs. Coupling guard shall have a hinge to open and inspection window to see the healthiness of the coupling shims.
- 3.14 The coupling hubs to be mounted on compressor rotor (both active and spare) shall be delivered to BHEL works within 8 months after placement of order.
- 3.15 Start-up procedure / start-up curve including time required to reach minimum speed of the compressor shall be indicated in the offer.

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- 3.16 The variable speed planetary gear consists of items like a hydrodynamic coupling, torque converter, a stationary planetary gear and a revolving planetary gear and other items as per OEM proven standard.
- 3.17 VSPG manufacturer's drawings, complete with installation details, dimensions, and manufacturer's part numbers shall be included in the Operation and Maintenance Manuals.
- 3.18 The Vendor shall be responsible for the complete design, engineering, coordination, inspection and testing, delivery and proper functioning of the complete package of VSPG. The Vendor shall have single point responsibility for the VSPG package.
- 3.19 The allowable noise level of the VSPG package shall not exceed 85dBA. This shall be demonstrated at site & if the noise limit exceeds the specified value, the necessary arrangement to meet the noise criteria, shall be provided by vendor without any time/cost implication.
- 3.20 Vendor shall provide filled EIL format data sheets provided with specification for VSPG, Couplings, Working oil system, oil pump and working oil heat exchanger.
- 3.21 Vendor shall provide table of terminal points for clear understanding of scope of supply.
- 3.22 Vendor shall provide applicable P&ID's with scope demarcation. However same shall be reviewed and finalized during detailed engineering stage.
- 3.23 Lube Oil and Control Oil piping shall be minimum SS304 grade.
- 3.24 Positive Material Identification (PMI) requirements shall be as per EIL specification number B269-6-81-0001.
- 3.25 Dynamic simulation study of compressor package shall be performed by BHEL. Vendor shall provide all the required inputs for dynamic simulation study during detailed engineering stage.
- 3.26 Vendor shall provide earthing provision on base plate.
- 3.27 Vendor shall provide necessary technical support in finalization of Motor and VFD soft starter.
- 3.28 Vendor shall provide complete details for the interfacing such as the data for motor design, data for sizing the lube oil system such as lube oil requirements, mechanical losses to decide the oil cooler etc. and the VSPG drawing for generating overall GA drawings etc.
- 3.29 As per customer specification, the compressor train shall also be designed for accidental reverse rotation case along with bearings, lube oil system, seal system & other auxiliaries. Hence VSPG shall also suitable for accidental reverse rotation case. Necessary instrumentation and controls shall be included in vendor's scope for the same to avoid any damage to the VSPG and its auxiliaries because of reverse rotation.



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- 3.30 As per customer specification, Electric motor offered shall be suitable for starting the compressor under specified loading conditions including against maximum settle out pressure. Compressor must also be able to restart under maximum settle out pressure. Hence VSPG shall also suitable for the same.
- 3.31 Any special requirements for coasting down shall be clearly indicated in the offer.
- 3.32 Sub supplier List for bought out items shall be as per Attachment-2.
- 3.33 Electrical area classification is Zone 2, Gas Group IIB, Temp Class T3. Enclosure type Ex-d.
- 3.34 The motor power shall be at least 110 % of the greatest power required (including gear and coupling losses) for any of the specified operating conditions.
- 3.35 Painting shall be as per EIL painting specification B269-000-02-42-PCS-0001.
- 3.36 All equipment covered in the VSPG Package shall be packed for an outside storage period of twelve (12) months.
- 3.37 Packaging shall be of export quality and sea- worthy.
- 3.38 Vendor's recommended extended storage and preservation procedure shall be furnished to Purchaser/ Owner before dispatch.
- 3.39 Field trial test is required as per clause 14.3 of Job specification B269-454-80-42-SP-5155. Vendor shall participate during this test on per diem basis, if required.
- 3.40 All open ends on the skid shall be blinded with suitable blind flanges/ Plugs as applicable. Small bore threaded connections shall be taped over.
- 3.41 Vendor nameplate shall be provided with the key operating details of the equipment.
- 3.42 All the documentations must be in English language.
- 3.43 Documentation format and procedure will be discussed during detailed engineering stage.
- 3.44 Vendor shall provide necessary technical information and supporting documents whenever asked for by BHEL/customer/ consultant.
- 3.45 In case of conflicting requirements, most stringent requirement shall be followed. However, decision of customer shall be final.

**4. ACCEPTANCE CRITERIA:**

- 4.1 The Variable speed planetary gear mechanism shall be procured from a regular and established manufacturer having requisite design, manufacturing and testing facilities and shall meet the following minimum service and manufacturing experience requirements.



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- 4.2 The offered model shall be of proven design and shall be from manufacturer's existing regular production range.
- 4.3 Past one references (i.e. one Unit) of the offered Variable speed planetary gear mechanism model as designed, manufactured, tested and supplied from the proposed manufacturing plant, in the last TEN years, shall be similar to the present case in terms of Power rating, speed, gear ratios, type of bearing, Lubrication system, and as a minimum same reference shall have completed one year of operation at site for similar compressor drive application, as on 23.05.2022.
- 4.4 Vendor shall furnish duly filled in Experience Record Proforma as per B269-454-80-42-ERP-5156 to justify provenness of the proposed model.

**5. SCOPE OF SUPPLY:**

Vendor's Scope of supply shall include but not be limited to the following for VSPG package:

- 5.1 Variable speed planetary gear: Design, engineering, vendor documentation, manufacturing, inspection, testing, packing & forwarding and transport up to BHEL Hyderabad works. Transit insurance up to BHEL Hyderabad works.
- 5.2 Both connecting couplings i.e. between motor and VSPG (C1) & VSPG and compressor (C2) along with non-sparking type coupling guards with expansion bellows. The required shaft end details of motor and compressor will be furnished by BHEL during detailed engineering.
- 5.3 One number additional complete C2 coupling (between VSPG and compressor) shall be provided. This is required to mount coupling hubs on compressor rotor and VSPG rotor.
- 5.4 Common base plate for VSPG and Motor. Motor details shall be provided during detailed engineering stage.
- 5.5 Complete working oil system: All items of working oil system including working oil cooler are in vendor scope except the following:
- 5.5.1 Interconnecting piping from working oil cooler to VSPG skid is in BHEL scope. (2 terminal points on skid and 2 terminal points on cooler).
- 5.5.2 Cooling water supply and return piping for working oil cooler is in BHEL scope. (1 terminal point for supply and 1 terminal point for return).
- 5.6 Connections for the lube oil inlet, outlet along with counter flanges.
- 5.7 Speed control actuator and linkages to control the speed variation.
- 5.8 Instrumentation as specified under clause no: 7.
- 5.9 Lateral critical speed analysis report for VSPG.

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- 5.10 Torsional critical speed analysis report for complete train. Drive motor and compressor data shall be furnished by BHEL during detailed engineering stage.
- 5.11 Erection and Commissioning spares: Vendor's scope of supply shall include all erection & commissioning spares (mechanical, electrical and instrumentation) for the VSPG package as deemed necessary by vendor. The same shall be included in the base price of VSPG package. Vendor shall provide the E&C spares list for review. Any spares required over and above these spares, during commissioning, shall be in Vendor's scope of supply and the same shall be supplied without any time and cost implication. Any un-used commissioning spares shall be retained at purchaser's end.
- 5.12 Mandatory Spares: Mandatory spares shall be supplied by vendor as per Clause 8. Vendor shall provide item wise price. Cost for mandatory spares shall be included in base scope.
- 5.13 2 Year O&M Spares: Vendor shall furnish an itemised list of recommended spare parts with unit prices for two years normal and continuous operation of the complete VSPG unit (including mechanical, electrical and instrumentation spares), required over and above the mandatory spares.
- 5.14 Special Tools and tackles required for operation and maintenance including coupling assembly / disassembly tools.
- 5.15 Services of an expert during unitization (compressor, motor and VSPG shall be unitized on the job base plate) at BHEL shop shall be included in base scope.
- 5.16 Services of an expert during site erection and commissioning of machine for technical support, diagnostics and troubleshooting shall be on per diem basis. Vendor shall provide per diem rates in offer. Maximum of 25 man days shall be considered for evaluation purpose.
- 5.17 Performance Guarantee shall be as per Clause 10.
- 5.18 Scope of supply shall also include shop & site assembly/disassembly assistance for the guarantee period.
- 5.19 Counter flanges along with gaskets and fasteners shall be provided by vendor at all terminal points.
- 5.20 Connecting fasteners (bolts, nuts etc) to foundation frame.
- 5.21 Third party inspection charges shall be included in base scope.
- 5.22 The vendor shall quote a separate lumpsum cost for carrying out training of Purchasers/owner's personnel at the site for 3 working days. The group deputed for training shall be a multidisciplinary group (comprising of process, mechanical, electrical, and instrumentation) of a maximum of 6 persons. All requisite training material like books/documents shall be provided by the vendor.
- 5.23 Vendor shall participate during HAZOP study of the compressor package on per diem basis.



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- 5.24 Vendor shall include all the required spreader bars and slings for handling VSPG package during transportation and erection.
- 5.25 Vendor shall depute technical persons free of charge for technical discussions with customer during pre-order and post order stage.
- 5.26 Any other item which is not mentioned above but required for safe & satisfactory operation of proposed VSPG as per vendor standard, same shall be included in the base scope and details shall be indicated in the offer.
- 5.27 Vendor shall provide necessary certificates required as per statutory guide lines like PESO certificate.

#### **6. DESIGN DATA FOR VARIABLE SPEED PLANETARY GEAR DESIGN**

- 6.1 Max Continuous Speed = 3884 rpm, Rated speed = 3699 rpm
- 6.2 Low speed shaft speed (Motor speed) = 1485 rpm
- 6.3 Rated power of Motor: To be decided by vendor based on VSPG losses.
- 6.4 The Variable speed planetary gear shall be designed for continuous run as per the operating condition mentioned in Attachment-3.
- 6.5 The coupling shaft end of the MCL 1002 compressor is with a taper of 1:20. The coupling hub is mounted by a hydraulic fixture. The coupling size and shaft end details will be provided during detail engineering.
- 6.6 The shaft end details of the motor will be informed during detailed engineering.

#### **7. CONTROL & INSTRUMENTATION**

The controls and instrumentation shall meet the following requirements:

- 7.1 All explosion protected instruments (Ex-I, Ex-d) and electrical items (as applicable) shall be provided with valid PESO approval certificate. This is mandatory.
- 7.2 The vibration and temperature monitoring system (MMS) are Bently Nevada 3500 series or equivalent. The MMS sensors, API 670 compliant along with extension cable & proximator shall be supplied in installed condition inside junction box.
- 7.3 The final make of vibration/axial probe and other accessories shall be informed to vendor during detailed engineering based on selection of the monitoring system.
- 7.4 All instruments, devices must be capable of operating continuously under ambient conditions specified in Clause no 16 without losing performance, accuracy etc.



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- 7.5 Supplier shall furnish detailed information for each & every type of instrument included in his offer with their make, model, technical literature for BHEL/Owner's review and approval.
- 7.6 Electronic field transmitter like PT / TT / FT / LT etc. shall be intrinsic safe, 4-20mA, HART type for interlock & protection. The Electronic field transmitter like PT / TT / FT / LT etc. used for monitoring & alarm shall be either HART or Foundation fieldbus. The exact type shall be informed during detail engineering.
- 7.7 All field transmitters shall be supplied in mounted and wired condition, including junction box. Junction box for foundation fieldbus transmitters shall be supplied by BHEL.
- 7.8 The cable glands shall be of SS316 MOC, Ex-d, IIC certified.
- 7.9 All junction boxes, proximator / drive housings shall be Ex-d IIC certified.
- 7.10 All solenoid valves (24 V DC) shall be Intrinsic safe, IIC certified.
- 7.11 Vendor shall provide working oil cooler bypass temperature control valve (self-actuated) as loose supply.
- 7.12 The make of oil field instruments shall be as per EIL approved vendors list.
- 7.13 RTD / TC: -
- All resistance temperature detectors shall be ungrounded, duplex, 3-wire type, Pt100 or TC-K type and shall conform to IEC 60752.
  - Accuracy of  $\pm 0.5\%$  of range, 0.05-ohm stability over full range of better and 0.02 ohm repeatability or better.
  - Vendor shall provide remote mounted transmitters for all RTD/TC except for bearing RTDs.
  - For bearing temperature duplex 3-wire type Pt100 RTD shall be used.
- 7.14 Instrument Spare parts as per following:
- Mandatory spares: Field instruments / transmitters / gauges / manifolds: 20% or 2 no's min, each type / range.
  - Commissioning spares: 02 no's MMS sensors, 06 no's bearing RTDs.
- 7.15 Local indicators/Gauges: Local indicators furnished integral to the instruments or control devices shall meet the following specifications:
- The temperature gauges shall be inert gas actuated of dial size 150 mm diameter.
  - The accuracy of the temperature gauges shall be  $\pm 1\%$ .
  - All thermometers shall be provided with thermowells.



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➤ Pressure gauges shall have sensing element as bourdon tube / bellows / diaphragm depending on the system pressure. The dial size and accurate of pressure gauges shall be 150 mm & ±1% respectively. All required accessories i.e. scrubbers, pulsation dampers, siphons; chemical seal shall be provided with pressure gauges wherever required.

7.16 Accessories like siphon, scrubber shall be provided wherever required. Parts below the diaphragm shall be removable for cleaning. The entire volume and above the diaphragm will be completely filled with an inert liquid suitable for the application.

7.17 The following instrumentation shall be included in the scope of supply. However, any additional instrumentation required for the safe operation of the equipment shall also be included.

- a) Duplex RTD's for all bearing temperatures.
- b) Contact thermometers for all bearing temperatures.
- c) Duplex RTD with temperature transmitters for working oil temperature at cooler inlet /outlet.
- d) Pressure transmitters for working oil and lube oil (trip & start).
- e) Differential pressure transmitter and indicator across duplex oil filter.
- f) Pressure gauges for lube oil and working oil.
- g) 4-20 mA position feedback transmitter for indicating scoop position at remote, suitable for 24 volts DC supply.
- h) Reverse rotation indicator with lamp indications for normal and reverse rotation of output shaft, micro switch contacts for alarm.

(Split price shall be quoted for reverse rotation indicating switch.)

All the field instruments shall be wired and terminated in junction boxes, properly grounded.

Sr. No.	Equipment Component	Vibration		Bearing temperatures	
		No. Of Probes	Trip Condition	No. Of RTD's	Trip Condition
<b>Variable speed planetary gear</b>					
1	All Journal Bearings	2 x 90° per Bearing (x & y)	See Note 1	2 per Bearing	See note-3
2	All Axial Bearings (Thrust)	3 Per bearing	2 out of 3	5 per Bearing (3 on active/ 2 on inactive side: 1 trip and 1 alarm)	See note 2
3	Key Phasor - Driver end	1 per shaft			
4	Key Phasor - Driven end	1 per shaft			



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**Note:**

1. Trip caused by any one out of two probes initiating the high high vibration trip.
2. Trip caused by High High temperature trip signal from active or inactive side.
3. Alarm at High Temperature level and trip at HH temperature level.
4. Vendor's scope shall include probes, integral cable & extension cable and Proximeters, Proximeters housing. Make shall be informed to the vendor during detailed engineering.
5. All field mounted instruments (probes, integral cable & extension cable and Proximeters, Proximeters housing, transmitters etc.) shall be suitable for hazardous area classification Zone-2, Gas group IIC, temperature class T3.
6. Suitable Earthing and bonding system shall be provided by the vendor on skid.
7. The thermo elements shall be assembled & properly routed and through conduit and wired to explosion proof junction box fixed on the VSPG assembly. The junction box shall be explosion proof to area classification indicated above. The junction box shall be provided with 2 Nos. of 1 ½" NPT-F connection for outgoing cables.
8. The Bearing thermo elements shall be of replaceable type to facilitate removal and assembly at site.
9. The instruments shall be supplied with calibration as per applicable IEC / DIN standard.
10. All instruments shall be wired and terminated into the junction boxes mounted on the instrument gauge board.
11. If over-speed monitoring is recommended, the necessary probes; proximeters/ drivers shall be provided by the vendor.

**8. MANDATORY SPARES**

8.1 Following mechanical items spares shall be supplied by vendor

Item	Spare Part	Quantity Required
A	Variable Speed planetary gear	
1	Set of Bearings	1
2	Complete set of high speed planetary gear assembly	1
3	Bushes/Gaskets (as applicable)	1



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4	Working Oil Filters	400% of installed quantity
<b>B</b>	<b>Special Purpose Coupling (For Low speed and High Speed)</b>	
1	Set of Coupling Shim Membranes	1
<b>C</b>	<b>Working Oil Pump (Centrifugal)</b>	
1	Set of shaft & impellers	1
2	Set of mechanical seals	1
3	Set of Bearings	1
4	Set of Casing Wear Rings	1
5	Set of Impeller Wear Rings	1
6	Set of throat bush	1
7	Set of Gaskets	1
8	Set of O'- rings	1

- 8.2 Instrumentation items mandatory spares shall be included as per B269-454-80-42-SL-5155.
- 8.3 Customer mandatory spares list is as per EIL document no. B269-454-80-42-SL-5155. In case any applicable item which is mentioned in customer spares list and same is not provided in Clause 8.1 shall be included in vendor scope.
- 8.4 Spare rotor shall be boxed in a metal container for vertical storage with nitrogen purging. Storage container shall be property of the owner. Storage metal container shall be provided with Pressure Indicator & Nitrogen cylinder for ensuring recommended positive pressure so as to cater transit requirements.
- 8.5 The word 'Set' means the quantity required for full replacement of that part in one machine.
- 8.6 The vendor shall quote for all the mandatory spares as defined in B269-454-80-42-SL-5155 & as applicable to the proposed design of the equipment. In case, any spare which is listed in the table but not applicable due to specific construction/design of the equipment, the same shall be highlighted as 'Not Applicable' against that spare supported with proper technical explanation.
- 8.7 Spare part shall be identical in all respects to the parts fitted on the main equipment, including dimensions, material of construction, and heat treatment.



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**9. INSPECTION & TEST REQUIREMENTS**

- 9.1 Shop Inspection and Testing requirements of VSPG shall be as per attached VSPG Datasheet (B269-454-80-42-DS-5155-009)
- 9.2 Other test considerations shall be as per API 613 -5th Edition. Any other test not included above but required for satisfactory performance of the equipment shall be included and specified in the quality plan.
- 9.3 Oil pump ITP requirements shall be as per 6-81-0024.
- 9.4 Quality plan & testing procedures shall be submitted within four weeks of placement of order.

**10. PERFORMANCE GUARANTEE:**

Performance Guarantee case is Rated Case. During field trial test of compressor package, incase power consumption and lube oil consumption values are abnormally high, then vendor shall:

- a) Devise a method to calculate the power losses / oil consumption in VSPG. If any additional equipment's/instruments are necessary in addition to those in vendor's scope of supply for the purpose of testing & measurement, vendor shall bring them to site duly calibrated and shall take them back after successful completion. Price for the additional equipment's/instruments shall be included in base scope.
- b) In case the values are higher than the guaranteed, vendor shall modify / rectify the supplied items to meet the specified guaranteed power losses without any cost and time implication to BHEL.

**11. DELIVERY PERIOD**

Refer Commercial Section

**12. GUARANTEE / WARRAENTY PERIOD**

Refer Commercial Section

**13. DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER:**

- 13.1 Vendor shall sign technical specification document (C1211002) and submit.
- 13.2 Motor sizing document
- 13.3 VSPG Lube oil requirements



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- 13.4 Working oil system details
- 13.5 Filled in VSPG EIL format Data sheet
- 13.6 Filled in VSPG EIL format PTR
- 13.7 VSPG Performance details
- 13.8 P&ID's with scope demarcation
- 13.9 VSPG overall dimensional drawing indicating the following: -
- Location of various connections.
  - Mounting details on base plate.
  - Shaft end details.
  - Instrumentation provided.
- 13.10 Cross-sections drawings of Variable speed planetary gear.
- 13.11 Table of terminal points
- 13.12 Filled in Mandatory Spares List
- 13.13 Data required as per this specification
- 13.14 Typical Quality Plan
- 13.15 Electrical load list (As applicable)
- 13.16 Utility List
- 13.17 Filled in deviation list

**14. DETAILS REQUIRED DURING DETAILED ENGINEERING STAGE**

Sl No	Description	Weeks from LOI
1.	VSPG GA Drawing.	4
2.	VSPG EIL Format Data Sheet	4
3.	VSPG Performance Curves	4
4.	Motor Sizing Input	4
5.	Lube Oil/Working Oil System Inputs	4
6.	VSPG EIL Format PTR	4
7.	Cross Sectional Drawing	4
8.	Working Oil System Data Sheet	#
9.	P&ID's	#
10.	Oil Pump Data Sheet	#
11.	Coupling Data Sheet	#

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12.	Coupling GA Drawing	#
13.	VSPG Lateral analysis report	#
14.	Train Torsional analysis report	#
15.	Electrical Load List	#
16.	Utility List	#
17.	O&M Manual	#
18.	Force and loading on foundations	4
19.	VSPG ITP	4

14.1 # Will be decided during KOM

14.2 VSPG vendor shall provide all the required downstream engineering documents within 4 weeks from LOI.

14.3 Above indicated document list is preliminary and same will be finalized during KOM in line with EIL VDR documents B269-454-80-42-VR-5155.

### 15. DEVIATIONS

15.1 Vendor shall propose only deviations, exceptions to the bid documents in the attached format (Document No. B269-454-80-42-DF-5155). No deviations, exceptions whatsoever will be considered unless entered in this document.

15.2 Deviations which can be withdrawn with time and cost implication shall not be included.

15.3 Any clarifications/ deviation/ exception appearing elsewhere in the bidder's offer shall not be considered and will be treated as withdrawn.

### 16. LOCATION AND ENVIRONMENTAL CONDITIONS

Refer EIL Document B269-454-80-42-SU-5155 for details

### 17. DATA TO BE FURNISHED BY THE VENDOR

#### 17.1 General data

Moment of inertia of input Shaft $GD^2/4$	Kgm <sup>2</sup>
Moment of inertia of output shaft	Kgm <sup>2</sup>
Total wt of variable speed planetary gear	Kg
Max wt for lifting (for maintenance)	Kg
Total power dissipated	KW
Power loss	
Effective service factor	
Maximum permissible axial displacement input shaft	
Maximum permissible axial displacement output shaft	

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Description	Flexural critical speeds			Torsional critical speeds		
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>
Input shaft						
Output shaft						

**17.2 Coupling**

Sl no	Description	Max shaft end diameter	Coupling type and supplier
1.	Input shaft		
2.	Output shaft		

**17.3 Variable speed planetary gear connections**

LO inlet	Location	:	
	Size	:	
LO outlet	Location	:	
	Size	:	
WO inlet	Location	:	
	Size	:	
WO outlet	Location	:	
	Size	:	
Filter Breather	Location	:	
	Size	:	

**17.4 Details of gear Teeth to be furnished by vendor**

Description		Output shaft	Input shaft
Base diameter	mm		
Pitch velocity	m/s		
Helix angle	°		
Pressure angle	°		
Tooth face length	mm		
Finish of teeth			
Specific pressure on teeth	N/mm <sup>2</sup>		
Clearance between the tooth flanks	mm		
Geometric factor AGMA (j)			
Normal module	mm		
Minimum contact area for each stepping up	%		
Pinion Hardness (Case Hardened) API	BHN		

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**17.5 Lubrication**

Lube oil viscosity:	ISO VG 46	
Inlet oil pressure		
Normal	Alarm	Trip:
Inlet oil temperature		
Normal	Alarm	Trip:
°C	°C	°C
Minimum start up temperature:	°C	
Oil quantity (for gears & bearings):	lpm	
Grade of filtration:	Microns	
Out let temperature of oil:	°C	

**17.6 Working oil**

Working oil viscosity:	ISO VG 46	
Inlet oil pressure		
Normal	Alarm	Trip:
Inlet oil temperature		
Normal	Alarm	Trip:
°C	°C	°C
Minimum start up temperature:	°C	
Oil quantity:	lpm	
Grade of filtration:	Microns	
Out let temperature of oil:	°C	

Working oil pump (by vendor)	
Type & supplier:	
Capacity:	lpm
Speed:	rpm
Maximum permissible pressure:	
Power consumed (at the normal pressure and maximum oil viscosity):	KW

**17.7 Journal bearing details by vendor**

	Input shaft	Output shaft
Journal bearing type / manufacturer		
Diameter		
Axial length		
Peripheral speed		
Specific effective pressure		
Diametrical clearance		
Permissible specific pressure		

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**17.8 Thrust bearing details by vendor**

	Input shaft	Output shaft
Thrust bearing type / manufacturer		
Diameter OD/ID (thrust collar)		
Specific effective pressure		
Axial clearance		
Permissible specific pressure		

**17.9 Materials**

Casing:	
Shaft:	
Gear:	
Piping:	

**18. APPLICABLE DOCUMENTS.**

Following is the list of documents applicable along with this specification:

S.No.	Document Title	Document Number	Rev
<b>Attachment-1</b>			
1	VSPG Data Sheet	B269-454-80-42-DS-5155-009	A
2	VSPG PTR	B269-454-80-42-ERP-5156	A
3	Coupling Data Sheet	B269-454-80-42-DS-5155-007	A
4	Job specification for centrifugal compressor package	B269-454-80-42-SP-5155	B
5	Working Oil System Data Sheet	B269-454-80-42-DS-5155-003	A
6	Oil Pump Data Sheet	B269-454-80-42-DS-5155-010	A
7	Heat Exchanger Data Sheet	B269-454-80-42-DS-5155-010	A
8	List of Mandatory Spare Parts	B269-454-80-42-SL-5155	A
9	ITP for Pump	6-81-0024	4
10	Standard specification for PMI	B269-6-81-0001	0
11	Deviations Format	B269-454-80-42-DF-5155	A
12	Site & Utility Data	B269-454-80-42-SU-5155	A
13	Vendor Data Requirements	B269-454-80-42-VR-5155	A
14	Specification for surface preparation and protective coating system	B269-000-02-42-PCS-0001	2

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15	Job spec for Non Destructive Examination Requirements of Piping	B269-454-6-44-0016	A
Attachment-2		Sub supplier list	
Attachment-3		VSPG Sizing Input	

### 18.1 International Standards

API STD 617 - 8th edition	Axial and Centrifugal Compressors and Expander-compressors
API STD 614 - 5 <sup>th</sup> edition	Lubrication, Shaft-sealing and Oil-control Systems and Auxiliaries
API STD 613 - 5 <sup>th</sup> edition	Special Purpose Gear Units for Petroleum, Chemical and Gas Industry Services
API STD 610 - 11 <sup>th</sup> edition	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
API STD 670 - 5 <sup>th</sup> edition	Machinery Protection Systems
API STD 671 - 4 <sup>th</sup> edition	Special Purpose Couplings for Petroleum, Chemical and Gas Industry Services

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