

PROJECT SPECIFIC REQUIREMENTS TSI SYSTEM

TC 65342-51-52

Rev. No: 00

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1 SCOPE:

This specification defines the project specific requirements for TSI System package for APL Assam NG & SG Compressor Project.

2 TECHNICAL REQUIREMENTS:

a TSI SYSTEM:

Sl.No	Technical Requirements	
i	Hazardous area classification	IEC Zone-2, Gas Group IIA, IIB, T3
ii	TSI Rack Location	Satellite Rack Room (SRR)
iii	TSI Rack Display (with connecting cable) & Location	Required, Field (LCP). Display shall be suitable for hazardous area.
iv	Cable Distance	i. Field Sensor to TSI Rack: 250 mts. ii. TSI Rack to TSI Display: 250 mts. iii. TSI Rack to DCS / PLC: 100 mts.
v	SIL Certification for TSI System	Required.
vi	Intrinsic safe Barrier	Yes, in BHEL scope. MTL5500 or eqv series.
vii	4-20 mA output from TSI rack	Required for each TSI sensor measurement.
viii	Serial communication with DCS	Dual Redundant, RS485 Modbus RTU.
ix	Connectivity with Condition Monitoring System	Individual buffered output (raw data) connections for all system transducers (except temperature) from both front as well as rear of the MMS racks for connectivity to purchaser's machine conditioning monitoring and analysis system.
x	Power supply	110 VAC (redundant)
xi	TSI Scheme & Loop Drawing	During detail engineering.
xii	TSI System material supply by BHEL	i. Proximitors Junction Box. ii. Triad cable from Proximitors to TSI Rack. iii. Bearing RTD. iv. TSI Panel with TSI Barriers.
xiii	TSI Sensors, Rack, Spares Qty	Vendor to quote for all items listed in the RFQ / Price Schedule. The separation of items as Main / Spares etc. is BHEL responsibility.

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3 PRICE SCHEDULE:

Enquiry ref no.

Date:

Offer ref no.

Date:

A: Material Supply:

Sl No	PR No	Material Code	Material Desc	PR Qty	PR MU	Price
1	7000075529	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	2	EA	
2	7000075530	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	2	EA	
3	8000082290	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	14	EA	
4	8000082300	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	12	EA	
5	7000075521	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	2	EA	
6	7000075522	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	2	EA	
7	8000082276	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	6	EA	
8	8000082336	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	6	EA	
9	8000082341	TC9765342012	Prox Sensor,Rev Mnt,1.2" Len,3/8-24unf	6	EA	
10	8000082291	TC9765342039	Proximity Probe Extension Cable, 4mts	12	EA	
11	8000082301	TC9765342039	Proximity Probe Extension Cable, 4mts	12	EA	
12	7000075540	TC9765342039	Proximity Probe Extension Cable, 4mts	2	EA	
13	8000082275	TC9765342039	Proximity Probe Extension Cable, 4mts	6	EA	
14	8000082338	TC9765342039	Proximity Probe Extension Cable, 4mts	6	EA	
15	8000082342	TC9765342039	Proximity Probe Extension Cable, 4mts	8	EA	
16	7000075532	TC9765342039	Proximity Probe Extension Cable, 4mts	2	EA	
17	8000082292	TC9765342047	Proximity Probe Driver For 5mts System	12	EA	
18	8000082302	TC9765342047	Proximity Probe Driver For 5mts System	12	EA	
19	7000075541	TC9765342047	Proximity Probe Driver For 5mts System	2	EA	
20	8000082274	TC9765342047	Proximity Probe Driver For 5mts System	6	EA	
21	8000082339	TC9765342047	Proximity Probe Driver For 5mts System	6	EA	
22	8000082343	TC9765342047	Proximity Probe Driver For 5mts System	8	EA	
23	7000075533	TC9765342047	Proximity Probe Driver For 5mts System	2	EA	
24	8000082293	TC9765342055	Casing Acceleration Sensor, M8x1	2	EA	
25	8000082294	TC9765342063	Accel Sensor Cable 5mts With Connector	2	EA	
26	8000082303	TC9765342071	Connector Protector Set	3	SET	
27	8000082273	TC9765342071	Connector Protector Set	4	SET	
28	8000082304	TC9765342098	Low Pressure Cable Seal 3/4"Nptm	6	EA	
29	8000082272	TC9765342098	Low Pressure Cable Seal 3/4"Nptm	8	EA	
30	7000075542	TC9765342128	Transducer Calibration Kit	1	SET	
31	7000075543	TC9765342136	Rack Power Supply, 110vac, Duplex	1	SET	
32	7000075534	TC9765342136	Rack Power Supply, 110vac, Duplex	1	SET	
33	7000075544	TC9765342144	Rack Trans Data Interfac Module,Ethnet	1	SET	
34	7000075535	TC9765342144	Rack Trans Data Interface Module,Ethnet	1	SET	
35	7000075545	TC9765342152	Keyphasor & Tachometer Module	1	SET	
36	7000075536	TC9765342152	Keyphasor & Tachometer Module	1	SET	

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Sl No	PR No	Material Code	Material Desc	PR Qty	PR MU	Price
37	7000075546	TC9765342160	Proximity Sensor Module	1	SET	
38	7000075537	TC9765342160	Proximity Sensor Module	1	SET	
39	7000075547	TC9765342179	Temperature Module	1	SET	
40	7000075538	TC9765342179	Temperature Module	1	SET	
41	7000075548	TC9765342187	Programmable Relay Module	1	SET	
42	7000075539	TC9765342187	Programmable Relay Module	1	SET	
43	7000075549	TC9765342195	Communication Gateway	1	SET	
44	7000075570	TC9765342195	Communication Gateway	1	SET	
45	7000075524	TC9765342209	Rack Configuration Laptop	1	SET	
46	7000075495	TC9765342209	Rack Configuration Laptop	1	SET	
47	7000075525	TC9765342217	Rack Configuration Software	1	SET	
48	7000075496	TC9765342217	Rack Configuration Software	1	SET	
49	8000082305	TC9765342225	Tsi Rack System Display	1	SET	
50	7000075550	TC9765342225	Tsi Rack System Display	1	SET	
51	8000082332	TC9765342225	Tsi Rack System Display	1	SET	
52	7000075571	TC9765342225	Tsi Rack System Display	1	SET	
53	8000082306	TC9765342233	Eth To Sm Fo Convert,Patch Cords & Liu (For Tsi Display Connection To Tsi Rack)	2	SET	
54	7000075551	TC9765342233	Eth To Sm Fo Convert,Patch Cords & Liu (For Tsi Display Connection To Tsi Rack)	1	SET	
55	8000082333	TC9765342233	Eth To Sm Fo Convert,Patch Cords & Liu (For Tsi Display Connection To Tsi Rack)	2	SET	
56	7000075572	TC9765342233	Eth To Sm Fo Convert,Patch Cords & Liu (For Tsi Display Connection To Tsi Rack)	1	SET	
57	7000075526	TC9765342250	Rs485 Serial Cable With Connectors	300	M	
58	7000075497	TC9765342250	Rs485 Serial Cable With Connectors	300	M	
59	7000075523	TC9765342292	Prox Sensor,Std Mnt,1.6" Len,3/8-24unf	2	EA	
60	8000082344	TC9765342292	Prox Sensor,Std Mnt,1.6" Len,3/8-24unf	2	EA	
61	7000075527	TC9765342306	Armoured Fo Cab 6 Fibre,Orange	300	M	
62	7000075498	TC9765342306	Armoured Fo Cab 6 Fibre,Orange	300	M	
63	7000075528	TC9765342314	Hdpe Conduit+Fittings Is-4984,Orange	300	M	
64	7000075499	TC9765342314	Hdpe Conduit+Fittings Is-4984,Orange	300	M	
65	8000082307	TC9765342519	TSI RACK-1 consisting of the following items:			
			Sl. No.	Module	Qty	
			a	19" Rack	01	
			b	Rack Power Supply, 110VAC, Duplex	01	
			c	Rack Transient Data Interface Module (if applicable) / RAW Data connectivity to CMS / Rack Programming	AR	
			d	Keyphasor & Tachometer Module	01	

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Sl No	PR No	Material Code	Material Desc			PR Qty	PR MU	Price
			e	Proximity Sensor module	07			
			f	Programmable Relay module for min 48 relays with atleast 01 no independent relay module	AR			
			g	RS485 Modbus Communication gateway for DCS dual redundant connectivity	AR			
			h	TSI Display IO Module	AR			
66	8000082334	TC9765342519	TSI RACK-1 consisting of the following items:			1	SET	
			Sl. No.	Module	Qty			
			a	19" Rack	01			
			b	Rack Power Supply, 110VAC, Duplex	01			
			c	Rack Transient Data Interface Module (if applicable) / RAW Data connectivity to CMS / Rack Programming	AR			
			d	Keyphasor & Tachometer Module	01			
			e	Proximity Sensor module	07			
			f	Programmable Relay module for min 48 relays with atleast 01 no independent relay module	AR			
			g	RS485 Modbus Communication gateway for DCS dual redundant connectivity	AR			
			h	TSI Display IO Module	AR			
67	8000082308	TC9765342527	TSI RACK-2 consisting of the following items:			1	SET	
			Sl. No.	Module	Qty			
			a	19" Rack	01			
			b	Rack Power Supply, 110VAC, Duplex	01			
			c	Rack Transient Data Interface Module (if applicable) / RAW Data connectivity to CMS / Rack Programming	AR			
			d	Temperature Monitor module	06			
			e	Programmable Relay module for min 48 relays with atleast 01 no independent relay module	AR			
			f	RS485 Modbus Communication gateway for DCS dual redundant connectivity	AR			
			g	TSI Display IO Module	AR			
68	8000082335	TC9765342527	TSI RACK-2 consisting of the following items:			1	SET	
			Sl. No.	Module	Qty			
			a	19" Rack	01			
			b	Rack Power Supply, 110VAC, Duplex	01			
			c	Rack Transient Data Interface Module (if applicable) / RAW Data	AR			

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Sl No	PR No	Material Code	Material Desc	PR Qty	PR MU	Price
			connectivity to CMS / Rack Programming			
		d	Temperature Monitor module	06		
		e	Programmable Relay module for min 48 relays with atleast 01 no independent relay module	AR		
		f	RS485 Modbus Communication gateway for DCS dual redundant connectivity	AR		
		g	TSI Display IO Module	AR		

B: Commissioning & Training Services:

Sl No	Service Description	Remarks	QTY	Price
I	SERVICE PR FOR NATURAL GAS COMPRESSOR:			
1	Commissioning Assistance for 6 days at site and two visits inclusive of Travel, boarding, lodging, and local conveyance	PR No: 1600014514	Lumpsum	
2	TSI Panel Integration Assistance for 6 days at BHEL / Site and two visits inclusive of Travel, boarding, lodging, and local conveyance	PR No: 1600014515	Lumpsum	
II	SERVICE PR FOR SYNTHESIS GAS COMPRESSOR:			
1	Commissioning Assistance for 6 days at site and two visits inclusive of Travel, boarding, lodging, and local conveyance	PR No: 1600014517	Lumpsum	
2	TSI Panel Integration Assistance for 6 days at BHEL / Site and two visits inclusive of Travel, boarding, lodging, and local conveyance	PR No: 1600014516	Lumpsum	
III	OPTIONAL PRICES (PER-DIEM RATES AND TRAINING):			
3	Per-diem Rates for Commissioning Assistance at site inclusive of Travel, boarding, lodging, and local conveyance.	Optional price	Per-diem	
4	Training for 3 days at site and one visit inclusive of Travel, boarding, lodging, and local conveyance	Optional price	1 set	
5	Per-diem Rates for Training inclusive of Travel, boarding, lodging, and local conveyance.	Optional price	Per-diem	

Total Price for L1 Evaluation (A + B-I-1&2 + B-II-1&2):.....

Notes:

- Vendor shall indicate unit price of all items including TSI Rack breakup of Price Schedule irrespective of RFQ Qty.
- The prices shall be valid for one year from the date of order.
- Any additional requirements which are essential for proper functioning of the control system, however not indicated in this specification shall be explicitly listed and included in the offer by vendor.

VENDOR SEAL & SIGNATURE

SPECIFICATION OF TURBO SUPERVISORY INSTRUMENTATION (TSI) SYSTEM

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1 SCOPE:

The scope of vendor shall cover Engineering, Design, Manufacture, Inspection, packaging, supply, commissioning supervision at site, Training and Documentation of TSI (Turbo supervisory instrumentation / **MMS**) Transducers, TSI Monitoring Rack and accessories. Vendor shall supply all the hardware, software and accessories required for reliable and efficient measurements of various parameters.

2 TECHNICAL REQUIREMENTS:

- a The Engineering, design, manufacture, and supply of Turbo supervisory systems for measurements of different parameters like shaft vibration, axial displacements, bearings housing vibration, Casing expansion, Eccentricity, Key-phasor & Tachometer and bearing metal temperature etc. for continuous monitoring shall be as per the technical details as given in this specification.
- b The turbo-supervisory system and components shall conform to API-670 (Latest edition).
- c Turbo supervisory system shall be provided for continuous monitoring and indication of machine parameters like shaft vibration, Housing vibration, axial displacement, Key-phasor & Tachometer, differential expansion, casing expansion and bearing temperature as per the requirement against respective items.
- d The bill of material furnished by the vendor is for information only, it is the responsibility of the vendor to check the completeness and correct model selection of the bill of material to meet BHEL specification requirements. Any changes or additions to the bill of material offered by the vendor to meet the BHEL specification requirements identified during detailed engineering shall be accommodated by the vendor without any commercial or delivery implications.
- e The selection of models and BOM along with mounting accessories suitable for the application for the entire package is the responsibility of the vendor. Any change in the offered models or requirement of additional items in view of the system requirements identified during detailed engineering shall be supplied by the vendor without any commercial or delivery implications.
- f Vendor shall confirm compliance to this technical specification. Deviation, if any, shall be brought out giving technical reason for the same.
- g If the vendor's standard system is different than the system envisaged, vendor shall clearly bring out the difference giving technical advantages for the offered system. Acceptance of the system offered is entirely at the discretion of BHEL
- h Vendor shall furnish detailed reference list for system similar to the offered system with detail like client's name / address, model no, year of commissioning, type and rating of machines (steam turbine, generator, compressor etc.).
- i Vendor shall furnish the latest EIL approved data sheets of TSI system supplied for any earlier project with the same models offered for this enquiry for reference.
- j Vendor to refer project specific TSI Loop Drawing for TSI system rack arrangement [as specified in project specific input data](#).
- k [The TSI rack, modules, sensors, drivers etc. shall be SIL certified.](#)

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3 TRANSDUCER (PROBE, SENSOR) AND ACCESSORIES:

The transducers (proximity sensors and driver) shall be mounted in the field on the machine in hazardous area classification IEC Zone-1, IIC, T3.

a Proximity Sensor for Vibration, displacement, Zero speed, Eccentricity and Keyphasor & Tachometer: Reverse Mount Type

The sensors shall be Non-contact type sensors with connecting leads and terminal connectors. The sensors shall be capable of operation in an atmosphere of oil fumes. The casing of the sensor shall be made of stainless steel and the measurement shall not be affected by the presence of oil in the air gap. The sensor integral cable and the extension cable shall be insulated to meet the high operating temperature requirement of the respective sensor. The length of the cable from Sensor up to nearest local junction box (JB not in the scope of vendor) shall be equal to 5 meters. The vibration transducer shall be with tip diameter 8mm, reverse mounting type and thread connection 3/8"-24 UNF with 1 meter integral cable and miniature male coaxial connector.

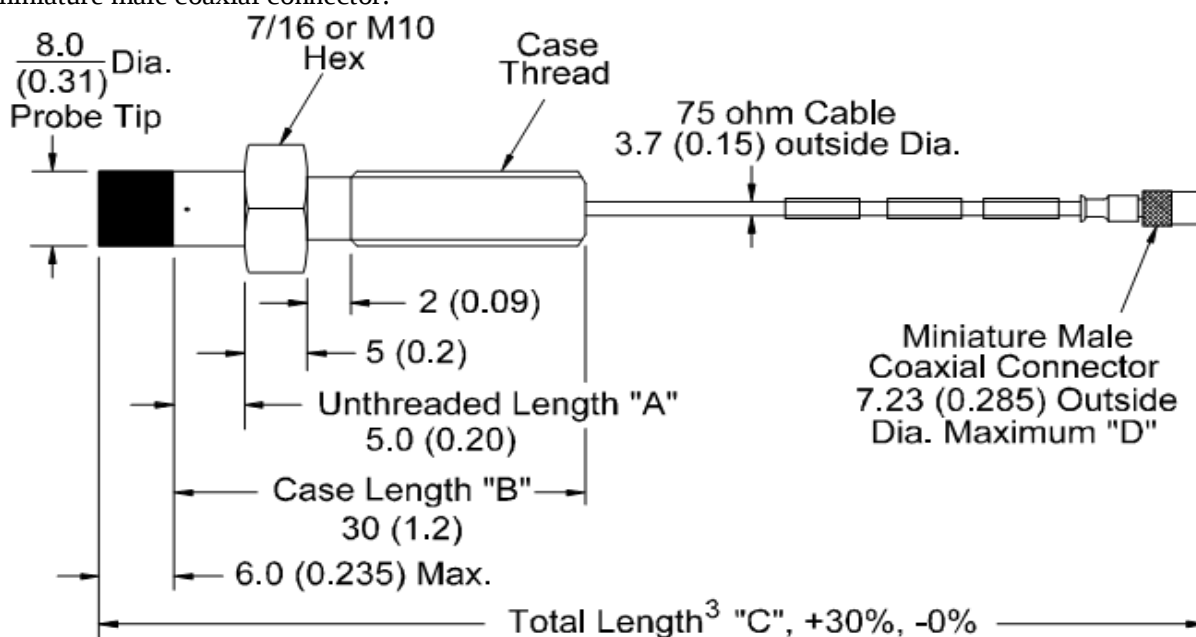


FIG: 3-a: 8 MM REVERSE MOUNT PROBE

Total length "C": 1.0 meter.

Unthreaded length "A": 0mm

Threaded Case length "B": 30mm

Sl No	Parameter	Requirement
i.	Connectors	Gold plated, corrosion resistant
ii.	Environmental Protection	Encapsulated/ Hermetically sealed
iii.	Frequency Range	10 Hz to 10 KHz
iv.	Temperature Range	0 – 177 DegC
v.	Hazardous area approval	Intrinsic safe Exia

b Proximity Sensor for displacement: Standard Mount Type

The transducer shall be same as 3-a above except the transducer shall be standard mounting type, thread connection M10x1. Refer variant table for dimensional details.

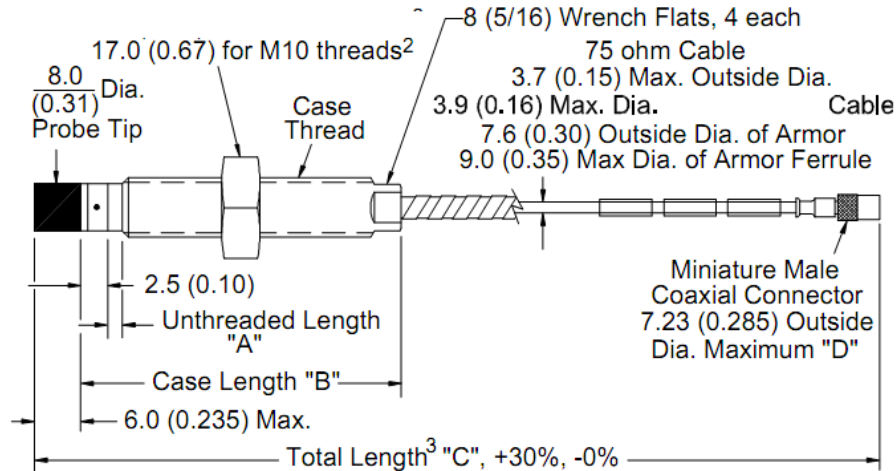


FIG: 3-b: 8 MM STANDARD MOUNT PROBE

Total length "C": 1.0 meter.

Unthreaded length: 0mm

Threaded Case length: 70mm

c Proximity Sensor Extension cable:

The extension cable shall be suitable for respective transducers and total length of 4 meter with suitable connector & protector for connection to the sensor cable on one side and to the driver on the other side. The electrical parameters shall match with the corresponding proximity sensor and proximator / driver.

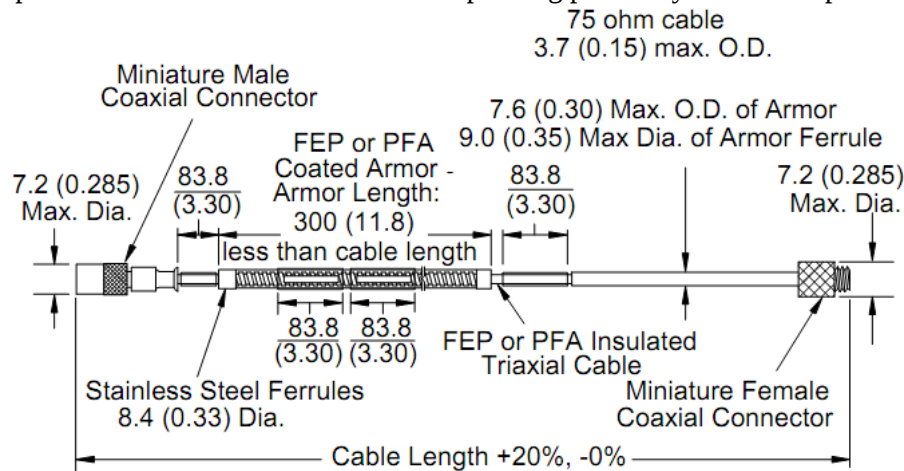


FIG: 3-c: Extension Cable

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d Proximity sensor driver / proximator:

It shall be suitable for total cable length of 5 meter (transducer integral cable of 1 meter plus 4 meter extension cable) and shall be compatible with respective transducers.

Sl No	Parameter	Requirement
i.	Sensor input	Accepts one non contacting 5 mm, 8 mm Proximity sensor and Extension Cable.
ii.	Power	-23 Vdc to -26 Vdc with barriers from TSI rack.
iii.	Supply Sensitivity	Less than 2 mV change in output voltage per volt change in input voltage.
iv.	Mounting	DIN rail or 4 hole (2"x2" apart)
v.	Connectors	Gold plated, corrosion resistant
vi.	Environmental Protection	Encapsulated/ Hermetically sealed
vii.	Hazardous area approval	Intrinsic safe Exia

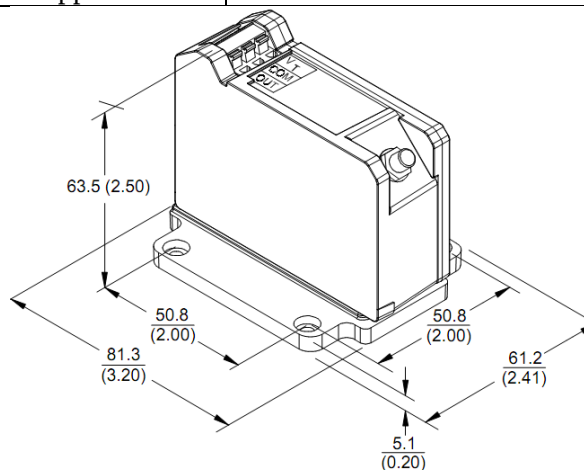


FIG: 3-d: Proximator driver

e Acceleration transducer (Bearing housing vibration):

The seismic probe complete with connecting leads, terminal connectors shall be provided, and the sensors shall meet the following specifications:

The length of the cable from the sensor up to the nearest local junction shall be 5 meters. The sensor integral cable and extension cable shall be insulated and armored meeting the operating temperature requirements.

Sl No	Parameter	Requirement
i.	Connectors	Gold plated, corrosion resistant, with 5 meter connecting cable with connectors
ii.	Environmental Protection	Encapsulated/ Hermetically sealed
iii.	Acceleration range	490 m/s ² (50g) peak overall acceleration within the 1 Hz to 20 kHz frequency span
iv.	Temperature Range	0 to 85 DegC
v.	Hazardous area approval	Intrinsic safe Exia
vi.	Amplitude linearity	±1% to 490 m/ s ² (50 g) peak
vii.	Sensitivity	10.2 mV/m/s ² (100 mV/g) ±5% at 100 Hz

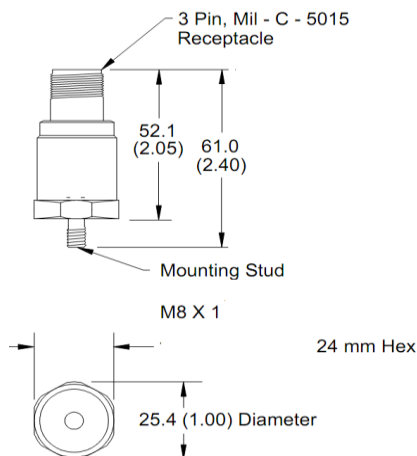


FIG: 3-e: Acceleration Probe

4 **SENSOR FITTINGS AND INSTALLATION ACCESSORIES:**

Vendor shall include all types of fittings, cable seals and accessories required for field installation and protection of sensors, extension cables, probe driver etc.

a **Connector protectors:**

It shall provide the environmental protection and electrical isolation of the connector at the junction where the proximity sensor joins with the extension cable. The connector kit shall include minimum 10 sets of connector protectors.

b **Connector protector kit:**

The kit shall preferably include minimum 10 sets of connector protector, silicon lubricant, tape, easy to use installation tools, instructions and a convenient carrying case.

c **Low pressure cable seal:**

The low pressure cable seal shall be used to exit the transducer cable through a single hole in a machine case. It shall be constructed out of SS & molded silicon rubber grommet to prevent leakage of fluids along the outer jacket of the cable. The seal is threaded on both ends & fits in to a trapped hole on the machine case. External pipe threads shall enable the seal to be mated to conduit or housings. It shall be designed to seal up to 50 psi. The high pressure side and low pressure side thread size shall be 3/4" NPTM. The cable seal shall be supplied with 01 hole full drilled and remaining 03 nos half drilled.

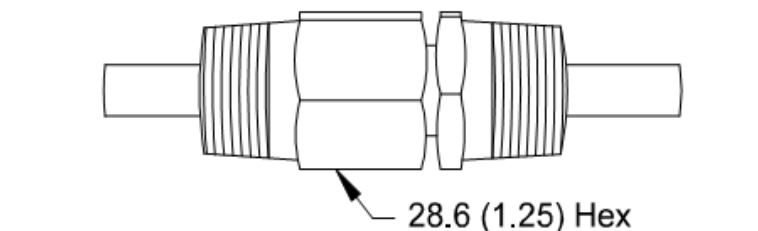


FIG: 4-c: Low Pressure Cable Seal

d **Flexible conduit:**

Flexible conduit (3/4", 30 meters) shall be provided to route the proximity sensor cables safely to the driver housing to protect transducer. It shall consist of galvanized steel core with an extruded thermoplastic cover. The conduit shall be 'Anaconda Sealtite' or equivalent.

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e **Flexible conduit connector:**

The vendor shall supply conduit connectors (3/4" NPT, SS MOC) for connecting the conduit to JB and Machine Housing. **The flexible conduit connector shall be T&B 5333SST or eqv.**

f **Calibration Kit & Calibration Board:**

The calibration kit & Calibration board shall be suitable for performing acceptance testing of all transducers to the performance specifications and to the API 670 standard. Special calibration / Test and configuration equipment with its accessories required, if any, should be indicated & included in the offer. **The calibration kit shall be Bentley Nevada TK3-2E or eqv., powered by 90 to 270 VAC.**

g **Portable Offline Measurement Kit:**

The portable offline measurement kit shall be dual-channel vibration data collector and analyzer. It shall be used for data collection and analysis and shall be suitable for use in hazardous area (IEC Zone-1, IIC). The portable kit shall be supplied with the following as a minimum. **The portable offline measurement kit shall be Bentley Nevada Scout 100 or eqv.**

- i Carry Case.
- ii DC Adaptor.
- iii AC Adaptor.
- iv Vibration sensor Connecting cable (02 nos).
- v Accelerometer (2 nos).
- vi Accelerometer magnetic base (2 nos).
- vii Data Transfer cable.
- viii Reference / Operation Manual.

5 **TSI MONITORS AND TSI MONITORING RACK:**

The electronic modules, to drive the various sensors shall be housed in adequate no of instrument racks / DIN rail mounted. The hardware design shall allow replacement of monitors without isolation / disconnection of the input / output cable connections. Each module shall be provided with LED status for module / channel OK / fault.

The TSI rack shall be completely assembled & pre-programmed to the specified parameters and shall be connected to purchaser supplied common machine diagnostic and health monitoring system (Analysis Package). Necessary hardware, software shall be provided for connectivity to overall machine monitoring and diagnostic system.

a **Monitor rack:**

The entire monitoring system including power supply module shall accommodated in a durable, easy to access, expandable mounting rack. The Rack bezel shall allow to individually identify machine / monitor point or loop number by using the factory engraved bezel number or clear plastics strips provided with the system to hold paper tags. The rack design shall be such that which eliminates the need for internal rack wiring and allows easy expansion to meet increased monitoring requirements. The rack size shall be selected as per project requirement. The rack shall be suitable for flush panel mounting and vendor shall also supply the necessary mounting accessories. Vendor to furnish the dimensional detail for different rack sizes along with the offer.

b **Rack power supply module:**

The power supply module shall be in redundant configuration and shall supply power (from customer supplied UPS supply of 110VAC) for operation for all the modules, field sensors etc. Each power supply module shall be capable for driving the total rack and proximity sensors.

c **Rack transient data interface module / RAW data provision:**

The rack interface module shall be used for interfacing the rack transient data to **common machine diagnostic and health monitoring system (Analysis Package)**. The module shall be provided with Ethernet interface. Alternatively, incase vendor does not have a dedicated transient data interface module, each

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sensor transient RAW data shall be available from the rack for connection to [purchasers common machine diagnostic and health monitoring system \(Analysis Package\)](#).

d Rack keyphasor & tachometer module:

The rack keyphasor module shall be used for interfacing the keyphasor data for proximity sensor module and shall be connected to TWO number of keyphasor sensors, mounted on different rotors. The tachometer function / module shall provide two isolated speed (4-20mA) signals. The tachometer function shall be able to detect rotor zero speed and actuate a corresponding relay in rack relay module. [Incuse vendor does not have a common keyphasor and tachometer module, two separate module shall be provide in the TSI rack, however the sensor signal shall be single only. Vendor shall provide all necessary hardware for connection of the sensors to two different modules. The tachometer module shall have provision of reverse rotation detection. In case it is not inbuilt function of tachometer module, an additional module shall be provided. BHEL shall provide \(upto\) TWO no of proximity sensors \(key phasor probes\) for connection to reverse rotation module.](#)

e Rack Proximity Sensor module:

The rack Proximity Sensor module shall be used for measurement of the Promity Sensor signal from field. The module shall be microprocessor based monitors (Maximum 4 channel per module) with digitally adjustable alert and danger set points for on-line measurement and monitoring of vibration, axial displacement, bearing housing vibration, Casing acceleration, Eccentricity etc. with the following technical requirements. Proximity Sensor module shall meet the following specifications as a minimum:

- i. Continuous two channel monitoring with each channel input from one probe. Readout scale shall read higher of the two sensors.
- ii. Each channel shall have two independent alarm levels one for pre trip alarm and one for each trip, settable continuously over measurement range. Two relay potential free contacts for each pre trip alarm and trip alarm per channel shall be provided.
- iii. LED lamps on monitor front for each channel to indicate pre-trip alarm, trip alarm and circuit not OK conditions.
- iv. Selector switches on monitor front to read vibration/ displacement pre-trip alarm and trip set points for each channel shall be provided.
- v. One number each potential free contacts to be provided for hooking up to DCS for following:
 - System failure (Rack wise or system wise as per manufacturer's standard practice).
 - Power supply OK/Failure.
- vi. Broken sensor failure detection without causing shut down.
- vii. Continuous 4 to 20mA DC isolated output for each channel of measurement shall be provided. The output signal of each channel shall be independent and fault in one channel shall not reflect on other output channels. Each module shall have in built indication to show at least
 - Alarm indication
 - Module healthy / Fault indication
 - Facility to set the measuring range.
- viii. All alarms and related data shall be interfaced to PLC / DCS using serial interface.
- ix. [RAW data provision for all the input sensors.](#)

f Vibration measurement (Relative shaft vibration):

The monitor shall provide radial vibration measurement for rotating machine with two probes at 90 degree apart for each location shall be provided and connected to same monitor. It shall continuously measure and monitor two independent channels of radial vibration accepting inputs from two proximity sensors. The various full scale ranges for the monitor shall be user programmable. Preferably without use of jumper

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pots or dip switch display of gap measurement in voltages or in engineering units shall be possible. The minimum specifications are as follows for various monitor options in addition to clause 5-d above:

- i. Frequency response is user-programmable for 4 to 4000HZ (240 to 240,000 cpm) or 1 to 600 hz (60 to 36,000 cpm);-3dB.
- ii. An output for recorder etc. shall be 4-20 mA, Galvanically isolated. Individual recorder outputs shall be provided for each channel. Monitor output shall remain unaffected for short circuits on recorder outputs.
- iii. One coaxial connector per channel on the front panel and one terminal connection per channel on the rear panel shall be provided for buffered transducer outputs.
- iv. Transducer supply voltages shall be user programmable.
- v. Vibration alert and danger setpoints shall be available for both the channels. The setpoints shall be digitally adjustable from 0 to 100% of fullscale.
- vi. Alarm time delay option shall be programmable for 0 sec to 6 seconds
- vii. Selectable alert reset option (latching / nonlatching).
- viii. Danger relay voting option(OR voting for relay drive/AND voting for relay drive)
- ix. The display meter shall be non-multiplexing vertical bar graph type. Probe gap also shall be indicated.
- x. The following minimum indication shall be provided.
 - **OK:** This will indicate system status.
 - **Alarm:** status indication for alert & danger shall be provided.
- xi. **RAW data provision for all the input sensors.**

g Axial displacement measurement

The Axial displacement / thrust position monitor shall provide early warning of thrust bearing failure. It shall continuously measure and monitor one or two independent channels of axial shaft position relative to the axial clearances within the machine accepting inputs from two-eddy current probes. The various full-scale ranges for the monitor shall be user programmable. The minimum applicable technical specification shall be same indicated in clause 5-d & e above.

h Bearing temperature module:

Temperature Sensors shall be 3-wire / 4-wire RTD PT-100 / **TC-k / TC-j** as per **IEC60752** standard, the monitors shall have broken sensor failure detection without causing shutdown.

- i. In general, bearing temperature shall be measured at the points which are under maximum loading.
- ii. Bearing temperature shall be monitored by means of a (six channel maximum) temperature monitor.
- iii. Continuous six channel maximum monitoring with each channel input from one RTD. Read out scale shall read higher of the six temperatures.
- iv. Each channel shall have two independent alarm levels one for pre-trip alarm and one for trip alarm, settable continuously over measurement range.
- v. Broken sensor failure detection without causing shut down.
- vi. Selector switches on monitor front, to read temperature, pre-trip alarm and trip set points for each channel shall be provided.
- vii. All alarms and related data shall be interfaced to DCS using serial interface.

i Programmable Relay module:

The Relay Module shall provide (min) 16 relay outputs. Each output of the Relay Module shall be independently programmed to perform needed voting logic. Each relay utilized on the Relay Module shall include "Alarm Drive Logic". Programming for the Alarm Drive Logic uses AND and OR logic, and shall use alarming inputs (Alert and Danger statuses), Not OK, or individual PPLs from any monitor channel or any combination of monitor channels in the rack. Users shall program this Alarm Drive using the Rack

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Configuration Software to meet the specific needs of the application. The module shall be provided with status LED for each relay as well as module status. The relay shall be single pole dual throw type.

j **Communication gateway:**

Communication gateway module with redundant RS 485 MODBUS RTU / **TCP** protocol shall be provided with necessary hardware including the cable for redundant serial data communication from TSI rack to DCS. The module shall have facility for daisy chaining another rack. Vendor shall furnish all details like pin configuration details and tag number wise MODBUS address mapping list etc. for interfacing with DCS.

The data via this interface shall include the following on a per channel basis:

- i. Proportional value for each monitored variable as current values and a Fast Trend file
- ii. Proportional value for probe gap voltage (for proximity probe channel)
- iii. Ok status
- iv. Alert and Danger alarm status
- v. Bypass status

The above requirement, if provided in different fashion, shall be elaborated in detail by the vendor

k **Rack Configuration laptop:**

One laptop with required configuration software and hardware for configuration of TSI system including the communication cable between the configuration laptop and TSI rack shall be supplied. Vendor shall provide the hardware latest configuration with operating system compatible with the rack configuration software. Vendor shall supply a copy of back up disk of the laptop OS with all the software installed along with antivirus.

l **Rack Configuration software:**

The rack configuration software shall be used for programming and configuration of TSI rack. The software shall not be license limited for a specific rack (project specific) or number of racks to be programmed / configured. The rack configuration software and final rack configuration shall be supplied as separate software copies.

m **TSI rack System display:**

The System Display shall be suitable for panel mount and shall be designed to meet the requirements of American Petroleum Institute (API) Standard 670. It shall provide local or remote visual indication of all TSI Machinery Protection System information residing in the rack including:

- i. System Event List.
- ii. Alarm Event List.
- iii. All Channel, Monitor, Relay Module, Keyphasor Module or Tachometer Module data.

The display shall be backlit type and shall include Display interface module & power supply if required along with the cable and connectors for connection between the rack and the display.

6 **INSPECTION AND TEST REQUIREMENTS:**

- a Calibration test certificate shall be furnished.
- b Certificate for Explosion proof/ intrinsic safe execution shall be furnished.
- c Materials compliance certificate shall be furnished.
- d Statutory certificates shall be furnished as follows:
 - i. For all intrinsically safe / explosion proof / flameproof equipments / instruments / systems or equipments with any other type of protection allowable as per this package which are manufactured abroad and certified by any statutory authority like BASEEFA, FM, UL, PTB, LCIE etc. should also have the approval of Petroleum And Explosives Safety Organisation (PESO)/ Chief Controller of Explosives (CCE), Nagpur.
 - ii. For all flame proof equipments manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like CMRI/ERTL etc. The equipment shall in addition bear

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- the valid approval from Petroleum and Explosives Safety Organisation (PESO) / Chief Controller of Explosives, Nagpur and a valid BIS license.
- iii. For all intrinsically safe equipment manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like CMRI/ERTL etc. The equipment shall in addition bear the valid approval from Petroleum and Explosives Safety Organisation (PESO)/ Chief Controller of Explosives, Nagpur

7 DOCUMENTATION:

Documentation shall be in three steps, during offer submission as response to BHEL Enquiry stage, drawing approval stage, and during delivery of items stage (as-built). Incomplete data, without title blocks, name of the item, document number, revision number, page number etc. will not be acceptable. Bidder shall be responsible for creating, making and arranging complete documentation as per BHEL requirements at all stages.

- a During Technical offer submission: Two copies of following
 - i. Filled up check list as per clause 17.
 - ii. Catalogues of TSI system and other hardware.
 - iii. Communication interface diagram.
 - iv. GA & Bill of material.
 - v. Deviation list as per “deviation format clause 12 if any.
 - vi. Compliance certificate (duly signed & stamped copy of complete specification).
 - vii. Un-priced price schedule.
 - viii. Reference list (mandatory) as per clause 14 for all the items.
 - ix. Filled in Certificate of logistics support as per clause 15.
 - x. Cable specification for TSI Sensors.
- b Vendor shall visit BHEL office within one week of PO / LOI to collect the project specific information (Tag no's, services, range, etc.) for engineering their drawings/documents.
- c During drawing approval after PO placement: Two copies of the following within 2 week of order placement
 - i. General arrangement
 - ii. Bill of material
 - iii. MODBUS address list for serial communication
 - iv. Wiring diagram.
 - v. Quality plans of individual items.
 - vi. Detailed GA drawing for each item as per PO.
 - vii. Type Test certificates.
- d It is the responsibility of the vendor to review the documents for total compliance with all the BHEL specifications furnished with the inquiry before submitting to BHEL.
- e The data sheets will be forwarded by BHEL to Customer/Consultant for approval, comments if any from Customer/Consultant shall be clarified and revise the data sheets if required by the vendor in line with BHEL specifications furnished with the inquiry.
- f Vendor has to attend technical meeting with Customer/Consultant along with BHEL if required for technical discussions and obtaining approval of documents for the package items.
- g Along with material, final documentation in 6 Copies shall be sent to project site and two numbers of soft copies in USB with the following listed documents. However, one advance copy shall be handed over to BHEL- Engineering for approval before dispatching multiple sets to the project site.

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- i. Packing list.
- ii. All the documents submitted during drawing approval.
- iii. Inspection reports & Test certificates.
- iv. Copy of BHEL Approved documents.
- v. Warrantee certificates.
- vi. Operation & Maintenance manual.
- vii. Erection & commissioning procedure.
- h It is Vendors responsibility for obtaining approvals on drawings/documents from BHEL/Customer within time frame and dispatch material in time to project site office as per purchase order delivery schedule. Further vendor requests for any clarifications or approvals for delivery extensions etc. are not entertained at any stage.
- i Within 15 days after commissioning:
 - i. Final reports giving details of commissioning data, its analysis and recommendations, if any.
 - ii. Vendor shall supply the portion of system engineering document, which requires updating as per commissioning data, and 06 copies of it shall be furnished.

8 **GUARANTEE:**

Vendor shall be responsible for all the items supplied in this package. i.e. vendor shall provide a guarantee certificate for trouble free performance of all the items for 18 months from date of supply. Vendor shall have tie-ups with sub-vendors for providing guarantee & only OEM authorized agency shall handle the warranty period services. If any defect in the material is reported from site the same shall be replaced by vendor at site immediately without any commercial or delivery implications.

9 **PACKING, MARKING & SHIPPING:**

a **PACKING:**

- i. All the items shall be packed in very good quality packing; the packing shall be such that the items should not be damaged during loading, unloading and transportation, the packing shall be suitable for 6 months of outdoor storage from the date of shipment.
- ii. The operation and maintenance manuals of all the items 2 copies shall be included in the packing.
- iii. One copy of the packing list shall be fixed on the packing with suitable protection to with stand loading, unloading, transportation and rain.
- iv. Adequate amount of silica gel or equivalent shall be provided in each box before dispatch for the removal of moisture till installation.
- v. All safety instructions for storage and handling shall be indicated on external surface of each box.

b **PACKING LIST:**

- i. Detailed packing list with description, quantity, tag nos, make and model no. etc. including the list of O&M manuals shall be prepared by vendor and submitted to BHEL before dispatch.
- ii. All the items shall be shipped in a single shipment.
- iii. It is the responsibility of the vendor to check that all the items are dispatched along all the accessories i.e. Cable glands, Mounting brackets, adapters etc. queries if any received from site regarding the ASC system package items shall be clarified by vendor immediately, malfunction or defects of any items reported from site within the guarantee period shall be replaced at site immediately without any commercial or delivery implications.

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- iv. Bidder to consider and include charges for one visit to site as part of the main package as and when informed by BHEL to resolve issues if any reported from site regarding material discrepancy of the ASC system package items.
- v. Each device shall be identified with the following information as a minimum. The information shall be in a permanent form on a stainless steel nameplate and permanently attached to the device/equipment.
 - OEM name or identity
 - Manufacturer's model and /or serial number
 - instrument range
 - Tag no.

10 ERECTION AND COMMISSIONING:

- a The erection of the TSI system shall be by BHEL / Customer. However expert E&C services are required to commission the offered items and Bidder to consider the supervision of E&C services in the offer.
- b Commissioning Assistance for 3 days at site and one visit inclusive of Travel, boarding, lodging, and local conveyance shall be considered.

11 TRAINING:

- a The training shall include configuration, operation and maintenance of the TSI system. The training shall be conducted at site. All requisite training material for the said training shall be provided by the vendor during the training.
- b Optional offer for Training of 5 engineers for 2 days at site and one visit inclusive of Travel, boarding, lodging, and local conveyance shall be indicated in Price Schedule.

12 DEVIATION FORMAT:

Bidder shall submit duly filled deviation format (as given below) along with technical offer, otherwise, it will be presumed that there are no deviations from this specification. Offer without this deviation list will not be evaluated & shall be considered for rejection. If, there are no deviations, bidder shall submit signed copy of this format, mentioning "No Deviations".

Sl.No	Clause No. of Spec	Deviation	Reason for deviation	Deviation category	
				Product / design limitation	Optimization
1					

13 PROVEN TRACK RECORD:

The system being offered as per specification shall have well proven performance record of operating satisfactorily in TWO similar units in a hydrocarbon processing industry for a minimum of 8000 running Hours. The above criteria shall be applicable to main equipment, sub- components as well as brought out items if any. Prototype equipment / instruments or instrument under phase out cycle shall not be offered or supplied. Bidder shall submit necessary supporting documents / past users confirmation supporting to above PTR requirements along with technical offer. Bidder to furnish the PTR details as per clause 14.

14 PROVEN TRACK RECORD FORMAT

- a Name of the Bidder
- b Whether manufacturer & supplier:
- c Whether System Integrator & Supplier:
- d Name of Packager:

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Sl.No	PTR Requirement	Ref-1	Ref-2	Ref-3	Ref-4
1	Description of the items offered: Please add list of MMS items as follows: (Make / Model) 1) Sensor 2) Sensor Cable & Driver 3) MMS Rack with Dual Redundant Power Supply 4) MMS Rack-Proximity card 5) MMS Rack-Temperature card 6) MMS Rack-Key Phasor card, Zero Speed and Speed Measurement / Reverse Rotation. 7) MMS Rack-Communication card 8) MMS Rack Module-Relay Card.				
2	Description of item as manufactured & Supplied/ engineered (identify bidder's scope of work)				
3	Purchaser's name, address, Tel no, Fax no, email and contact person				
4	Date of order placed				
5	Contractual completion date				
6	Actual completion date/ month & year of commissioning				
7	Reasons of delay if any				
8	Details of major break down till date.				

15 CERTIFICATE FOR LOGISTICS SUPPORT:(To be signed by Manufacturer's corporate level signatory on company's letterhead and submitted along with offer)

I, on behalf of M/s _____confirm that the (Name of the Instrument/Equipment) Model No_____ for (name of application: TSI System & TSI Field Instruments) quoted by M/s _____for M/s (BHEL Customer) against M/s BHEL inquiry no _____shall continue to be supported by us. The quoted Items shall not be withdrawn from Indian market in next three (3) years from the date of placement of order as a matter of our corporate policy.

I further confirm that in case of placement of order by M/s BHEL on us, we shall continue to support M/s in providing back-up engineering, maintenance support and spare part support to M/s (BHEL Customer) for a period of ten (10) years from the date of expiry of warranty.

SIGNATURE WITH SEAL

AUTHORISED, SENIOR MANAGEMENT LEVEL SIGNATORY

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16 TENDER EVALUATION CRITERIA

- a The total price for the complete package i.e. Main System, Spares, Supervision of erection & commissioning charges shall be considered for L1 evaluation.
- b Duly signed & stamped un-priced price schedule and unit prices shall be submitted along with technical offer by bidder as a token of concurrence that all items are quoted without which the offer will not be evaluated. For un-priced bid bidder to fill 'Quoted' for each item and submit (refer clause 19 for PRICE SCHEDULE).

17 CHECK LIST:

(TO BE FILLED BY BIDDER AND SUBMITTED ALONG WITH OFFER)

SL. NO.	DESCRIPTION	Vendor confirmation	Comments / Remarks
1	Offer for complete package as per BHEL specification Vendors shall furnish the complete bill of material offered against the respective material codes.		
2	Offer for Spares as per BHEL specification. Vendor shall furnish the bill of material of mandatory spares offered.		
3	Clause wise confirmation / deviation to BHEL specification (as per the deviation format clause 15) included in the offer.		
4	Reference list for TSI System satisfying the Proven track record requirement as per clause no 14 of BHEL specification included in the offer.		
5	Certificate of logistic support as per clause no 15 of BHEL specification included in the offer for TSI System.		
6	Cable specification / datasheet for TSI Sensors (for cable distance indicated in project specific requirement).		
7	Filled in Un-priced Price schedule is included in the technical offer.		

(Signature and stamp of bidder with date)

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18 VARIANT TABLE:

a Variant Table-1:

Var No	Material Description	Ref. Drawing	Material Code
1	Proximity sensor (Vibration / axial measurement, keyphasor, speed), reverse mount, 8mm tip, 1.2" length, 3/8-24 UNF thread	3-a	TC9765342012
2	Proximity sensor (Vibration / axial measurement), Standard mount, 8mm tip, 70mm length, M10x1 thread, , Unarmoured	3-b	TC9765342020
3	Proximity Probe Extension Cable, 4mts, Unarmoured	3-c	TC9765342039
4	Proximity Probe Driver for 5mts system	3-d	TC9765342047
5	Acceleration Sensor, M8x1, with 5mts Cable & Connector	3-e	TC9765342055
6	Acceleration Sensor Cable 5mts with Connector, Armoured	3-e	TC9765342063
7	Connector protectors (10nos per set)		TC9765342071
8	Connector protector Kit (assembly kit with 1 connector protector set)		TC9765342080
9	Low Pressure Cable Seal 3/4"NPTM	4-c	TC9765342098
10	Flexible Conduit 3/4", 30 mts		TC9765342101
11	Flexible Conduit Connector 3/4"		TC9765342110
12	Transducer Calibration Kit		TC9765342128
13	Rack Power Supply, 110VAC, Duplex		TC9765342136
14	Rack Transient Data Interface Module, Ethernet TCP/IP		TC9765342144
15	Keyphasor & Tachometer Module (with reverse rotation function)		TC9765342152
16	Proximity Sensor module		TC9765342160
17	Temperature module		TC9765342179
18	Programmable Relay module		TC9765342187
19	Communication gateway		TC9765342195
20	Rack Configuration laptop		TC9765342209
21	Rack Configuration software		TC9765342217
22	Rack System display		TC9765342225
23	Ethernet to SM Fiber optic Convertor with patch cords & LIU		TC9765342233
24	RS485 Serial to SM Fiber optic Convertor with patch cords & LIU		TC9765342241
25	RS485 Serial Cable, armoured with Connectors		TC9765342250
26	Rack Power Supply, 220VAC, Duplex		TC9765342268
27	Proximity sensor (Keyphasor & tachometer), reverse mount, 8mm tip, 1.2" length, 3/8-24 UNF thread	3-a	TC9765342276
28	Portable Offline Measurement Kit		TC9765342284
29	Proximity sensor (Vibration / axial measurement), Standard mount, 8mm tip, 40mm / 1.6" length, 3/8-24 UNF thread	3-b	TC9765342292
30	Fibre optic cable, 6 fibre, armoured, Orange colour		TC9765342306
31	Fibre optic cable HDPE conduit as per IS-4984 or eqv. IEC standard. Colour shall be orange with black fittings (1" or 3/4 ")		TC9765342314

b Variant Table-2:

Var No	Material Description	Ref. Drawing	Material Code
51 to 99	TSI Rack & Spares as per TC65342-<Variant No.>	Project specific	TC9765342xxx

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RECORD OF REVISIONS

Rev. No.	Date	Revision Details	Revised By	Approved By
00	03.11.15	ISSUE	-----	PSVS
01	30.01.16	Variant 26, 53 & 54 added for 220VAC	RAM	PSVS
02	16.09.16	Revised and new variants added.	RAM	PSVS
03	09.08.17	Updated for IOCL Haldia BS-VI	RAM	PSVS
04	07.05.18	Updated for APL	PG	RAM