Purchase Specification OF Turbine Supervisory System and Analysis & Diagnostic System For Main Turbine ,BFPDT & TDBFP

PROJECT: YADADRI TPS (5X800MW), NALGONDA

CUSTOMER: M/S TSGENCO

CONSULTANT: M/S TCE

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GENERAL INSTRUCTIONS TO BIDDERS:

1.0 ALL REQUIRED DOCUMENTS AGAINST THIS TENDER / SPECIFICATION SHALL BE SUBMITTED IN ENGLISH ONLY.

2.0 Introduction: Bidders are required to offer Turbine Supervisory System (TSS) for Steam Turbine Generator, Analysis & Diagnostic System for Main Turbine, BFPDT &TDBFP.

3.0 In order to accept the Technical offers / proposals from Bidders as per the Section-C &D of this Specification, certain Pre-qualification criteria are required to be met by Bidder.

4.0 Pre-qualification requirements (PQR) are clearly mentioned in Section-B of this Specification. Bidder to read the same carefully and submit the details required for BHEL's acceptance.

5.0 The detailed guidelines for packaging is provided in Annexure-I.

5.1 For vibration monitors, rack etc. being dispatched from OEM (countries other than India to India) packing which is suitable for transportation by Lorry and Storage at site for extended periods up to 24 months shall be used. For this a reference standard ED 490092 Rev 05 clause 3.1.2 is attached. OEMs shall follow this standard at minimum. If any other OEM standard packing is available same shall be submitted to BHEL for review and acceptance as part of Technical offer.

5.2 For items typically from Indian manufacturers packing which is suitable for transportation by Lorry and Storage at site for extended periods up to 24 months shall be used. For this a reference standard ED 490092 Rev 05 clause 3.1.1 is attached. OEMs shall follow this standard at minimum. If any other OEM standard packing is available same shall be submitted to BHEL for review and acceptance as part of Technical offer.

5.3 The packing shall be separate for Mandatory spares & Main items. The main items for each unit of the project shall be packed separately.

6.0 In case Bidder does not include the details or meet the requirements of Pre-qualification requirements, their offer will be summarily rejected and Bidder's Technical offers will not be evaluated.

7.0 Evaluation methodology: BHEL shall initially open Bidder's PQR documents only as per Section-B of this specification for review & acceptance. Only after acceptance of PQR documents, BHEL shall open Bidder's technical offers for evaluation. Commercial bids of only technically accepted and approved Bidders by End users/Customers, shall be considered by BHEL for further processing.

BHEL shall review PQR documents and submit Vendor Credentials of accepted vendors to End User / Customer for their approval and await decision for a maximum of one month from the date of opening of bid. If approval is not received within the above period, BHEL shall treat the offer as "NOT Meeting PQ Criteria" and offer shall be rejected.

8.0 Bidders are required to submit offers as detailed below :

aa. Documents pertaining to Pre-Qualification requirement (Cl. AA of Section B of this Specification) shall be in a Separate folder/cover with reference no. "PS/409/2117/S-B Cl. AA of Section B" marked on it.

bb. Documents pertaining to Pre-Qualification requirement (Cl. BB of Section B of this Specification) shall be in a Separate folder/cover with reference no "PS/409/2117/S-B Cl. BB of Section B" marked on it.

cc. Technical offers/proposals for the Project, whose requirements are mentioned in in sub-sections of Sections-C & D of this specification will be submitted in separate covers with Project name & reference marked on it.

9.0 Whenever required during evaluation of PQR and Technical offers/bids, vendor is required to be present at BHEL Electronic Division, Bangalore, for discussions. Further in the event of order, during approval of the Vendor documents by End users/Customers, Vendor shall accompany BHEL representative for discussions.

10.0 Any change in scope/specification during technical evaluation of the offer will be communicated only to the participating bidders for the tender. Deviations (if any) shall be discussed with only those vendors who quote for this tender.

AA. Pre-Qualification Requirements (PQR) of Bidders for Turbine Supervisory System (TSS) and Analysis & Diagnostic System for Main Turbine, BFPDT & TDBFP, as a part of Offer :

Note: All documents shall be compiled clause wise and submitted with proper tagging in following order.

1.0 Submit Reference List of Projects wherein offered system is supplied & commissioned, along with details of machines & similar measurements and Year of Commissioning of the system. Reference list shall contain name of end user, latest contact email id and contact telephone number.

2.0 Qualifying Criteria:

i. Vendor shall give the list of installations where the systems supplied by them are working satisfactory for last 1 year as on Bid opening date.

ii. Vendor shall have supplied this system (as offered) to minimum 1 no. of 660 MW or bigger (rating) supercritical power plant units. In support of above requirements vendor shall give copies of :

- **Purchase order (un-priced)**
- **Commissioning report**
- **Performance report (for minimum 6 months of satisfactory continuous operation) for the offered system from end-user.**

iii. The vendor shall have adequate after sales support (maintenance, trouble shooting, spares supply etc.) in India.

iv. Bidders who are participating in this tender, for supply and services (such as design & engineering, procurement, erection & construction, commissioning, trial operation etc.) shall be such a manufacturer / service provider who have been in the field of manufacture / these activities, of these items in India/ abroad, which are equal to or superior than this specification in Section – C & D.

Note: Full documentary evidence in support of above claims shall be enclosed in the PQR Offer document by the Vendor. If documents furnished by vendor, with end user contact details provided above, is found invalid, then the offer will be rejected.

3.0 Submit List of Project/s (rating of > or = 660 MW Supercritical Power Plants) for which Erection & Commissioning has been carried out by Subsidiary / Authorized Indian representative for last 1 year & at least for 1 system. Bidder has to submit signed commissioning protocol from the end-user/s, in support of the same.

4.0 Submit duly-filled Source Request Form (SRF), which will be accessible by Bidder from our website "www.bhel.com".

5.0 Vendors who are making offer for this tender shall have authorized representatives in India for support related to Documentation, Erection, Commissioning and any other co-ordination work.

6.0 BHEL shall submit vendor credentials to customer and await customer's approval for one month from the date of PQ bid opening. If approval is not received within above period, BHEL shall treat the offer as "NOT Meeting PQ" criteria and offer shall be rejected.

BB. Along with the documents related to PQR above, following details shall also be included in the Offer:

1.0 Technical literature / Manuals of offered Vibration modules, power supplies & other electronic modules etc.

2.0 Name & registered address of the Indian branch office or Indian representative for support of Erection & Commissioning and after sales service, with Organization chart.

3.0 Details of Manufacturing, testing & inspection facility for information.

4.0 Bidder shall have facility in India for Engineering activities, preparation of Documents, Servicing of offered System, Stocking of Spare & other related Engineering activities. Bidder shall submit these details for information.

5.0 If Bidder is not Original Equipment Manufacturer (OEM), then Bidder to include Authorization letter from OEM for Design, Engineering, Manufacture, Testing, Supply, Erection, Commissioning and Servicing of the offered System. This Authorization letter provided by OEM to Bidder shall indicate the Type and Duration of the agreement. The validity of authorization letter shall be at least upto the end of warrantee period.

<u>Important note:</u> In case Bidder does not submit details mentioned in above clauses or meet the requirements of Pre-qualification requirements, Offers will be summarily rejected and Bidder's Technical offers/proposals will not be evaluated. Please read carefully the General instructions in Section-A of this specifications.

Project Synopsis in brief : TSGENCO – YADADRI TPS (5X800 MW)
Location: VEERLAPALEM VILLAGE, DAMERACHERLA MANDAL, NALGONDA DISTRICT, Telangana- 508207, Dameracherla is the nearest Railway Station and Nalgonda railway station is the nearest well-connected Railway Station. Rajiv Gandhi International Airport of Hyderabad is the nearest international airport.

AA Scope: Vendor shall offer Turbine Supervisory System (TSS) for Turbine-Generator, Exciter and Analysis & Diagnostic (A&D) System for measurements specified in TABLE-1,2&3 of this purchase specification for Yadadri 5x800mw Thermal Power plant. Technical requirements for the above machines are as per **Clause BB** of this Purchase specification. Scope of Supply shall include Engineering, Manufacturing & Testing and Erection & Commissioning activities as per this specification.

This A&D System has been specified in clause 2.0 & 3.0 of Technical Requirement of this specification. Detail of buffered vibration signals is listed in Table-2&3 under Technical Requirement clause BB.

The TSS and A&D System shall be offered separately for each Unit of the Plant.

- Make and model nos. of same type of sensors, monitors racks etc. shall be same for all equipment mentioned in this specification.
- Any change in scope / specification, during technical evaluation of the offers, will be communicated only to the participating bidders for this tender.

BB Technical Requirements:

1.0 Turbine Supervisory System (TSS) :

Measurement required for TSS shall be as per Table-1

TSS system shall generally comply to API-670-5th edition. Any product specific limitations / deviations with respect to API 670 standard, shall be informed by the bidder in their offer.

Vendor shall indicate the IP class to which the sensors are complied. All the sensors shall be provided at least as per following technical details.

1.1 Absolute Bearing Vibration Measurement:

For Turbine & Exciter Bearing *(for bearing 1, 2,3,4,5 & 8 as per annexure-I)*

Parameter Description	**Setting Value**
Sensor Family	(AC) Dynamic Input
Sensor Type	Piezoelectric Accelerometer (standard Version)
Frequency range	2Hz to 5KHz
Sensor sensitivity	100 Pc/g
Dynamic range	0.001g to 400 g peak
Type of sealing for sensor	Hermetically sealed
Operating Temperature	-55 º C to 260º C
Sensor Integral cable	6 meter integral cable protected by flexible stainless steel tube welded to the case
Cable type	The sensor integral shall be Teflon insulated
Conditioner	I/P 100 pC/g, O/P 77µA/mm/s (standard version) to be mounted in Local JB
Sensor Sensitivity Unit	mm/s
Signal Sensitivity	77 µA / mm/s
Filter Type	Broad Band Absolute Bearing Vibration
High Pass Cut-Off Frequency	10 Hz

Low Pass Cut-Off Frequency	500 Hz
Filter Characteristic	24db/Octave
Environmental	Standard
Operating temperature range	0ºC to 85ºC

For Generator Bearing ***(for bearing 6 & 7 as per annexure-I)***

Parameter Description	Setting Value
Sensor Family	(AC) Dynamic Input
Sensor Type	Piezoelectric Accelerometer (ATEX Version)
Frequency range	2Hz to 5KHz
Sensor sensitivity	100 Pc/g
Dynamic range	0.001g to 400 g peak
Type of sealing for sensor	Hermetically sealed
Operating Temperature	-55 º C to 260º C
Sensor Integral cable	6 meter integral cable protected by flexible stainless steel tube welded to the case
Cable type	The sensor integral shall be Teflon insulated
Conditioner	I/P 100 pC/g, O/P 25µA/mm/s (ATEX version) to be mounted in Local JB (with Galvanic separation unit & isolation kit)
Sensor Sensitivity Unit	mm/s
Signal Sensitivity	77 µA / mm/s
Filter Type	Broad Band Absolute Bearing Vibration
High Pass Cut-Off Frequency	10 Hz
Low Pass Cut-Off Frequency	500 Hz
Filter Characteristic	24db/Octave
Environmental	Explosive (Exi)
Operating temperature range	0ºC to 85ºC

1.2 Relative Shaft Vibration Measurement :

For Turbine Bearing (For bearing 1, 2 as per annexure-I)

Parameter Description	Setting Value
Sensor Family	(ADC) Relative Vibration
Sensor Type	Proximity probe (standard version)
Location of the sensor	Inside Bearing casing
Mounting type	Standard Mount
Temperature Range	0ºC to 180ºC
Frequency response	0 Hz to 20 KHz (-3dB)
Target Material	VCL 140 steel
Sensitivity	4mV/µm or better
Sensor Tip Diameter	8 mm
Body Thread size	M10 X 1
Body Length	165 mm
Unthreaded length	80 mm
Sensor Integral cable length	5 meters
Cable Protection	None

Cable type	The sensor integral shall be Teflon insulated
Conditioner	4 mV/ µm (standard version) to be mounted in Local JB
Operating temperature range	0ºC to 85ºC

For Turbine Bearing *(For bearing 3, 4 & 5 as per annexure-I)*

Parameter Description	Setting Value
Sensor Family	(ADC) Relative Vibration
Sensor Type	Proximity probe (standard version)
Location of the sensor	Inside Bearing casing
Mounting type	Reverse Mount
Temperature Range	0ºC to 180ºC
Frequency response	0 Hz to 20 KHz (-3dB)
Target Material	VCL 140 steel
Sensitivity	4mV/µm or better
Sensor Tip Diameter	8 mm
Body Thread size	M10 X 1
Body Length	120 mm
Unthreaded length	35 mm
Sensor Integral cable length	5 meters
Cable Protection	None
Cable type	The sensor integral shall be Teflon insulated
Conditioner	4 mV/ µm (standard version) to be mounted in Local JB
Operating temperature range	0ºC to 85ºC

For Exciter Bearing *(For bearing 8 as per annexure-I)*

Parameter Description	Setting Value
Sensor Family	(ADC) Relative Vibration
Sensor Type	Proximity probe (standard version)
Location of the sensor	Inside Bearing casing
Mounting type	Standard Mount
Temperature Range	0ºC to 180ºC
Frequency response	0 Hz to 20 KHz (-3dB)
Target Material	VCL 140 steel
Sensitivity	4mV/µm or better
Sensor Tip Diameter	8 mm
Body Thread size	M10 X 1
Body Length	72 mm
Unthreaded length	00 mm
Sensor Integral cable length	5 meters
Cable Protection	None
Cable type	The sensor integral shall be Teflon insulated
Conditioner	4 mV/ µm (standard version) to be mounted in Local JB
Operating temperature range	0ºC to 85ºC

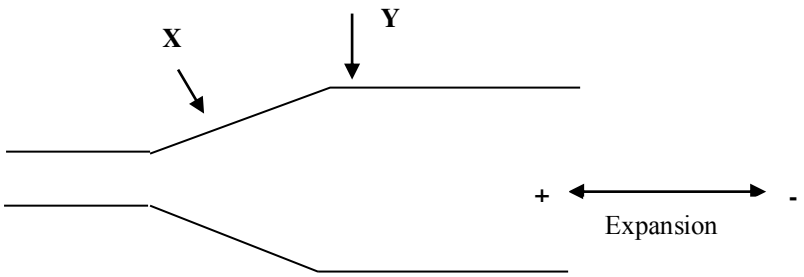
For **Generator Bearing** ***(For bearing 6 & 7 as per annexure-I)***

Parameter Description	Setting Value
Sensor Family	(ADC) Relative Vibration
Sensor Type	Proximity probe (ATEX version)
Location of the sensor	Inside Bearing casing
Mounting type	Standard Mount
Temperature Range	0ºC to 180ºC
Frequency response	0 Hz to 20 KHz (-3dB)
Target Material	VCL 140 steel
Sensitivity	4mV/µm or better
Sensor Tip Diameter	8 mm
Body Thread size	M10 X 1
Body Length	120 mm
Unthreaded length	00 mm
Sensor Integral cable length	5 meters
Cable Protection	Flexible Protection Tube
Cable type	The sensor integral shall be Teflon insulated
Conditioner	4 mV/ µm (ATEX version) to be mounted in Local JB (with Galvanic separation unit and cable feed through M12 x 1.5 double stuffing glands)
Operating temperature range	0ºC to 85ºC

1.3 Rotor Expansion Measurement:

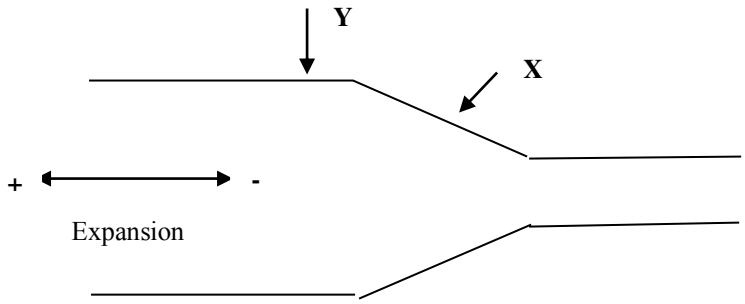
1.3.1 Bearing Before HP Turbine(MAD11)

Parameter Description	Setting Value
Measurement	HP Rotor Expansion
Sensor Family	Relative Vibration (position)
Sensor Type	Proximity probe (standard version)
Location of the sensor	Inside Bearing casing
Mounting type	Standard Mount
Temperature Range	0ºC to 180ºC
Frequency response	0 Hz to 20 KHz (-3dB)
Target Material	VCL 140 steel
Mounting Angle sensor X	5 grad
Mounting Angle sensor Y	0 grad
Sensitivity	4mV/µm or better
Sensor Tip Diameter	8 mm
Body Thread size	M10 X 1
Body Length	72 mm
Unthreaded length	00 mm
Sensor Integral cable length	5 meters
Cable Protection	None
Cable type	The sensor integral shall be Teflon insulated
Conditioner	4 mV/ µm (standard version) to be mounted in Local JB
Operating temperature range	0ºC to 85ºC



1.3.2 Bearing behind Last LP Turbine(MAD15)

Parameter Description	Setting Value
Measurement	LP Rotor Expansion
Sensor Family	Relative Vibration (position)
Sensor Type	Proximity probe (standard version)
Location of the sensor	Inside Bearing casing
Mounting type	Standard Mount
Temperature Range	0ºC to 180ºC
Frequency response	0 Hz to 20 KHz (-3dB)
Target Material	VCL 140 steel
Mounting Angle sensor X	5 grad
Mounting Angle sensor Y	0 grad
Sensitivity	1.33 mV/µm or better
Sensor Tip Diameter	8 mm / 18 mm
Body Thread size	M10 X 1 / M20 X 1.5
Body Length	072 mm / 086mm
Unthreaded length	00 mm
Sensor Integral cable length	5 meters
Cable Protection	None
Cable type	The sensor integral shall be Teflon insulated
Conditioner	1.33 mV/ µm (standard version) to be mounted in Local JB
Operating temperature range	0ºC to 85ºC



1.4 Absolute Casing expansion HPT and LPT:

Parameter Description	Setting Value
Sensor Family	LVDT
Sensor Type	Inductive expansion probe with 6 meter integral cable
Measuring Range	0-50 mm

1.5 Axial Shift :

Parameter Description	Setting Value
Sensor Family	Relative Vibration (Position)
Sensor Type	Proximity probe (standard version)
Location of the sensor	Inside Bearing casing
Mounting type	Standard Mount
Temperature Range	0ºC to 180ºC
Frequency response	0 Hz to 20 KHz (-3dB)
Target Material	VCL 140 steel
Sensitivity	4mV/µm or better
Sensor Tip Diameter	8 mm
Body Thread size	M10 X 1
Body Length	72 mm
Unthreaded length	00 mm
Sensor Integral cable length	5 meters
Cable Protection	None
Cable type	The sensor integral shall be Teflon insulated
Conditioner	4 mV/ µm (standard version) to be mounted in Local JB
Operating temperature range	0ºC to 85ºC

1.6 Reference Phase Measurement (Key Phasor):

Parameter Description	Setting Value
Sensor Family	Relative Vibration (Position)
Sensor Type	Proximity probe (standard version)
Location of the sensor	Inside Bearing casing
Mounting type	Standard Mount
Temperature Range	0ºC to 180ºC
Frequency response	0 Hz to 20 KHz (-3dB)
Target Material	VCL 140 steel
Sensitivity	4mV/µm or better
Sensor Tip Diameter	8 mm
Body Thread size	M10 X 1
Body Length	72 mm
Unthreaded length	00 mm
Sensor Integral cable length	5 meters
Cable Protection	None
Cable type	The sensor integral shall be Teflon insulated
Conditioner	4 mV/ µm (standard version) to be mounted in Local JB
Operating temperature range	0ºC to 85ºC

TABLE-1: LIST OF MEASUREMENT FOR TSS

Sl.No	KKS	Description	Sensor Range	Remark	Comment
1	MAD11CY021	ABS BRG VIBRN PED 1	0-20 mm/s	0- pk	
2	MAD11CY022	ABS BRG VIBRN PED 1	0-20 mm/s	0- pk	
3	MAD11CY023	ABS BRG VIBRN PED 1	0-20 mm/s	0- pk	Option-1
4	MAD11CY041	REL SHAFT VIBRN BRG 1	0-500 μm	pk - pk	
5	MAD11CY042	REL SHAFT VIBRN BRG 1	0-500 μm	pk - pk	
6	MAD12CY021	ABS BRG VIBRN PED 2	0-20 mm/s	0- pk	
7	MAD12CY022	ABS BRG VIBRN PED 2	0-20 mm/s	0- pk	
8	MAD12CY023	ABS BRG VIBRN PED 2	0-20 mm/s	0- pk	Option-1
9	MAD12CY041	REL SHAFT VIBRN BRG 2	0-500 μm	pk - pk	
10	MAD12CY042	REL SHAFT VIBRN BRG 2	0-500 μm	pk - pk	
11	MAD13CY021	ABS BRG VIBRN PED 3	0-20 mm/s	0- pk	
12	MAD13CY022	ABS BRG VIBRN PED 3	0-20 mm/s	0- pk	
13	MAD13CY023	ABS BRG VIBRN PED 3	0-20 mm/s	0- pk	Option-1
14	MAD13CY041	REL SHAFT VIBRN BRG 3	0-500 μm	pk - pk	
15	MAD13CY042	REL SHAFT VIBRN BRG 3	0-500 μm	pk - pk	
16	MAD14CY021	ABS BRG VIBRN PED 4	0-20 mm/s	0- pk	
17	MAD14CY022	ABS BRG VIBRN PED 4	0-20 mm/s	0- pk	
18	MAD14CY023	ABS BRG VIBRN PED 4	0-20 mm/s	0- pk	Option-1
19	MAD14CY041	REL SHAFT VIBRN BRG 4	0-500 μm	pk - pk	
20	MAD14CY042	REL SHAFT VIBRN BRG 4	0-500 μm	pk - pk	
21	MAD15CY021	ABS BRG VIBRN PED 5	0-20 mm/s	0- pk	
22	MAD15CY022	ABS BRG VIBRN PED 5	0-20 mm/s	0- pk	
23	MAD15CY023	ABS BRG VIBRN PED 5	0-20 mm/s	0- pk	Option-1
24	MAD15CY041	REL SHAFT VIBRN BRG 5	0-500 μm	pk - pk	
25	MAD15CY042	REL SHAFT VIBRN BRG 5	0-500 μm	pk - pk	
26	MKD11CY021	ABS BRG VIBRN PED 6 (GEN FRONT)	0-20 mm/s	0- pk	
27	MKD11CY022	ABS BRG VIBRN PED 6 (GEN FRONT)	0-20 mm/s	0- pk	
28	MKD11CY023	ABS BRG VIBRN PED 6 (GEN FRONT)	0-20 mm/s	0- pk	Option-1
29	MKD11CY041	REL SHAFT VIBRN BRG 6 (GEN FRONT)	0-500 μm	pk - pk	
30	MKD11CY042	REL SHAFT VIBRN BRG 6 (GEN FRONT)	0-500 μm	pk - pk	
31	MKD12CY021	ABS BRG VIBRN PED 7 (GEN REAR)	0-20 mm/s	0- pk	
32	MKD12CY022	ABS BRG VIBRN PED 7 (GEN REAR)	0-20 mm/s	0- pk	
33	MKD12CY023	ABS BRG VIBRN PED 7 (GEN REAR)	0-20 mm/s	0- pk	Option-1
34	MKD12CY041	REL SHAFT VIBRN BRG 7 (GEN REAR)	0-500 μm	pk - pk	
35	MKD12CY042	REL SHAFT VIBRN BRG 7 (GEN REAR)	0-500 μm	pk - pk	
36	MKD21CY021	ABS BRG VIBRN PED 8 (EXC REAR)	0-20 mm/s	0- pk	
37	MKD21CY022	ABS BRG VIBRN PED 8 (EXC REAR)	0-20 mm/s	0- pk	
38	MKD21CY023	ABS BRG VIBRN PED 8 (EXC REAR)	0-20 mm/s	0- pk	Option-1
39	MKD21CY041	REL SHAFT VIBRN BRG 8 (EXCREAR)	0-500 μm	pk - pk	
40	MKD21CY042	REL SHAFT VIBRN BRG 8 (EXC REAR)	0-500 μm	pk - pk	
41	MAD11CY001M	ABS SHAFT EXP MEAS BRG1 (HP Rotor)	-5to35mm		
42	MAD11CY001R	ABS SHAFT EXP REF BRG1 (HP Rotor)	-5to35mm		
43	MAD11CY002	ABS CSG EXP BRG 1	–5to 45mm		
44	MAD12CY011	AXIAL SHIFT POSN1 BRG 2	-1.5to1.5mm		
45	MAD12CY012	AXIAL SHIFT POSN2 BRG 2	-1.5to1.5mm		
46	MAD12CY013	AXIAL SHIFT POSN3 BRG 2	-1.5to1.5mm		
47	MAD15CY001M	ABS SHAFT EXP MEAS BRG5 (LP Rotor)	-10to45mm		
48	MAD15CY001R	ABS SHAFT EXP REF BRG5 (LP Rotor)	-10to45mm		
49	MAD15CY002	ABS CSG EXP BRG 5	–5to 45mm		
50	MAD12CY045	KEY PHASOR	0-360deg		

The three signals of Axial Shift measurement shall be connected to three different monitors. Three different cables shall be used for interconnection of these sensors from JB to Panel.
Also three separate relay contacts(COC) shall be given to DCS from three different relay modules building logic for abs. brg vibration(…..21,…22&…23) becomes v.high for any bearing(1 to 8).

1.9 Other items :

1.9.1 Measuring Attachment (Transducer/Driver/Conditioner):
The Measuring Attachment Unit shall be suitable for mounting near the turbine as mentioned in respective sensor above. Driver shall be suitable for mounting on DIN rail.

1.9.2 Local Junction Box :
Not in Vendor scope. Required no of JB shall be supplied by BHEL
.

1.9.3 Electronic Racks:

(i) The Electronic Transmitter modules, to drive the various sensors as detailed in Table-1 above shall be housed in adequate No of Instrument racks. The hardware design shall allow online replacement of monitors without isolation/disconnection of input/output cable connections. The Instrument racks and necessary power supply module shall be installed in a freestanding cabinet supplied by BHEL.

(ii) Power Supply:
The equipment shall work with **240VAC** +/- 10%, 50Hz dual redundant power supply feeder. The Common Power Supply to electronic rack shall be Redundant power supply module in each rack such that on failure of one power supply, the other power supply shall cater to the requirement of the equipment. All the components required to achieve this shall be supplied. Any deviation/ alternate scheme proposed to be clearly brought out in the offer and same is subjected to BHEL acceptance.

(iii) The Microprocessor based Electronic Transmitter modules shall not have more than 4 Channels per module. The Transmitter modules shall receive the sensor signals and give two (2) buffered & one (1) 4 - 20mA signal FOR EACH CHANNEL AND COMPUTATION CHANNEL for hardwired link to DCS

1.9.4 Link to DCS:

All the measured signals and the other Related Parameters shall be hooked up to the DCS and Analysis & Diagnostic OWS through redundant MODBUS TCP/IP link.

1.9.5 The mounting arrangement for sensors shall be supplied by BHEL.

1.9.6 Teflon Insulated stainless steel flexible conduit to be used from sensor to JB routing.

1.9.7 All the signals (Buffered, 4-20 mA, contact, key phasor etc..) coming from field & going to other instruments shall be terminated on cage clamp type terminal blocks.

1.9.8 Cables:

Cables between JB and panels are in scope of BHEL and NOT in vendor scope of supply. **BHEL is providing paired individual and overall shielded cable for the same. If vendor has different requirement, then same shall be included in the offer and supplied.**

1.9.9 Panel:
Not in vendor scope. Panel for housing above racks shall be supplied by BHEL.

1.9.10 Configuration Software:
Any software required for configuration of the system shall be part of offer. Licensed copy of same shall be supplied along with the system.
PC/Laptop of general configuration, if required, to load this configuration software will be provided by BHEL. Any specific requirement may be informed to BHEL along with offer itself. Programing cable required for Configuration shall also be considered and will be part of supply.

Vendor to arrange his own calibration/configuration setup/equipment during Erection and Commissioning of the system.

Vendor shall supply total one number of calibration system for all the 5 units

2.0 Specification of Analysis & Diagnostic(A&D) System:

2.0.1 The system shall acquire & analyze static, dynamic and transient machine data to guide the maintenance engineer and operator to detect fault and take corrective action as required.

2.0.2 The system shall have dual redundant interface with the TSS racks and DDCMIS and monitoring systems to acquire raw data for further analysis and alarms.

2.0.3 The system shall be provided with redundant server/workstation and 24 inch TFT monitor, A3 laser printer and one no. Laptop.

2.0.4 Machine Vibration Analysis server shall be capable of running several software including client software, on single platform and interfacing with multiple machinery protection racks using communication link. Configuration and downloading of programs for different modules shall be executable from this server with at least two levels password protection.

2.0.5 Display features provided in the system shall not be limited to the Graphical plant and machine area presentation with location of sensors and their current value, Bar graph and point display indicating the set points, Multiple Trends - transient and historical including process value for data correlation, Bode / Polar / Nyquist / Cascade plots, Waterfall, Diagnostic of the system and machine data, Spectral band and waveform plotting including Lissajous waveform, Harmonic analysis, Orbit and time base plotting, Shaft centerline plot indicating position of a machine, for Main Turbine & machines listed in Table-2&3 in this specification.

2.0.6 The system shall have capability for Log & Report generation and there shall be provision for beeping icon in case of appearance of alarm.

2.0.7 The Advanced Automated Diagnostic System shall utilize both vibration and process information from the Data Acquisition software plus programmed rules to provide clear analysis and recommendations for effective machinery management. Rule generator shall reject any rule, which is not syntactically correct. It shall be an extensive and accurate knowledge base to enable quick determination of the condition of a machine by providing alarm notification or advisories of the machinery malfunction. It shall also have the capability to send advisories through pagers and e -mails in addition to the RC.

2.0.8 Presence of the frequently occurring machine malfunctions / occurrence to be detected by the system shall be, but not limited to, High synchronous vibration, Misalignment, Unbalance, Shaft bow / crack, Fluid induced instability (Whirl and Whip), Radial pre-load forces (including misalignment), Vector change, Rotor rub, Looseness of rotating parts, Gear mesh problems, pump cavitation, resonance with critical speed etc. for Turbine, measurement specified in Table-1, 2 & 3 in this specification.

2.0.9 Data collected in the system shall also be accessed on the plant wide area network for condition based maintenance.

2.0.10 Bidder shall supply the licensed version of all the applicable software in run & edit mode for the system and for integration of his system with third party system such as DDCMIS & Analysis system. Redundant Bi-directional OPC connectivity with DDCMIS shall be provided.

2.1.0 Specification of Main Server:

a. Intel Xeon /Quad Core Processor, 1.9 GHz (min.) processor
b. Min 2TB hard disc with mirroring type hard disc to ensure data integrity
c. Minimum 2 x 4GB (min.) DDR RAM
d. Combo Drive, DVD R/W 16x or higher,
e. RAID level 5, SAS-channels
f. Master Slave card for Time synchronization in SNTP protocol
g. 4 nos. USB ports. (2nos. on front side)
h. Redundant hot-swappable power supply
i. Network card (2 Nos.),
j. Necessary Cables with accessories for inter connecting and connecting to Redundant Server / TSS panels and DCS Panel/s. Software CDs with License/s.
k. 24" colored TFT/ LCD monitor for each server
l. QWERTY Keyboard,
m. Optical mouse
n. Third party operating system, graphical users interface, Firewall, Anti-spam, Anti-virus & spyware for Gateways.

2.2.0 Specification of Client PC / Redundant Server:

a. Processor: Latest , minimum Intel Core i5; Tower, 3.2 GHz (min.), 32 bit
b. Video Card: PCI
c. Hard drive: 500 GB SATA; Cache : 512 KB Level 2
d. RAM: 4 GB (Minimum) DDR
e. CD&DVD - Both Read & Write
f. Operating system: Latest , Window
g. Graphic accelerator: 8MB (min.)
h. Communication ports: 2nos. (min.) Ethernet ports (1000 MB).
i. 4 nos. USB ports (min.)
j. Necessary Cables with accessories for inter connecting and connecting to Main Server / TSS panels and DCS Panel/s. Software CDs with License/s.
k. 24" colored TFT/ LCD monitor for each server
l. QWERTY Keyboard,
m. Optical mouse
n. Firewall, Anti-spam, Anti-virus & spyware for Gateways.

2.3.0 Specification of Printer:

a. Type : Laser jet, tabletop, network ready
b. Printer Memory : 256 MB (min.)
c. Speed : Color 6 ppm - A3
d. Resolution : 1200 x 1200 DPI in color
e. No. of color (Basic) : 4 (four) minimum
f. Power supply : 240 V, 50 Hz, 1 phase
g. Ambient temperature : 0-50 Deg C
h. Humidity : 95% non-condensing
i. Size of paper: Letter, A4, Legal, Ledger, A3
j. Print media: Plain paper, transparencies, thick stock, glossy stock, envelopes
k. Accessories: Adapters, Connector Cable, Multiplexer switch (4 point)

2.4.0 Specification of Managed Ethernet Switches:

a. Data highway shall be of high speed Ethernet and full duplex configuration. Network shall be built on the Managed Ethernet switches for better control of data traffic & performance and future expansion. Switch configuration shall be redundant with seamless changeover without any upset in the process or equipment. Failure reporting shall be available at HMI. MTBF of the switch shall be more than 20 Years. Configuration shall be automatic.
b. All Ethernet switches to be used in the plant shall be of same type and shall conform the specification requirements.
c. All managed switches shall work in IEC-61850-3 protocol environment and shall support IEC-62439 standard ring redundancy topology (MRP) and also fast MRP.

It shall also support IEC-62439-3 standard PRP& HSR technology with 0 ms recovery time and also support IEC-61850 switch (RSP & MSP switches)

d. Switch shall have the capacity for maximum of 4 Giga bit fiber port and 24 fast Ethernet port.
e. Switch shall act as IGMP-querier and minimum 2 alarm contacts shall be available
f. It shall have High MTBF value
g. It shall support ACA adaptor for reconfiguration of the switch in case of failure to reduce MTTR value to less than one minute and shall have minimum of 4 fibre and 4 copper din rail switch RSPL.

2.5.0 Specification of Laptop:

a. Processor: i7 or latest.
b. Hard Disk: 2 TB
c. RAM: 16 GB DDR 3
d. Screen: 15 inch with touch.
e. Wifi: 802.11 ac OR higher.
f. Wifi model: Intel Centrino Wireless - AC 3160.
g. Blue tooth: 4
h. USB ports: 3
i. Hard Drive Speed: 5400 pm
j. Graphics Card: Intel HD Graphics 4400
k. Operating System: Windows 10 and Office 10 or latest versions.
l. Software: Acrobat Reader Professional 10, AUTOCAD 10 or latest versions.
m. Antivirus: Licensed for 4 years

Vendor shall offer required redundant networking components for Analysis & Diagnostic System.

3.0 Indigenous / Bought-out items shall be from following sub-vendors:

SN	ITEM	SUPPLIER	PLACE
1	NETWORKING COMPONENTS/ ETHERNET SWITCH	M/S GARRET	USA
		M/S HIRSCHMANN	GERMANY
		NETGEAR MAKE	
		BROCADE (FOUNDARY	
		CISCO MAKE	
		ALLIED TELESYN MAKE	
		M/S D LINK	GOA
		M/S JUNIPER	USA
2	SERVER / CLIENT PC / LAPTOP	DELL	
		HP	
		IBM-LENOVO	
3	TFT MONITOR	DELL	
		IBM-LENOVO	
		SAMSUNG	
		HP	
4	PRINTER	CANON	
		HP	
		IBM	
		XEROX	
		LEXMARK	

TABLE-2: Buffered Vibration Signal List of Turbine Drive BFP (TDBFP) per Unit, for Analysis & Diagnostic System (Option-2)

Sl. No.	Machine	Machine Qty./ Unit	Installation (Horz/ Vert)	Machine RPM	Measuring Parameter	No. of Brg. for mtrng. vibration	Vib.Alarm Level (mm/sec-RMS)	Vib .Trip Level (mm/sec-RMS)	No of Vibration Sensors/ Unit	No. of Phase Marker/ Unit
1	Boiler Feed Pump - BFP (2xTDBFP)	2	Horz	800-6500	Relative Shaft Vib.	2	90µm P-P	150µm P-P	8	2
					Absolute Brg. Vib.	2	11.0	18.0	8	
2	Booster Pump	2	Horz	1495	Relative Shaft Vib.	2	90µm P-P	150µm P-P	8	2
	TOTAL PER UNIT	4							24	4

Note: 1) KKS Tag Nos. for transducers will be provided during detailed Engineering.

TABLE-3: Buffered Vibration Signal List of BFP Drive Turbine (BFPDT) per Unit, for Analysis & Diagnostic System

Sl. No.	Tag No.	Signal Description	Sensor Range
		BFPDT-A	
1	XKD14CY042A	GEAR BOX LSS (RJB) RELATIVE SHAFT VIBRATION	0-200 µm
2	XKD14CY042B	GEAR BOX LSS (RJB) RELATIVE SHAFT VIBRATION	0-200 µm
3	XKD11CY041A	GEAR BOX HSS (FJB) RELATIVE SHAFT VIBRATION	0-200 µm
4	XKD11CY041B	GEAR BOX HSS (FJB) RELATIVE SHAFT VIBRATION	0-200 µm
5	XAD12CY041A	TURBINE F.J.B. VIBRATION	0-200 µm
6	XAD12CY041B	TURBINE F.J.B. VIBRATION	0-200 µm
7	XAD11CY042A	TURBINE R.J.B. VIBRATION	0-200 µm
8	XAD11CY042B	TURBINE R.J.B. VIBRATION	0-200 µm
9	XYA12CY021A	FRONT BRG. HOUSING VIBRATION	0-25 mm/s
10	XYA12CY021B	FRONT BRG. HOUSING VIBRATION	0-25 mm/s
11	XAD11CY021A	REAR BRG. HOUSING VIBRATION	0-25 mm/s
12	XAD11CY021B	REAR BRG. HOUSING VIBRATION	0-25 mm/s
13	XAD12CY021	TURBINE KEYPHASER	0-360deg
14	XKD14CY021	GEAR BOX KEYPHASER	0-360deg
		BFPDT-B	
15	XKD24CY042A	GEAR BOX LSS (RJB) RELATIVE SHAFT VIBRATION	0-200 µm
16	XKD24CY042B	GEAR BOX LSS (RJB) RELATIVE SHAFT VIBRATION	0-200 µm
17	XKD21CY041A	GEAR BOX HSS (FJB) RELATIVE SHAFT VIBRATION	0-200 µm
18	XKD21CY041B	GEAR BOX HSS (FJB) RELATIVE SHAFT VIBRATION	0-200 µm
19	XAD22CY041A	TURBINE F.J.B. VIBRATION	0-200 µm
20	XAD22CY041B	TURBINE F.J.B. VIBRATION	0-200 µm
21	XAD21CY042A	TURBINE R.J.B. VIBRATION	0-200 µm
22	XAD21CY042B	TURBINE R.J.B. VIBRATION	0-200 µm
23	XYA22CY021A	FRONT BRG. HOUSING VIBRATION	0-25 mm/s
24	XYA22CY021B	FRONT BRG. HOUSING VIBRATION	0-25 mm/s
25	XAD21CY021A	REAR BRG. HOUSING VIBRATION	0-25 mm/s
26	XAD21CY021B	REAR BRG. HOUSING VIBRATION	0-25 mm/s
27	XAD22CY021	TURBINE KEYPHASER	0-360deg
28	XKD24CY021	GEAR BOX KEYPHASER	0-360deg

4.0 Installed Spares:

i. 10% spare channel shall be provided in each type of input / output unit.
ii. 10% hot spare for each type of I/O modules (installed) shall be provided fully wired unto the marshalling/ termination TBs.
iii. 10% Usable Space in each of System Cabinet for mounting Electronic Modules shall shall be provided for future use.

5.0 Mandatory spares (OPTION-3):

Mandatory spares to be considered on total supplied quantity for **per unit** as follows:

a) Vibration pickups with extension cable: 10% of total quantity for each type & range or Minimum 4 nos whichever is higher.
b) Vibration pickups drivers/proximiters: 10% of total quantity for each type & range or Minimum 4 nos whichever is higher.
c) Axial shift probes: 1 no each for each type.
d) Power supply modules: 10% of total quantity for each rating or Minimum 2 nos whichever is higher.
e) Vibration Monitor: 10% of total quantity for each rating or Minimum 2 nos whichever is higher.
f) Interface cards and all other electronic cards: 10% of total quantity or Minimum 2 nos whichever is higher.
g) Alarm/Trip Relay modules: 10% of total quantity or Minimum 2 nos whichever is higher.
h) Any other system specific module/cards used in system: 10% of total quantity or Minimum 1 no whichever is higher for each type and model.

Note: **Total quantity (for all 5 units) of mandatory spares supplied shall be double of above quantity.**

6.0 Quality Requirements (TSS) :

6.1 Following minimum test requirements to be met :

- Calibration report of Sensors for the selected / approved Range with curves shall be furnished.
- For Vibration Sensors, Frequency response curves and for Proximity probes, Gap v/s voltage data to be furnished. Sample reports shall be included as a part of Quality plan.
- Calibration of Monitors for the approved Range shall be submitted.

The above documents shall form part of Acceptance documentation.

6.2 TESTING & INSPECTION:

The equipment covered under this specification shall be subject to vendor's Quality Plan to be approved by Customer/End user before start of manufacture. To ensure that quality is in-built in each equipment the Quality Assurance System manual & Quality Plan indicating the system followed by the vendor shall be submitted to purchaser for his review.

The vendor shall furnish relevant test result and test certificates to the purchaser for his review who will then issue Material Dispatch Clearance Certificate (MDCC) enabling supplier to dispatch the equipment.

7.0 Documents:

- All documentation shall be in **English language**.
- Following documents shall be supplied along with offer.

a) Configuration diagram of the system offered.
b) Specification / data sheets of various devices offered.

c) Vendor to submit separate deviation sheet along with offer, clearly indicating the specification clauses, specification requirement and the deviation taken. Even if there is No Deviation from the specification. This sheet need to be submitted with indication "**NO DEVIATION".**

- After award of contract, following documentation in no. of copies as mentioned below shall be supplied.

a) Quality plan

b) Storage instruction

c) Configuration diagram
& Machine train diagram
d) Mounting details for sensors

e) Wiring and cabling diagrams for
Cabinets & other devices
BOM, GA drawing & Rack layout drg
Loop scheme and cable schedule
Mounting blocks and JB Drawings
Datasheet and technical literatures

} 2 copies, within 2 weeks of Placements of P.O .

f) Test certificate & test results
g) Calibration results for sensors
h) Test results for Cables
i) Type test results

} 2 copies After completion of tests

j) Operation & maintenance
Manual for the system
Including wiring diagram,
Circuit diagrams, Sensor
Details, etc.

} 2 copies along with the equipment +
1 copy to BHEL

Also one set of soft copy on CD ROM for all the datasheet/drawings/test reports are to be furnished to BHEL after placement of Purchase order.
The drawings under (a),(c),(d),(e),(f) & (i) will be for approval & others are for information & records.

8.0 Training :

Vendor shall provide necessary training on the operation & application to BHEL / End-User. The training shall cover the basic aspects of Vibration monitoring, details of the System supplied, Analysis method, Operation and Maintenance etc. Training shall be provided at vendor's works/Training center

9.0 Warranty: Warranty shall be as per general terms & conditions of the contract.

Vendor to note that any item / services required to complete the Equipment to meet the specification requirement shall be taken cate without any cost implication to BHEL.

10.0 Erection & Commissioning (E & C):

10.1 Turbo Supervisory System (TSS) portion:

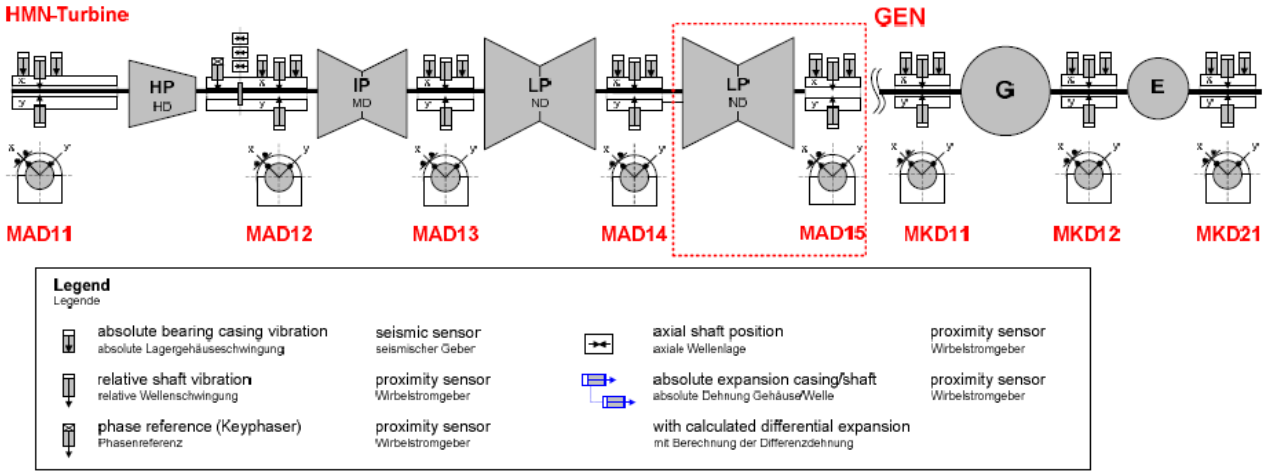
10.1.1 Vendor shall give a separate offer for supervision of erection and commissioning of the complete Turbine Supervisory system covered in this specification.

10.1.2 The total responsibility of commissioning of TSS system and supervision of erection lies with Vendor. Important events are listed below

Sl.No	Activity	Responsibility
1	Collection of material from stores	By BHEL
2	Preparation of mounting surface and mounting arrangement to suit the surface of the machine	By BHEL
3	Mounting of Sensors on the Machine/s	By Vendor
4	Mounting of local JB's	By BHEL
5	Laying and Termination of cables between sensors to local JB.	By Vendor
6	Laying of Instrumentation cable between Local JB and Cabinet	By BHEL
7	Laying of Power cable to TSS Panel	By BHEL
8	Termination of instrumentation cables between local JB's to cabinet	By BHEL
9	Termination of Ethernet cable between cabinet and PC (as applicable)	By BHEL
10	Laying & Termination of FO cables (as applicable).	By BHEL
11	Carrying out pre-commissioning checks, energizing Cabinets & PC (as applicable)	By Vendor
12	Commissioning of individual services	By Vendor
13	Installing various software packages on PC & establishing the operation (as applicable)	By Vendor
14	Checking for all functions of hardware and software when the plant is totally commissioned with all auxiliaries	By Vendor
15	Handing over the system to End-User.	By Vendor
16	Training the operation personnel on operation and maintenance aspects	By Vendor
17	**Relevant documentation for commissioning of this system in line with specification requirement.. Such as signed protocol with end user to be furnished along with calibration data**.	By Vendor

Note: Limitation of number of days / visit for Supervision of Erection, Commissioning activities is not acceptable.

ANNEXURE-1


HMN-Turbine
GEN
HP
HD
IP
MD
LP
ND
LP
ND
G
E
MAD11
MAD12
MAD13
MAD14
MAD15
MKD11
MKD12
MKD21
Legend
Legende
absolute bearing casing vibration
absolute Lagergehäuseschwingung
seismic sensor
seismischer Geber
axial shaft position
axiale Wellenlage
proximity sensor
Wirbelstromgeber
relative shaft vibration
relative Wellenschwingung
proximity sensor
Wirbelstromgeber
absolute expansion casing/shaft
absolute Dehnung Gehäuse/Welle
proximity sensor
Wirbelstromgeber
phase reference (Keyphaser)
Phasenreferenz
proximity sensor
Wirbelstromgeber
with calculated differential expansion
mit Berechnung der Differenzdehnung

TITLE:	TECHNICAL SPECIFICATION FOR TURBO SUPERVISORY INSTRUMENTATION (TSI) SYSTEM FOR BFP DRIVING TURBINE & TURBINE DRIVEN BOILER FEED PUMPS

1. SCOPE:

The scope of bidder shall cover Engineering, Design, Manufacture, Inspection, Packaging, Supply, Erection and commissioning at site, Training and Documentation of TSI (Turbo Supervisory Instrumentation System / Machine monitoring system) including Transducers, TSI Monitoring Rack and mounting Accessories for BFP drive Turbine in utility power plant application**.** It is the responsibility of the bidder to Engineer the system in completeness and consider all the hardware, software and accessories required for reliable and efficient measurements of various parameters as per specification.

2. TECHNICAL REQUIREMENTS FOR TSI OF BFPDT (OPTION-4)

a) The Engineering, design, manufacture, and supply of latest models of turbo supervisory instrumentation systems for measurements of different parameters like shaft vibration, axial displacement, bearing housing vibration, Casing expansion, Differential expansion, Eccentricity, Key-phasor and zero speed etc. for continuous monitoring shall be as per the technical details as given in this specification.

b) The turbo-supervisory instrumentation system offered and components shall conform to API-670 (Current edition).

c) TSI system shall be provided for continuous monitoring and indication of machine parameters like Shaft Vibration, Axial displacement, Bearing housing vibration, Casing expansion, Differential expansion, Eccentricity, Key-phasor, Zero speed as per the requirement against respective items.

d) The bill of material furnished by the bidder is for information only, it is the responsibility of the bidder 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 bidder to meet the BHEL specification requirements identified during detailed engineering shall be accommodated by the bidder without any commercial or delivery implications.

e) Any special connectors required for TSI probes, extension cables, drivers, driver housings and monitors at any stage till erection and commissioning of supplied TSI system shall be considered in the scope of bidder and offer the same. It is the responsibility of bidder to include the option of special connector in the model number of respective item if applicable.

2.1.0 TRANSDUCER AND ACCESSORIES:

Quantity per BFPDT & Ranges for the respective measurements shall be as per the below Table:

Sl.No	Tag/KKS	Description	Range	Quantity
01	XAD12CY041A,41B XAD11CY042A,42B	Rel. shaft Vibration	0 to 200micron	4
02	XAD12CY021A	Keyphasor for BFPDT	Pulse	1
03	XAD11CY021	Eccentricity	0 to 200micron	1
04	XAD12CY032	Zero speed for BFPDT	0 to 500mm	1
05	XAD12CY031A,31B,31C	Axial Displacement for BFPDT	-1 to +1mm	3
06	XAD11CY011	Diff. Expansion for BFPDT	-5 to +5 mm	1
07	XAD12CY021	Casing Expansion for BFPDT	0 to 25mm	1
08	XYA12CY021A,21B XAD11CY021A,21B	Bearing Housing Vibration	0 to 25mm/sec	4
09	XKD14CY042A,42B XKD11CY041A,41B	GB shaft vibration probe with Housing	0 to 200micron	4
10	XKD14CY021	GB shaft Key Phasor probe with Housing	Pulse	1
11	XKD13CY031A,31B	BFPDT-A GEAR BOX LSS AXIAL DISPLACEMENT	-1 to +1mm	2
		BFPDT-A GEAR BOX LSS AXIAL DISPL SENSOR **LOOSE**	-1 to +1mm	1

Above measurements are indicated for one BFPDT(A) and Vendor shall offer for two BFPDT(A&B) for one Unit. Tag Nos. for BFPDT-B area key: XKD/XAD11 to be replaced by XKD/XAD21 , XKD/XAD/XYA12 to be replaced by XKD/XAD/XYA22 , XKD13 to be replaced by XKD23 and XKD14 to be replaced by XKD24

2.1.1 <u>Vibration, Zero speed, Eccentricity and Key-phasor transducer:</u>

The sensors shall be Non-contact type sensors with connecting leads and terminal connectors. The sensors shall meet at least the following specifications:

- Location of the Sensor : Inside Bearing Casing
- Temp. Range : 0 – 177 Deg C
- Environmental protection : Encapsulated/ hermetically sealed.
- Frequency Range : **0** Hz to 10 KHz
- Sensitivity : 8mV/um or better
- Sensor integral Cable : 1meter

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 also included in the scope of vendor) shall be equal to 5 meters.

The vibration transducer shall be with tip diameter 8mm, reverse mounting type, thread connection 3/8”-24 UNF with 1 meter integral cable and miniature male coaxial connector with armour. The probe shall be used for measurement of relative shaft vibration, Key-phasor and eccentricity.
Figure 2.1.1 below gives the typical dimensional details of the transducer.

Total length "C": **1.0 meter**.
Unthreaded length "A": **0mm**
Threaded Case length "B" : **30mm**

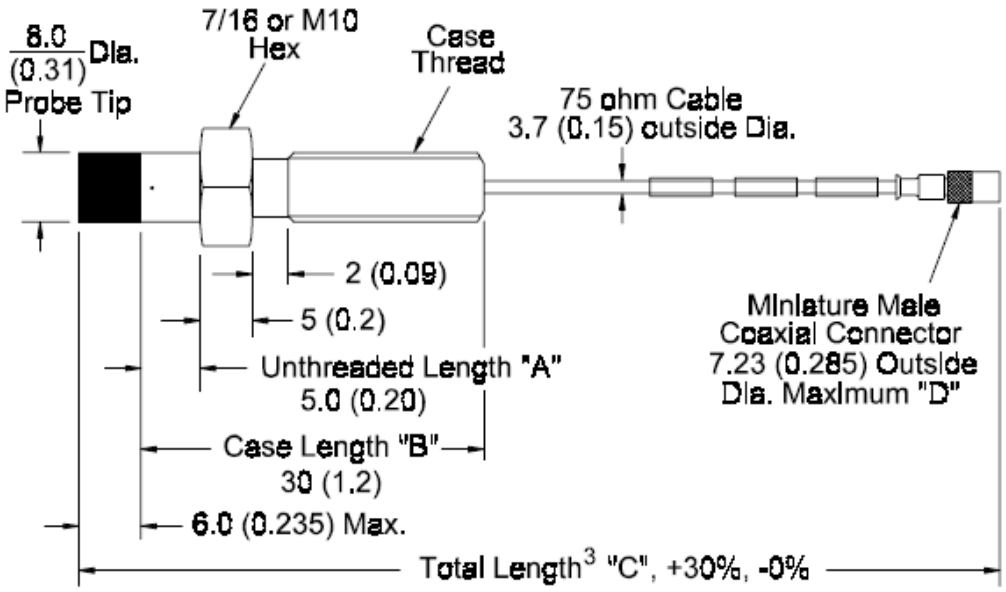


FIG: 2.1.1: 8MM REVERSE MOUNT PROBE

2.1.2 <u>Axial displacement transducer:</u>

Type	:	Non-contact
Temp Range	:	0 - 177^0 C
Environmental Protection	:	Encapsulated
Location of the sensor	:	Inside the bearing casing.
Sensitivity	:	4mV/um or better
Sensor integral Cable	:	1meter

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 and armoured to meet the high operating temperature requirement of the respective sensor.

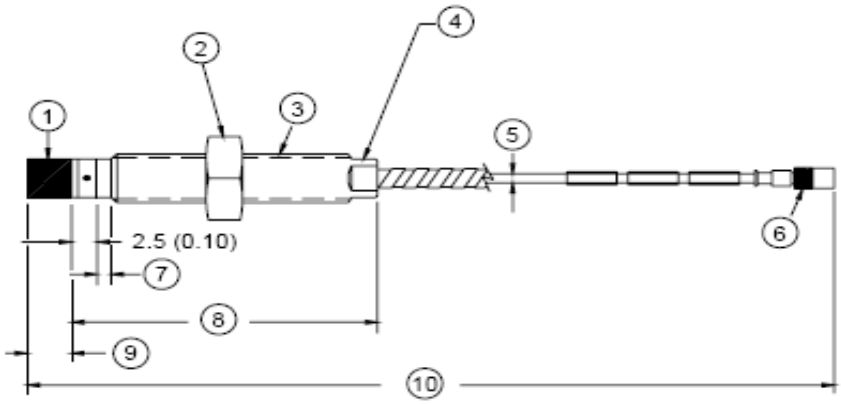
The axial displacement transducer shall be with tip diameter 8 mm, standard mounting type, thread connection M10x1.0 with 1 meter integral armoured cable and miniature male coaxial connector, with armor. The probe shall be used for measurement of axial displacement.

Figure 2.1.2 below gives the typical dimensional details of the axial displacement transducer

Unthreaded length: **0mm**

Threaded Case length: **30mm**

Total length: **1.0 meter Un-Armored**.



1. Probe tip, 8.0 mm (0.31 in) diameter
2. 9/16 in for 3/8-24 threads, M17 for M10 threads (see Note 2)
3. Case thread
4. 5/16 in wrench flats for 3/8-24 threads; 8mm wrench flats for M10 threads.
5. 75Ω cable, 3.68 mm (0.145 in) maximum outside diameter, 3.94 mm (0.155 in) maximum outside diameter for FluidLoc cable, 7.67 mm (0.302 in) outside diameter of armor, 9.5 mm (0.38 in) maximum diameter of armor ferrule
6. Miniature male coaxial connector, 7.24 mm (0.285 in) maximum outside diameter "D"
7. Unthreaded length "A"
8. Case length "B"
9. 6.0 mm (0.235 in) maximum
10. Total length "C", +30%, -0% (see Note 3)

FIG: 2.1.2: 8 MM STANDARD MOUNT AXIAL PROBE

2.1.3 Proximity probe housing assemblies for Gear box shaft vibration:

All the specifications as per clause 2.1.1 above are applicable; in addition the sensor shall be supplied with housing assembly.

Figure 2.1.3 below gives the typical dimensional details probe housing assembly
Probe: 8mm probe
Integral cable length: 1.0 meter.
C: 0 mm
D: 12.6 Inches
F: 3/4 -14 NPT

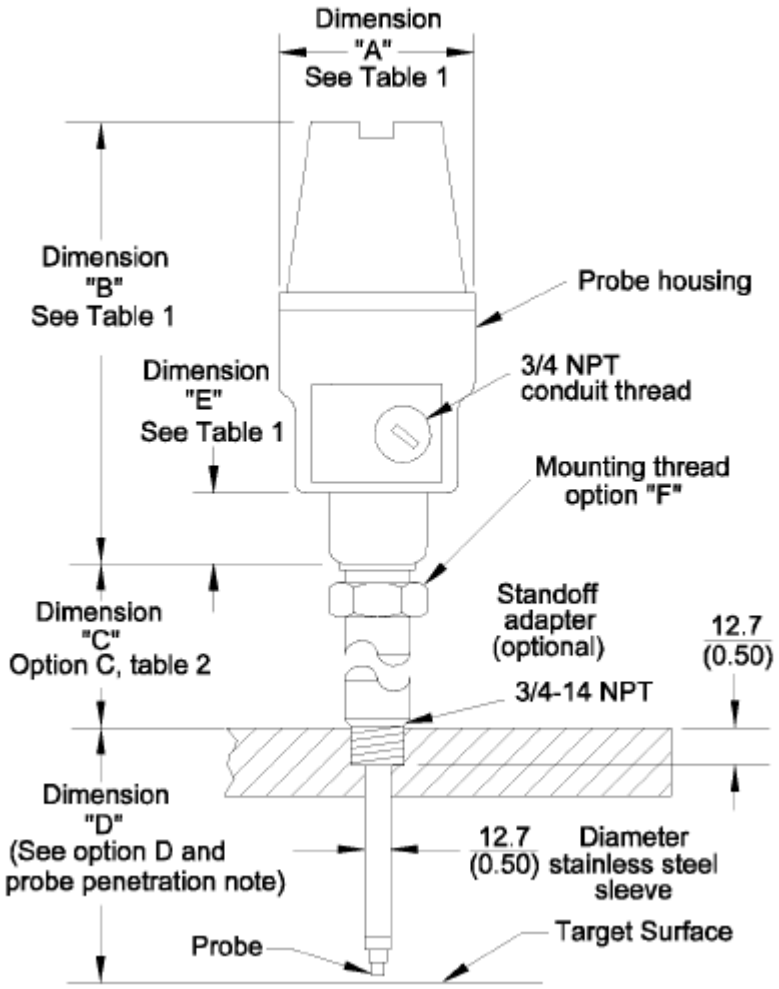


FIG: 2.1.3: PROBE HOUSING ASSEMBLY

2.1.4 Velocity transducer (Bearing housing vibration):

The seismic/velocity probe complete with connecting leads, terminal connectors are to be provided, and the sensors shall meet at least the following specifications:

Frequency range: 5 Hz to 5 KHz
Operating temperature: 0 to 85 Deg C
Environmental protection: Hermetically sealed
Sensitivity: 100mV /Inch/Sec, +/- 5%

The mounting Brackets/Pads required to fix these sensors on the bearings are also to be included in the offer. The length of the cable from the sensor up to the nearest local junction box (JB also included in the scope of vendor) shall be 5 meters. The sensor integral cable and extension cable shall be insulated and armoured meeting the operating temperature requirements.

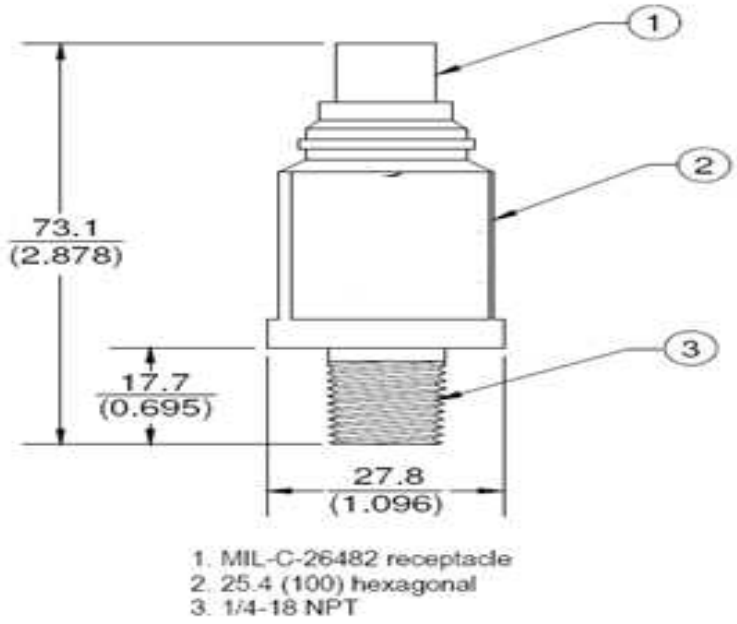


FIG: 2.1.4a: VELOCITY PROBE

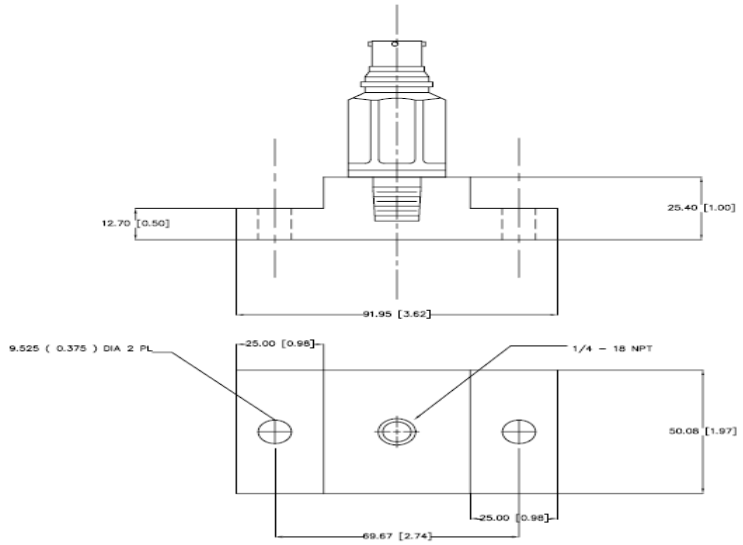


FIG: 2.1.4b: VELOCITY PROBE MOUNTING BRACKET

2.1.5 Differential expansion transducer:

Type	:	Non-contact
Temp Range	:	0 - 177^0 C
Environmental Protection	:	Encapsulated/ hermetically sealed
Location of the sensor	:	Inside the bearing casing.

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 capable and the extension cable shall be insulated to meet the high operating temperature requirement of the respective sensor.

The transducer shall be 25mm proximity probe.
Thread: M30 x 2
Unthreaded length: 0 mm
Overall threaded case length: 50mm
Total length: 1.0 meter Armored

Vendor shall furnish a detailed sketch transducer showing all the mounting brackets and any other accessories for mounting the Differential expansion transducer and the same shall be supplied along with the Differential expansion transducer.

2.1.6 Casing expansion transducers assembly:

Type	:	LVDT or Non-contact
Temp Range	:	0 - 85^0 C
Environmental Protection	:	Weatherproof Enclosure
Location of the sensor	:	Outside the bearing casing.

The mounting bracket required shall be included in the scope of vendor. The sensor integral cable and the extension cable shall be insulated and armored to meet the high operating temperature requirement of the respective sensor.

The transducer assembly shall consist of LVDT (linear variable differential transformer) which is housed in a weatherproof, protective enclosure. The linear range shall be minimum 25.4 mm (1.0 inch). The transducer shall be supplied with spring return. The thread shall be with 6-40 UNF -2B core end and ¼-20 UNC -2A machine end.

Figure 2.1.6 below gives the typical dimensional details of the Casing expansion transducer.

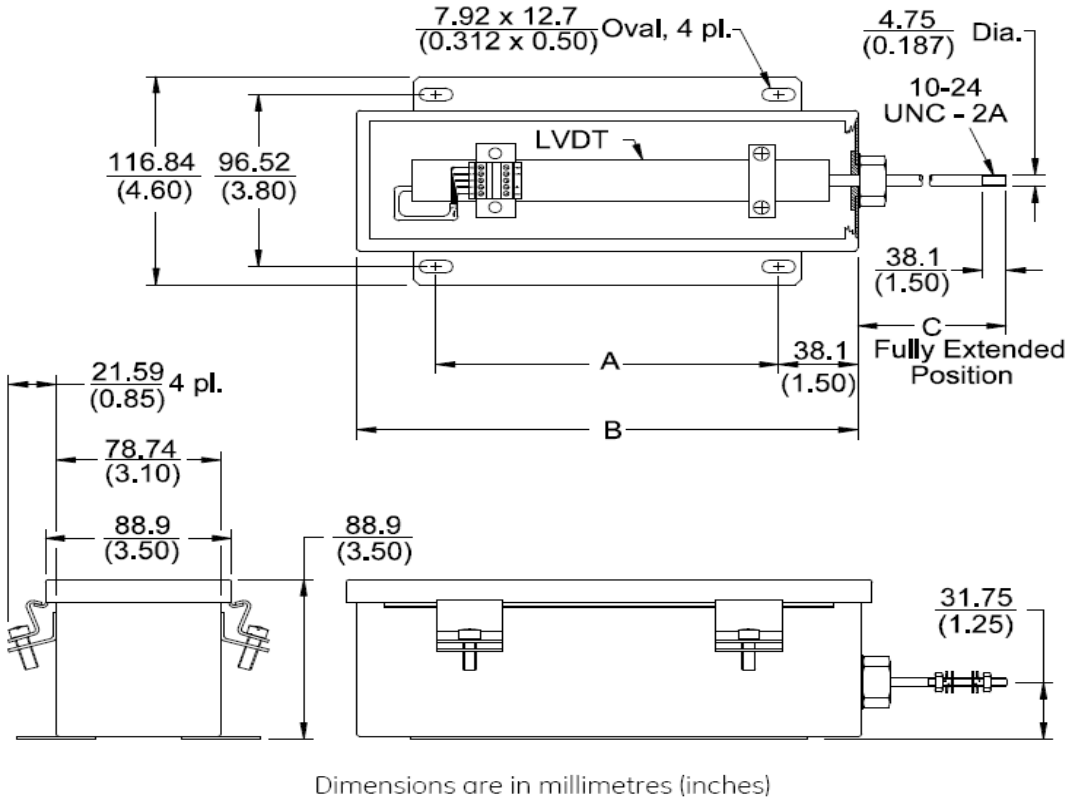


FIG: 2.1.6: CASING EXPANSION TRANSDUCER

2.1.7 Extension cable

The extension cable shall be suitable for respective transducers with SS armor and total length of 4 meter with suitable connectors for connection to the sensor cable on one side and to the driver on the other side.

2.1.8 Probe driver :

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.

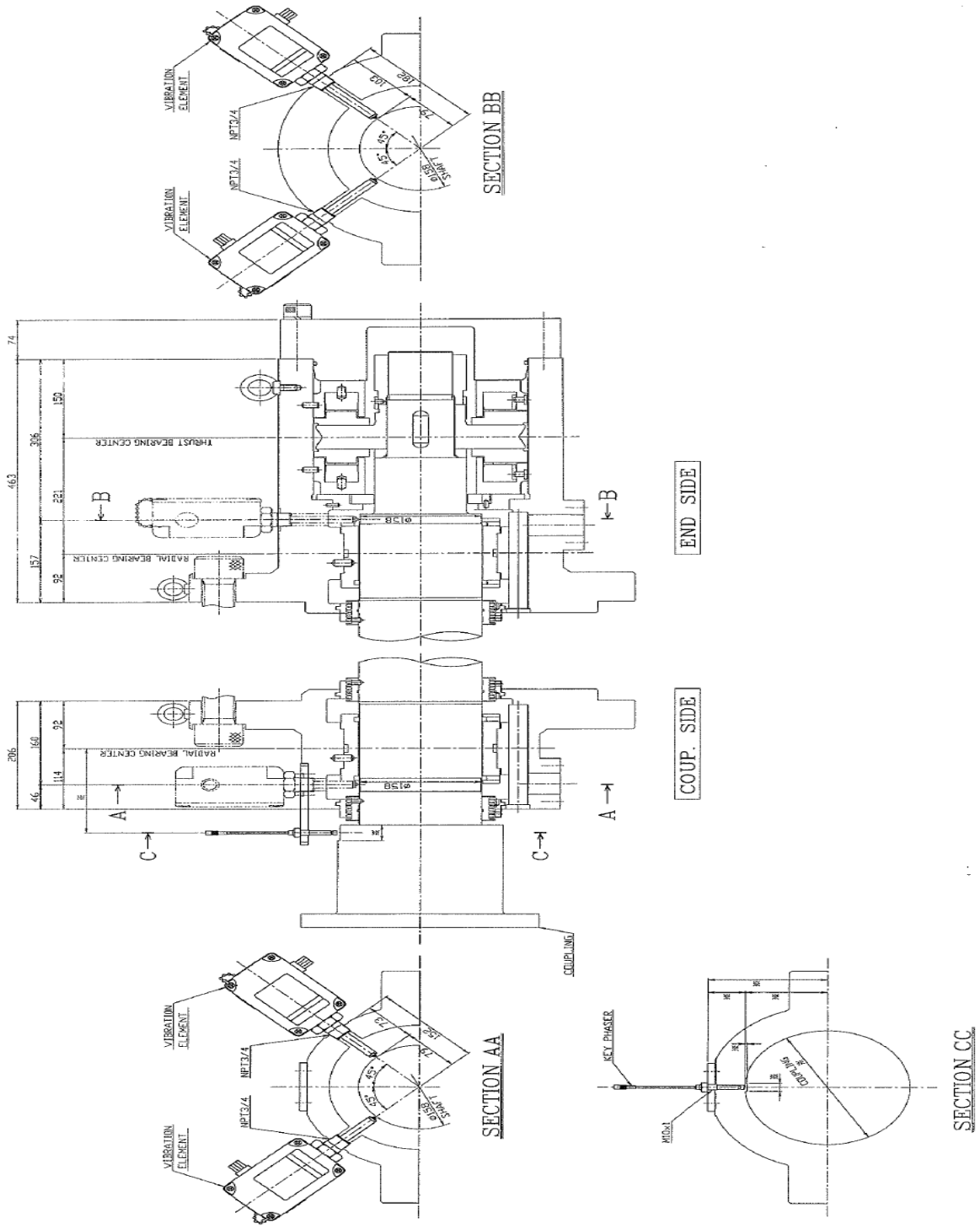
2.1.9 TECHNICAL REQUIREMENTS FOR TDBFP & BOOSTER PUMP (OPTION-5):

Section – A: Machine Data for Vibration Monitoring System

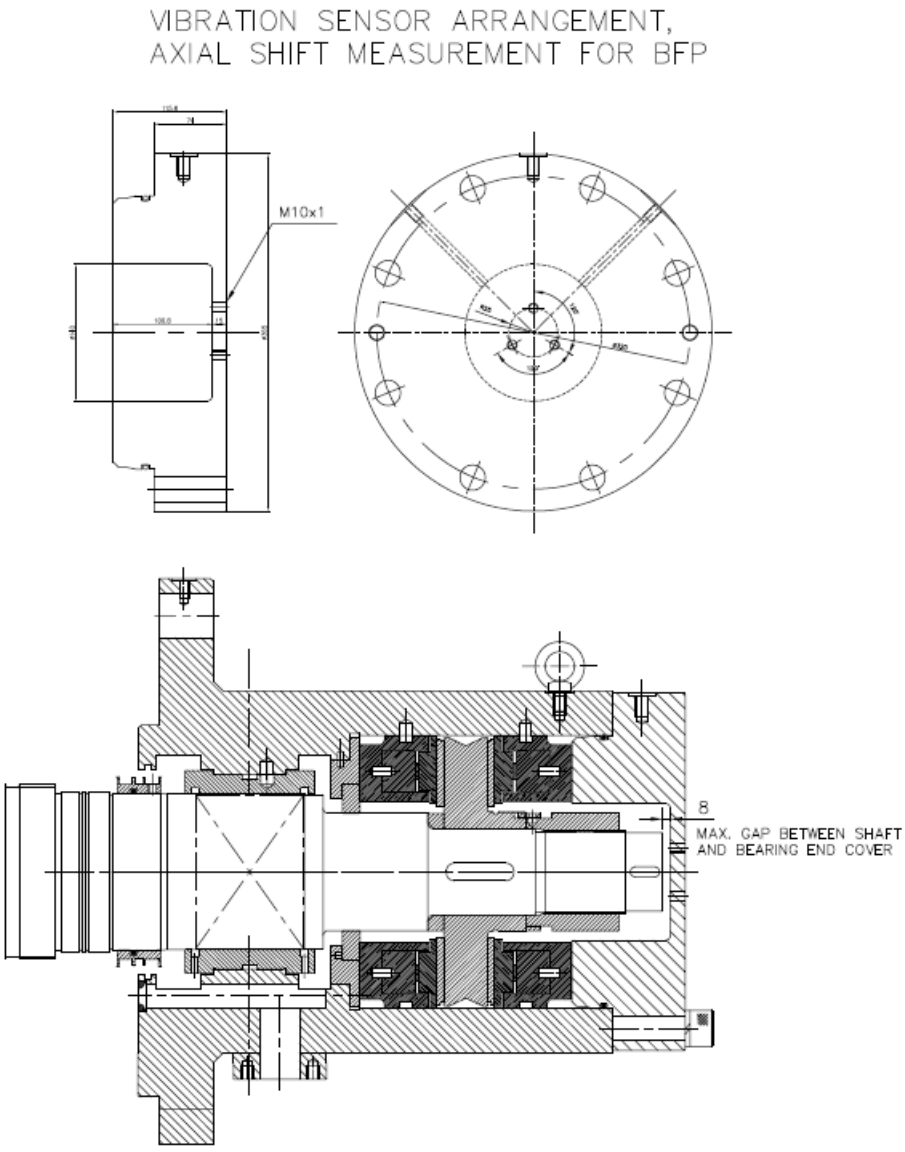
Sl. No.	Machine	Machine Qty./ Unit	Installation (Horz/ Vert)	Machine RPM	Measuring Parameter	No. of Brg. for mtrng. vibration (in X & Y axis)	Vib.Alarm Level (mm/sec-RMS)	Vib .Trip Level (mm/sec-RMS)	No of Vibration Sensors/ Unit	No. of Phase Marker/ Unit
1	Boiler Feed Pump - BFP (2xTDBFP)	2	Horz	800-6500	Relative Shaft Vib.	2	90μm^{P-P}	150μm^{P-P}	8	2
					Absolute Brg. Vib.	2	11.0	18.0	8	
					Axial Shift 3 probe NDE, range -0.35 to +0.35mm				6	
3	Booster Pump	2	Horz	1495	Relative Shaft Vib.	2	90μm^{P-P}	150μm^{P-P}	8	2
	TOTAL PER UNIT	4							30	4

Note: 1) KKS Tag Nos. for transducers will be provided during detailed Engineering.

Section – A1: Sensor mounting provision drawing for Boiler Feed



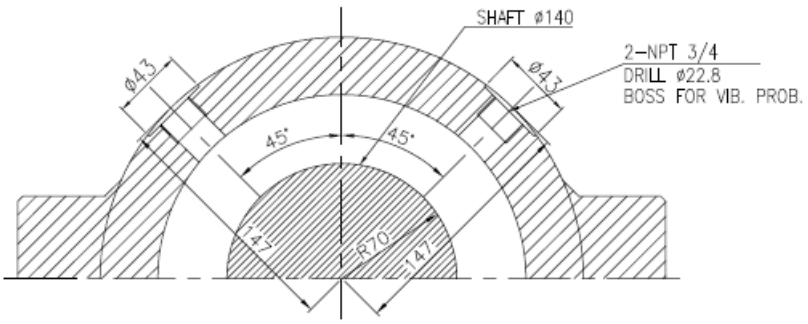
Section – A2: Axial Shift Sensor mounting provision drawing for Boiler Feed Pump



Eddy-current probe shall be forward mount type, M10x1 body thread, 70 mm threaded length. The probe shall be directly mounted on BFP NDE side casing without any bracket arrangement.

Section – A3: Sensor mounting provision drawing for Booster Pump

VIBRATION SENSOR ARRANGEMENT,
SHAFT VIBRATION MEASUREMENT
FOR BOOSTER PUMP



BP BEARING HOUSING
(VIBRATION PROBE)
PROBE SHALL BE REVERSE MOUNTING TYPE

Section – A4: Sensor mounting provisions for TDBFP

1. BFP Pump Bearing Casing Vibration: 40x40x40mm Pad with one M8 X 1 threaded hole for mounting horizontal probe & one M8 X 1 threaded hole for vertical probe, will be provided on the DE & NDE bearing housing of BFP.

Note: Bidders to include grub screws in the offer, for required quantity of sensors, as per above specified machine provisions, for direct mounting of sensors on the machine casing.

2.1.10 Probe driver housing/ ,Junction Box:

19.1. Type of Enclosure:	Dust tight & weatherproof conforming to IP 65
19.2. Material:	3 mm sheet steel / fiberglass reinforced polyester (UV stabilized)
19.3. Type of Cover:	Solid unhinged with retention chain / Screwed at all four corners
19.4. Paint:	i) Exterior: Opaline green shade 275 of IS: 5 ii) Interior: Brilliant Glossy White. Surface / Two (2) inch Pipe stanchion
19.5. Cable Entry:	3 mm (min) Bottom / side Gland plate
19.6. Gasket:	Neoprene
19.7. Grounding:	Brass earth lug with green screw head External-2 nos., Internal-1no. (M6)
19.8. Number of Drain Holes:	Two at bottom capped
19.9. Identification:	Label for JB and Tags for cable
19.10. Accessories:	a) Rail mounted cage clamp type screw less terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals b) Cable gland (Brass) & raceways c) Ferrules & lugs (Brass) d) Aluminum back panel e) Canopy at top f) Mounting brackets g) Bolts and nuts made of brass etc.

Sub Vendors for Junction Box :

Sl. No.	Item	Supplier	Place
1	Junction Box	M/s Pyrotech	Udaipur
		M/s CHEMIN CONTROLS	PONDICHERRY
		M/s ELECTRO MECHANICAL(INDIA)	KOLKATA
		M/s K.S. INSTRUMENTS	BANGALORE
		M/s KHODAY CONTROL SYSTEM	BANGALORE
		M/s MANISHA ENTERPRISES	PUNE
		M/s SAJAS ELECTRICALS	TIRUCHIRAPALLI
		M/s PRAMMEN INDUSTRIES	PUDDOKOTTAI

3.1.0 Monitors and monitoring rack:

The electronic transmitter 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.

Vendor to supply all the required applicable 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 expansion, Eccentricity, Key-phasor **and Zero speed** etc. The monitors etc shall be mounted in the rack completely assembled pre-programmed to the specified parameters and wired.

The offered Turbo Supervisory Instrumentation system shall have the facility to be connected to purchaser supplied common machine diagnostic and health monitoring system (Analysis Package) through buffered raw outputs for all the measurements. **Necessary hardware, software, connectors shall be provided for connectivity to overall machine monitoring and diagnostic system.**

Any item/activity specifically not listed in this specification, does not absolve the bidder of their responsibility to include such items/activities in their scope, otherwise is necessary, to supply the complete Turbo supervisory instrumentation system.

The technical details for different monitors shall be as follows:

3.1.1 **General**:

Three independent programmable potential free relay contacts shall be provided for each channel of measurement, one for pre-trip alarm and one for trip alarm, the alarm and trip set points shall be adjustable over the measurement range. The relay contacts shall be part of the relay modules, separate modules shall be provided for pre-trip alarm and for trip alarm.

One number each potential free contacts to be provided for hooking up to DCS for
- System failure (Rack wise or system wise as per manufacturers standard practice),
- Power supply OK/Failure.

Continuous 4 to 20mA DC 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.

Monitors shall be four channel type maximum and shall meet the following specifications as a minimum:

a) Continuous two channel monitoring with each channel input from one probe. Readout scale shall read higher of the two sensors.

b) 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.

c) Broken sensor failure detection without causing shut down.

d) LED lamps on monitor front for each channel to indicate pre-trip alarm, trip alarm and circuit not OK conditions.

e) Selector switches on monitor front to read vibration/ displacement pre-trip alarm and trip set points for each channel shall be provided.

f) All signals from individual machine monitoring equipments required for machine shut down shall be hardwired to DCS.

g) All alarms and related data shall be interfaced to DCS using serial interface.

3.1.2 Vibration monitor (Relative shaft vibration):

The monitor shall provide radial vibration for rotating machinery, two probes at 90 degree apart for each location shall be provided and connected to monitor. It shall continuously measure and monitor two independent channels of radial vibration accepting inputs from two eddy current probes. The various full scale ranges for the monitor shall be user programmable. Preferably without use of

jumper 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:

- Accepts one or two eddy current probe signals
- 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.
- 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.
- 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.
- Transducer supply voltages shall be user programmable.
- Vibration alert and danger set points shall be available for both the channels. The set points shall be digitally adjustable from 0 to 100% of full-scale.
- Alarm time delay option shall be programmable for 0 sec to 6 seconds
- Selectable alert reset option (latching/non-latching)
- Danger relay voting option(OR voting for relay drive/AND voting for relay drive)
- The following minimum indication shall be provided

OK: This will indicate system status.
Alarm: status indication for alert & danger shall be provided

3.1.3 Axial displacement monitor

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 for vibration monitor against clause no 3.1.2.

3.1.4 Velocity monitor (Bearing Housing vibration):

For measurement of Bearing housing vibration, seismic/velocity type sensor is provided, the velocity monitor shall provide two channels of continuous on-line machinery vibration monitoring. The monitor shall accept inputs from one or two velocity probes. The various full-scale ranges for the

monitor shall be user programmable. In addition to the standard programmable options, the following shall be included with the velocity monitor.

a) High pass filter
b) Low pass filter

The minimum technical specification shall be same as indicated for vibration monitor except the following Accepts signals from one or two velocity probes.
Frequency response (without filter) for velocity probe.

3.1.5 Differential expansion monitor:

The differential expansion monitor shall provide two channels of continuous differential expansion monitoring (both magnitude and direction) accepting two eddy current probes transducer signals. The various full scale ranges for the monitor shall be user programmable. The minimum applicable technical specification shall be same as indicated for vibration monitor against clause no 3.1.2.

3.1.6 Case expansion monitor :

The case expansion shall accept linear variable differential transformer (LVDT) to measure casing growth relative to the machine foundation. The various full scale ranges for the monitor shall be user programmable. The minimum applicable technical section shall be same as indicated for vibration monitor against clause no 3.1.2.

3.1.7 Eccentricity monitor:

The monitor continuously measures and monitors the single channels of eccentricity accepting proximity probes, one for eccentricity and other for key phasor input. It allows identifying the amplitude of thermal or gravity rotor bow. The monitor shall provide the types of eccentricity indication:
Direct eccentricity: The instantaneous eccentricity value

Peak-to-peak eccentricity: The difference between the positive and negative extremes of the rotor bow. It also provides information on gap voltages and the threshold voltage.

The various full-scale ranges shall be user programmable. The minimum applicable technical specification shall be same as indicated for vibration monitor against clause no 3.1.2

3.1.8 Reference phase measurement monitor:

For phase reference measurement, one non-contact type sensor and matching converter shall be supplied for performing analysis of vibration signals to determine machine malfunctions, the measurement shall provide necessary reference on the shaft to determine one-per-turn occurrence.

3.1.9 Zero speed measurement monitor:

One non-contact type sensor and matching converter shall be supplied for zero speed measurement.

3.1.10 Programmable Relay module:

Three independent programmable potential free relay contacts shall be provided for each channel of vibration/ axial displacement / differential expansion / casing expansion / bearing temperature / Zero speed / Eccentricity/ Bearing Housing vibration, one for pre-trip alarm and one for trip alarm, the alarm and trip set points shall be adjustable over the measurement range. The relay contacts shall be part of the relay modules, separate modules shall be provided for pre-trip alarm and for trip alarm.

3.1.11 Bearing temperature monitoring(not Applicable):

Sensors shall be 3-wire / 4-wire RTD PT-100 as per DIN 43760 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) Sensor shall be three wires RTD element of platinum having 100 ohms resistance at 0^0C. Calibration shall be to DIN 43760 standards.

iii) The temperature sensor, cables, terminal heads, junction boxes etc. should be capable of withstanding the mechanical vibration and environment of a rotating machinery atmosphere.

iv) Bearing temperature shall be monitored by means of a (six channel maximum) temperature monitor. The temperature monitors shall be mounted on the local control panel in hazardous area and shall meet following requirements:

a) Accept RTD inputs (platinum, 100ohm at 0^0C calibrated to DIN 43760 standards).

b) Continuous six channel maximum monitoring with each channel input from one RTD. Read out scale shall read higher of the six temperatures.

c) Each channel shall have two independent alarm levels one for pre-trip alarm and one for trip alarm, settable continuously over measurement range.

d) Broken sensor failure detection without causing shut down.

e) Selector switches on monitor front, to read temperature, pre-trip alarm and trip set points for each channel shall be provided.

f) All signals from individual machine monitoring equipments required for machine shut down shall be hardwired to DCS.

g) All alarms and related data shall be interfaced to DCS using serial interface.

3.1.12 <u>Communication gateway and Communication Cable:</u>

Communication gateway module shall have one RS 485 (MODBUS RTU protocol) and one Ethernet (TCP/IP protocol) and with necessary hardware including the cable for redundant serial data communication from Vibration monitoring system to DCS. Vendor shall furnish all details like pin configuration details and tag number wise MODBUS address mapping list etc. for smooth interfacing with DCS.

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

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

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

4.0 Power supply:

The power supply shall be redundant. The power supply modules shall be suitable for powering all the monitors and their associated transducers. The power supply modules shall be suitable for input voltage of single phase UPS 230 VAC / 110 VAC +/- 10%. (If single model is not suitable for the complete input voltage range, then the project specific voltage level shall be informed during detailed engineering). Two independent feeders of power supply will be provided to the TSI rack for redundancy purpose. All the components required to achieve this shall be supplied, mounted and necessary wiring to be done. Any deviation/alternate scheme proposed to be clearly brought out in the offer.

5.0 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.

6.0 Fittings and accessories:

It is the responsibility of bidder/vendor to include all types of fittings, cable seals and accessories required for field installation and protection of probes, extension cables, probe driver/ driver housing etc.

6.1 Connector protector kit: it shall provide the environmental protection and electrical isolation of the connector at the junction where the eddy current probe joins with the extension cable. The kit shall preferably include minimum 10 sets of connector protector, silicon lubricant, easy to use installation tools, instructions and a convenient carrying case. It shall be used with the 8-mm eddy current probe.

6.2 Flexible conduit: 150 meters

Flexible conduit shall be provided to route the eddy current probe cables safely to the driver housing to protect transducer wiring from damage caused by splashing liquids or accidental contact with other equipment. It shall consist of galvanized steel core with an extruded thermoplastic cover. The vendor has to supply the required number of male connectors for connecting the conduit to other equipment to cover all the loops as indicated in the loop diagrams.

6.3 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 (minimum) when properly installed.
The high pressure side and low pressure side thread size shall be suitable for the system.

6.4 Blank:

6.6.0 General:

6.6.1 Vendor shall confirm compliance to this technical specification. Deviation, if any, shall be brought out giving technical reason for the same.

6.6.2 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.

6.6.3 Quality Requirements, Documentation, Training & Warranty should be as per **Clause 6.0, 7.0, 8.0, 9.0** Section-C Reference No. PS4092117/S-C **of** this Document.

7.0 SPARE:

7.1 Installed Spares: Refer clause no. 4.0 of the Section-C Reference No. PS4092117/S-C of this Document.

7.2.1 Mandatory spares:

Refer clause no. 5.0 of the Section-C Reference No. PS4092117/S-C of this document.

8. 0 OTHER REQUIREMENTS:

8.1 ENGINEERING:

8.1.1 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.

8.1.2 Configuration Software: Any software required for configuration of the system shall be part of offer. Licensed copy of same shall be supplied along with the system.

9.0 ERECTION & COMMISSION (E & C) SCOPE:

9.1 Turbo Supervisory System portion:

9.1.1 Vendor shall give a separate offer for erection and commissioning of the complete Turbine Supervisory system covered in this specification.

9.1.2 The total responsibility of erection and commissioning of the system supplied shall rest with the vendor. The important events are listed below:

- Collection of material from stores by BHEL.
- Preparation of mounting surface and mounting arrangement to suit the surface of the machine By BHEL.
- Mounting of Sensors on the Machine/s by Vendor.
- Mounting of local JB's by BHEL & termination of cables between sensors to local JB by Vendor.
- Laying of cable between Local JB and Control Panels, is by BHEL.
- Termination of cables between local JB's to cabinet is by BHEL.
- Carrying out pre-commissioning checks, energizing Cabinets by Vendor.
- Commissioning of individual services by Vendor.
- Checking for all functions of hardware and software when the plant is totally commissioned with all auxiliaries by Vendor.
- Handing over the system to End-User by Vendor.
- Training the operation personnel on operation and maintenance aspects by Vendor.

Note: The total responsibility of above activities on the offered system shall rest with the vendor.

9.2 **COMMISSIONING:**

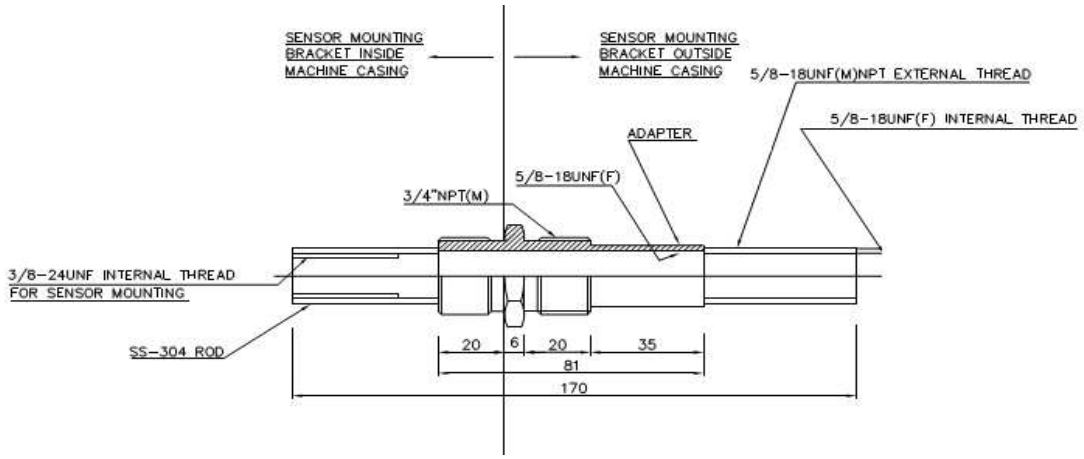
9.2.1 Vendor shall assess, correctly, the duration of the total period of commissioning of this nature of plant. Hence, Vendor may consider sufficient period of site stay and site visits of their engineers. No additional or extra payment will be made for site services other than price indicated in their price offer. Vendor shall quote for lump sum price for Commissioning, without any specified time duration.

9.2.2 Vendor shall quote for Commissioning on turnkey basis. Vendor shall ensure continuous Presence during all the stages of the project commissioning activities.

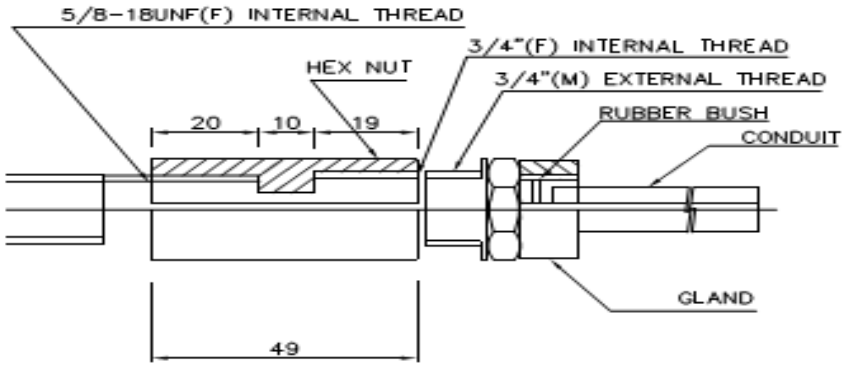
10. TSI MOUNTING ACCESSORIES:

The following are the general drawings of TSI probe mounting accessories. However it is the responsibility of vendor to select and provide the proper mounting arrangement for all the TSI probes offered.

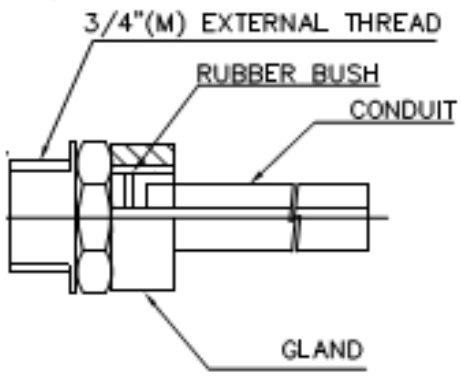
10.1 Mounting arrangement for Gear Box shaft vibration and Gear Box shaft key phasor probe:



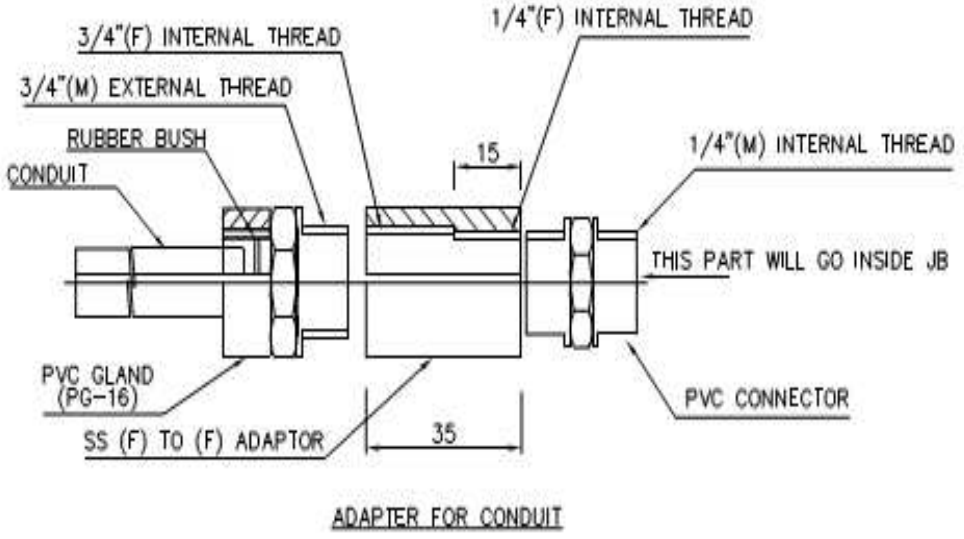
10.2 Conduit connector at Probe end (Gear box shaft vib and Gear box key phasor probe):



10.3 Conduit connector at Probe end (BFPDT shaft vib, Keyphasor, Eccentricy and Zero speed):

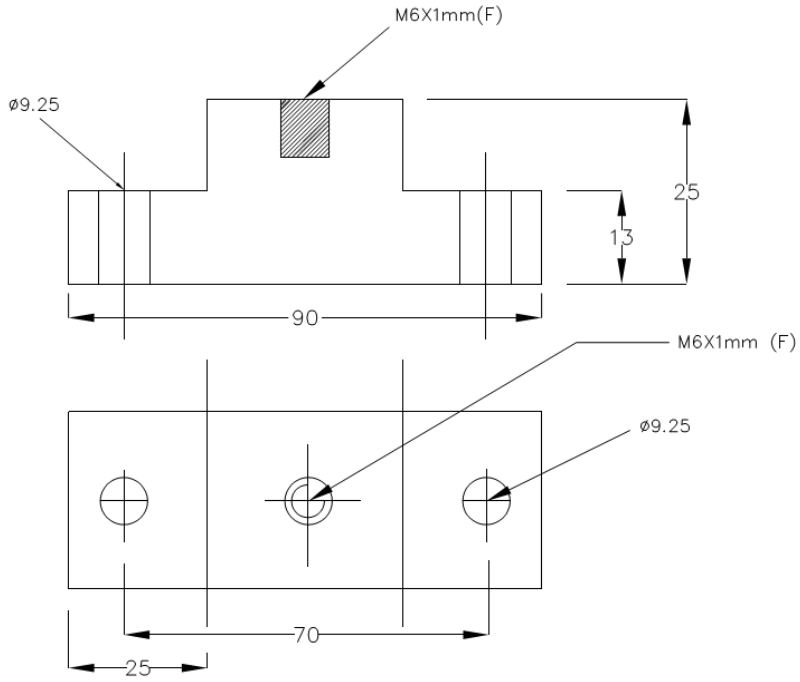


10.4 Conduit connector at Junction Box end:



10.5 Mounting bracket for Bearing Housing probe:

The material of construction shall be Mild steel with cadmium plating.



Annexure-I

		A4-10	REF. : CE/409-416/TSS-VMS/PKG REV. NO. : 00 PAGE : 01 0F 02

PACKAGING SPECIFICATION FOR

TURBINE SUPERVISORY SYSTEM (TSS), VIBRATION MONITORING SYSTEM (VMS), ANALYSIS & DIAGNOSTICS SYSTEM

REVISION : 00	APPROVED 3/6/14. (R PRABHU) (S M PATEL)		
	PREPARED D. Ghosh Sr Engr-BPE (MADHU CHANDRA)	ISSUED 409-416	DATE 03/06/2014

1.0 Packaging Guidelines

The detailed guideline for packaging is provided in specification reference ED 0490092, Rev. 05. The packing shall be separate for TSS & VMS, in separate boxes.

1.1 For Vibration sensors, Monitors, rack, special cable and signal conditioners being dispatched from OEM (countries other than India to India) packing which is suitable for transportation by Lorry and storage at site for extended periods up to 24 months, shall be used. For this a reference standard ED 490092 Rev 05 clause 3.1.2 is attached. OEMs shall follow this standard at minimum. If any other OEM standard packing is available same shall be submitted to BHEL for review and acceptance as part of Technical offer.

1.2 Imported items shall be packed in best fit boxes and total number of boxes per unit of TSS shall not exceed 1 box and for VMS shall not exceed 2 boxes.

1.3 For Panels, Server PC, Printer, Junction boxes, mounting pad / bracket, field cables etc (i.e. typically from Indian manufacturers) packing which is suitable for transportation by Lorry and storage at site for extended periods up to 24 months, shall be used. For this a reference standard ED 490092 Rev 05 clause 3.1.1 is attached. OEMs shall follow this standard at minimum. If any other OEM standard packing is available same shall be submitted to BHEL for review and acceptance as part of Technical offer.

1.4 Indigenous items, except for bare panels & cables, shall be packed in best fit boxes and total number of boxes per unit of TSS shall not exceed 2 box, for VMS shall not exceed 4 boxes and for Analysis & Diagnostics system shall not exceed 1 box.

1.5 Packing shall be separate for each unit of the project, TSS, VMS & Mandatory spares separately.

1.6 Packing of the items shall be such that they can be repacked properly after material verification at customs / site.

PROCEDURE FOR PACKING OF CONTROL EQUIPMENTS USING PLYWOOD.

1. **PURPOSE:** To describe the materials and procedure for Packing.

2. **SCOPE:** Applicable for packing of control cubicles, loose items, spares of Control Equipment and Transmission System Control products.

3. **MATERIALS**

3.1. **WOOD**

3.1.1 **For Inland contracts:**

3.1.1.1 Plywood of Boiling Water Resistance (BWR) grade and termite, fungus proof as per IS: 303 of 12 mm thick for control cubicles, single and multi cubicles, loose items and spares cases. The plywood shall be bonded with high Quality Phenol Formaldehyde Synthetic Resin and specially treated with preservatives to repel termites and wood destroying organisms. The plywood shall with stand the stress caused by cyclic changes in weather conditions. It shall be durable and resistant to heat, sun and moisture. The sheets such procured shall have IS mark IS 303 and BWR grade stamped on it.

3.1.1.2 Silver oak wood of cross section 45x45 mm as support battens for Loose items, spares and single suit, two suit, three suit Cubicles and 70x45 mm for longer sections to be used. These Silver oak wood battens shall be treated with ASCU solution as defined in 4.0. In the case of plywood, treatment with ASCU solution need not be done.

Alternative to silver oak battens, Plywood support battens of suitable cross section and combination of thickness can also be used as per clause 3.1.1.4

APPROVED : M. Sivaramaiah

PREPARED:	ISSUED:	DATE:
PGD/KPN	STDS GROUP	30/03/13

3.1.1.3

Plywood for general purposes i.e. moisture resistance or MR grade (Commercial ply wood) and termite, fungus proof as per IS: 303 of 9 mm / 12 mm thick for control cubicles, single and multi cubicles, loose items and spares cases. The plywood shall be bonded with high quality Phenol Formaldehyde Synthetic Resin and specially treated with preservatives to repel termites and wood destroying organisms. The plywood shall with stand the stress caused by cyclic changes in weather conditions. It shall be durable and resistant to heat, sun and moist ture.The sheets such procured shall have IS mark IS 303 and MR grade stamped on it. 9 mm thick plywood can be used with additional plywood support/ reinforcement suitable battens both for small cases and also for panels. Support batten as indicated at 3.1.1.4 shall be used.

Sample drawings of panels & loose boxes are attached for ready reference.
[Fig : 10 to 13]

3.1.1.4 Support Battens:

Ply wood sheet of cross section 18 mm x (100 mm) for support batten for loose items, spares, and plywood sheet of cross section 18 mm thk x 100 to 150 mm width as support batten for standard panels up to 2450 x 1350 x 2500 mm panels. Support batten of plywood cross section 12 thk x 75 to 100 mm can also be used for small cases apart from 18 mm x 100 mm cross section. These plywood support battens can also be used in place of silver oak support battens as referred in clause 3.1.1.2. Additional support battens/ cross battens of suitable sizes are to be provided on need basis.

Sample drawings of panel's .i.e. single suit, two suite and three suit cubicles are attached for ready reference [Fig: 10 to 13].

Special support battens for Rlys and similar panels:

Plywood of cross section 18 mm x 75mm x 3 no's at both bottom end and top end of front and back shook's , and also at top portion of both corner shook's for fixing with bolt and nut/ clamps, and 18 mm x 150 mm x 2 nos cross section as support batten/ slanting reinforcement batten on all sides. On need basis 18mm x 125 mm x 2 to 3 no's of plywood cross section can also be used additionally depending upon the size and weight of the panel.
Plywood shook's can be fixed with both Bolts and mechanical latching clamps or combination of both as the case may be.

Sample drawings of panels are attached for ready reference.
[Fig : 8 & 9]

3.1.2 For Export Contracts

3.1.2.1 Plywood of Marine grade as per IS: 710 of 9 / 12 mm Thick for control cubicles of single / two / three suite for loose items and spare cases. For suit of four and longer cubicle sections, 19mm thick is to be used.

It shall be highly resistant to attacks from fungi, termites and wood destroying organisms including marine borers. The plywood shall withstand the stress caused by cyclic changes in weather conditions. It shall be durable and resistant to heat, sun and moisture. The sheet shall have IS: 710 and marine grade marking.

3.1.2.2 Same as clause 3.1.1.2.

3.1.3 BHEL_EDN will be carrying out test on ISI marked ply Wood whenever required.

3.2 Fasteners:M8 x 130 mm and M8 x 150 long zinc plated Bolts and M8 zinc plated nuts for fixing, and spring Washers or suitable size can also be used.

3.3 Nails: Nails of dia 3.15 mm and about 40 mm for nailing of plywood and silver oak batten. Suitable smaller size is to be used for other nailing.

3.4 Polyethylene sheet: The polyethylene sheets are used to make covers for the jobs individually. The material shall have a minimum thickness of 0.175 mm (175 microns).

The polyethylene sheet shall be clear and transparent manufactured out of virgin material. Reprocessed material shall not be used.

3.5 Bituminised water proof kraft paper - used for lining the inside of shookes of cubicles.

3.6 Bitumen coated Hessian polyethylene kraft paper used for lining the inside of top cover for cubicles and all inner and top sides for small boxes.

3.7 Rubberised Coirs- used for cushioning and to fill the gap inside packing boxes.The coir shall be about 100 mm wide and 25mm thick.

3.8 Foam rubber/U Foam - This is used for covering the delicate items. This material is normally provided by BHEL.

3.9 Thermocole(Expanded polystyrene) sheets - This is used for covering delicate items. This material is normally provided by BHEL.

3.10 Silica gel - shall be of indication type to conform to IS: 3401: shall be blue in colour while usage.

3.11 Cotton bag - These are used for holding silica gel. The bags shall have the following matter indicated on them:

BHEL-EDN **BANGALORE-560026**

SILICA GEL
INDICATING TYPE

BLUE : ACTIVE
ROSE : REDUCED ACTIVITY
WHITE : NO ACTIVITY. TO BE REPLACED WITH FRESH SILICA GEL

3.12 Cotton / Plastic tape-This is used for tying small items and also to prevent vibrations of moving parts within the cubicles.

3.13 Polyethylene bags - These are to be used for keeping the packing slips. The bag shall be of size 70 mm X 100 mm (minimum).

3.14 Hessian cloth, twine thread, paint will have to be used in packing certain items.

3.15 Marking plate - This shall be of anodized aluminium sheet. Details and specifications are given in Fig-3.

3.16 Marking ink - Ink used shall be normally black in colour. The ink shall be indelible, non fading and non washable in water.

3.17 Packing Slip Holder - This shall be of galvanised iron tinned sheet / aluminium sheet.

3.18 Mechanical Latching clamps : For CLW Railway panels and similar Panels self locking clamps can also be used on need basis in conjunction with or apart from regular bolt and nut fixing arrangement. Sample drawing attached [refer Fig.7]. For reusable boxes, these clamps provides easy locking and unlocking arrangement. These clamps will be made available from BHEL in some cases.

3.19 Flex/Vinyl digital print media for labeling:
Labels made out of Flex/Vinyl/ other digital media shall be used for export contracts & some prestigious domestic contracts on need basis apart from existing present marking/ labeling system.

3.20 Aluminium foil for packing:
On need basis, suitable size & thickness of aluminium foil shall be used for packing of electronic panels and loose items for both indigenous & export contracts.

3.21 Pallets :
All cubicles are mounted on the pallets by BHEL. For loose items, HMI items & small cabinets for which no pallets are available, suitable size pallets have to be arranged by the contractor.

4.0 Chemical treatment for silver oak preservation

4.1 The silver oak battens are to be treated with ASCU solution. For plywood wood treatment is not required.

4.2 The chemical used shall be ready mix ASCU paste. This consists of Arsenic, copper sulphate, sodium dichromate. This paste shall be mixed at the rate of 1 kg of paste per 10 liters of water. Alternate to this CCA can also be used as indicated at para 4.4

4.3 The chemical treatment shall be done at the premises of the contractor. A cement concrete tank of capacity to hold a minimum of 2000 liters of solution shall be constructed. The solution shall be prepared in the presence of BHEL- EDN's representative by contractor. The wooden battens shall be soaked in the solution for a minimum of 12 hours.

The solution shall be replenished after treating a maximum of 12 cubic meters of wood for 2000 liters of solution. A log book shall be maintained by the contractor to give the details of date of preparation of solution, quantity of solution prepared, quantity of chemicals used, quantity of wood treated and the details of replenishment.

Samples of solutions [only paste before mixing] shall be tested at the laboratories designated by BHEL. The testing fees to be paid to the laboratories will have to be borne by the contractor. The solution [paste] shall be tested as and when required.

4.4 Specifications for water soluble type wood preservatives:
Copper - Chromium - Arsenic [CCA]:

Copper - Chromium - Arsenic preservative formulation shall be as per IS : 10013 Part - II - 1981 shall consist of following active ingradients in nominal proportions by weight as shown below:

Arsenic Pentoxide	$AS_2O_52H_2O$	12.5
Copper Sulphate	$CuSO_45H_2O$	37.5
Sodium Dichromate	$Na2Cr_2O_75H_2O$	50.0
Or		
Potassium Dichromate	$K_2Cr_2O_7$	

5.0 Jointing of plywood- to the extent possible, single plywood sheet shall be used in case of equipment of large size, jointing is allowed as bellow.

5.1 The joining shall be as close to the center of equipment as possible, but not less than 500 mm from one edge.

5.2 While joining (2 or more plywood sheets), care shall be taken to fix the sheets in the direction of the grain structure.

5.3a For joining Plywood and Silver oak wooden batten:
While joining, 2 sheets shall be kept close to each other and treated

silver oak batten of 100 mm width and 45 mm thick to be used and nailed to both plywood sheets alternately (2 numbers) in zig-zag manner.

5.3b For Joining plywood with plywood sheets :
While joining, 2 sheets shall be kept close to each other and plywood sheet batten of minimum 100 to 200 mm width and 18 mm thick to be used depending upon the size of the box/ case and nailed to both plywood sheets alternately (2 numbers)in zig-zag manner. Suitable size nails to be used.

5.4 Jointing of silver oak batten : Only single length silver oak batten shall be used. In case of height or width of equipment is more than 2400 mm, jointing of batten is acceptable. The jointing of batten shall be such that two batten are kept together and one more batten of width & length of about 200 mm to be nailed on both the planks as in Clause 5.3 above.

5.5 The above jointing is to be done close to center of equipment.

6.0 Packing procedure

6.1 Packing of cubicles for inland contracts.

6.1.1 Packing to be done using materials given in clause 3.0.

6.1.2 The cubicles are fixed on wooden pallets. Hence the contractor need not arrange the bottom pallets.

6.1.3 Loose parts : All loose parts in the cubicles, shall be tied using cotton/ plastic tape. Wooden battens shall be provided wherever necessary.

6.1.4 Additional loose items which may be kept inside the cubicle.

a. The components which are removed from cubicle for loose shipping, such as meters shall be kept inside the cubicle individually kept in wooden box and tied firmly to the bottom of cubicle.

b. Other items which are given loose in addition to cubicle, shall be packed in separate boxes (like cables).

c. For transformer cubicles loose items shall be packed in separate boxes and these boxes may be tied firmly in bottom of cubicles.

d. Items which are bigger in size such as impulse tubes may be kept at the top of cubicles firmly bunched and tied.

6.1.5 Wooden batten : This batten shall be silver oak wood .In case of Cubicle which are not rectangular in shape like control desks, sufficient number of wooden rafters/ battens of proper size shall be provided to give strength to the package.

6.1.6 Silica gel: Silica gel (as in 3.10) packed in cotton bag (as in 3.11) shall be kept at different place inside the cubicle as per BHEL-EDN directions. Each suit of cubicle shall provided with 1 kg of silica gel (for a suit of 4 cubicles, 4 kg of silica gel shall be used).

6.1.7 Polyethylene sheet covering: Cubicles shall be covered with polyethylene petticoat (sheet as in 3.4). This shall be tailor made to fit the cubicle. The sealing shall be such as not to allow any moisture to enter the cubicle. This sheet is to be folded to the bottom pallet with wooden planks on 2 larger sides.

6.1.8 After completion of this, the arrangement is as shown in Fig.1.

6.1.9 Rubberised coir: (as in 3.7) to be nailed from inner side of plywood after pasting kraft paper for full length with a pitch less than 500mm with a min. of 2 rows of cover is to be used.

6.1.10 Bituminised water proof kraft paper: (as in 3.5) to be pasted with glue on 4 inner sides of plywood. Whenever 2 pieces of kraft paper are used, the joint shall have an over lap of min 20 mm.

6.1.11 Bitumen coated Hessian polyethylene kraft paper (as in 3.6) to be nailed using nails (as in 3.3) on top cover inner surface. This sheet shall project outside on 4 sides by atleast 100 mm and shall be folded and nailed on to the sides. Joining of 2 sheets shall have an overlap of min 20 mm.

6.1.12 After completion of above steps, the arrangement shall be as given in Fig.2.

6.1.13 Marking Plate : One no (as in 3.15) shall be nailed to the front side of case, item as shown in Fig.3.

6.1.14 Case Marking : After complete packing, marking of various details and symbols as given by EDN shall be done using indelible ink (as in 3.16)

6.1.15 Packing Slip : Packing slip kept in polyethylene bag (as in 3.18) shall be placed inside the box at appropriate place before closing the top. in addition one more packing slip covered in polyethylene cover and packing slip holder (as in 3.17) shall be nailed to front or rear of shook.

6.1.16 At the end of this stage, the arrangement is as shown in Fig.4. Front and rear shook fixing arrangement to the bottom of the pallet is as shown in Fig.5

6.1.17 The lifting arrangement of the packed case is **shown in Fig.6**

6.2 Packing of cubicles for export contracts Procedure is same as that given in 6.1 except for the following changes:

- Two Polyethylene petticoat (as in 6.1.7) instead of one
- Fumigation may have to be done if required (BHEL Scope).

6.3 Packing of empty Cubicles Procedure is same as that given in 6.1 except For following changes

- Bituminised kraft paper, bitumen coated Hessian polyethylene paper,silica gel need not be used.

6.4 Packing of loose items/spares for inland contracts

6.4.1 All the materials and procedure are same as in 6.1 except that :

- No joining of plywood and silver oak batten
- Inner sides of all 6 sides shall be nailed with bitumen coated Hessian polyethylene kraft paper (as in 3.6) using nails.
- Kraft paper (as in 3.5) is not required
- Silica gel quantity is 100 gm approx per box.
- Rubberised coir is to be nailed to inner surfaces of bottom 4 sides of box.
- Bottom plywood sheet / pallet shall be of 18 mm thick for all practical purposes and 12 mm thick for smaller boxes on need basis. Suitable bottom beams made out of plywood/ any other wood of suitable cross section 75x36 mm, 75x54 mm,75x75 mm, 100x100 mm.
- Support battens of cross section 12x75 mm, 12x100mm, 18x75 mm, 18x100 mm can be used depending upon the size of the boxes. Plywood support battens can be used in the place of silver oak battens.
- Clause 6.1.10 is not applicable. Individual items to sealed with polyethylene sheet(as in 3.4) and one full cover of polyethylene sheet covering of all items is to be made.

6.4.2 In few cases gabled roof (single or double gable) may have to be made, details of which will be given by EDN.

6.4.3 Internal Packing: Items that go into the box shall be packed using polyethylene sheet/ U foam/ thermocol sheets/air bubbled sheets/ paper cartoons and cotton tape. Any space left between the job and the sides and the top of the box shall be filled with rubberised coir/air bubbled sheet /thermocole to get proper cushioning effect. Certain items like transformers, reactors, breakers, etc shall be bolted to the bottom of the box using bolts, nuts and washers.

6.5 Packing of Loose items/ Spares for Export Contracts: Procedure is same as that given in 6.4 except for following changes:

- Two polyethylene covers to be provided,
- Fumigation may have to be done, if required, for which payment will be made by EDN.

6.6 Any other changes/ new methods/ alternative packing systems can be undertaken with prior information and approval from the dept. For other parameters and further details concerned agency may please be contacted.

7.0 **ACCEPTANCE CRITERIA OF PLYWOOD :**

PLYWOOD FOR GENERAL PURPOSE
GRADE FOR PACKING - AS PER IS:303

1. Plywood sheets shall have IS:303 & BWR / MR grade stamped on each sheet.
2. Packing/contractor should give a certificate to this effect.
3. Contractor shall identify each sheet with their name/firm in suitable place.
4. Visual checks to be done by packing contractor and EDN-QC CE shipping.
5. For other parameters, testing will be done at authorised laboratories/institutions by EDN on sample basis.

7.1 **FOR BWR GRADE :** TABLE-1 QUALITY REQUIREMENTS OF PLYWOOD

Sl NO	Defect Category	Maximum Number of Defect Permitted on any one surface of panel (as applicable to Type A Surface of IS:303)
1.	Blister	Nil
2.	Check	Individual check not more than 50mm in length and the total length not more than 300mm/m²
3.	Discoloration	Nil
4.	Dote	5cm/m²
5.	Insect hole	Scattered up to 12 holes/m²
6.	Joints	One joint for every multiple of 200mm provided no individual piece is less than 100mm in width
7.	Knots(dead)	2 up to 12mm dia/m²
8.	Pin knots(dead)	2/m²
9.	Pin knots(live)	No restriction
10.	Knots(tight)	6 up to 25mm dia/m²
11.	Patches	4 patches/m sq provided they are all tight patches & do not mar the appearance

12.	Splits	2 splits each not more than 1mm wide and length not more than 100mm provided they are filled with suitable filler
13.	Swirl	Unlimited provided they do not mar the

7.2 FOR MR GRADE : TABLE -2 QUALITY REQUIREMENTS OF PLYWOOD

Sl NO	Defect Category	Maximum Number of Defect Permitted on any one surface of panel (as applicable to Type A Surface of IS:303)
1.	Blister	Nil
2.	Check	Individual check not more than 100mm in length and the total length not more than 1000mm/m²
3.	Discoloration	5 %
4.	Dote	15cm/m²
5.	Insect hole	Scattered up to 24 holes/m²
6.	Joints	: No restrictions
7.	Knots(dead)	4 up to 20mm dia/m²
8.	Pin knots(dead)	: 6/m²
9.	Pin knots(live)	No restriction
10.	Knots(tight)	: No Restrictions
11.	Patches	Any number provided they are all tight patches & do not mar the appearance
12.	Splits	3 splits each not more than 4 mm wide and length not more than 150 mm provided they are filled with suitable filler
13.	Swirl	NO restrictions

7.3 Thickness of Plywood sheets:

The plywood boards shall be of uniform thickness within specified tolerance limit specified. The faces of plywood boards shall be reasonably smooth.

7.4 PERMISSIBLE DEFECTS:

Gaps in cores and cross-bands may be permitted except for 3 ply plywood, provided the width of the gap does not exceed 1mm in case of and 2 mm in case of plywood of more than 5 ply and provided such gaps, if more than one, shall be spaces not less than 80mm away from each other and are staggered not less than 50mm away as between ply, the next ply having the same grain direction.

7.5 WORKMANSHIP AND FINISH:

The plywood boards shall be of uniform thickness.

The faces of plywood boards shall be reasonably smooth and face veneers shall be reasonably uniform thickness.

7.6 TESTS:

For testing any other mechanical property of general purpose plywood, Subject to agreement between the purchaser and the supplier, reference shall be made to the provisions of IS 1734 Part 1 and 20)

8.0 Details of Drawings / Figures attached:

Fig- 1	:	Packing of panel - Preparation
Fig- 2	:	Shookes preparation
Fig- 3	:	Marking Plate
Fig- 4	:	Packed panel with plywood and silveroak battens
Fig- 5	:	Detailed joining of pkg shookes with battens
Fig- 6	:	Lifting of packed case
Fig- 7	:	Mechanical Latching clamps
Fig 8 & 9	:	CLW Railway panel packing
Fig 10 to 13	:	Packing of panels and spares packing cases.
Fig 14	:	All Units supplying Initial and O & M spares (Recommendations from Corporate Systems & IT)

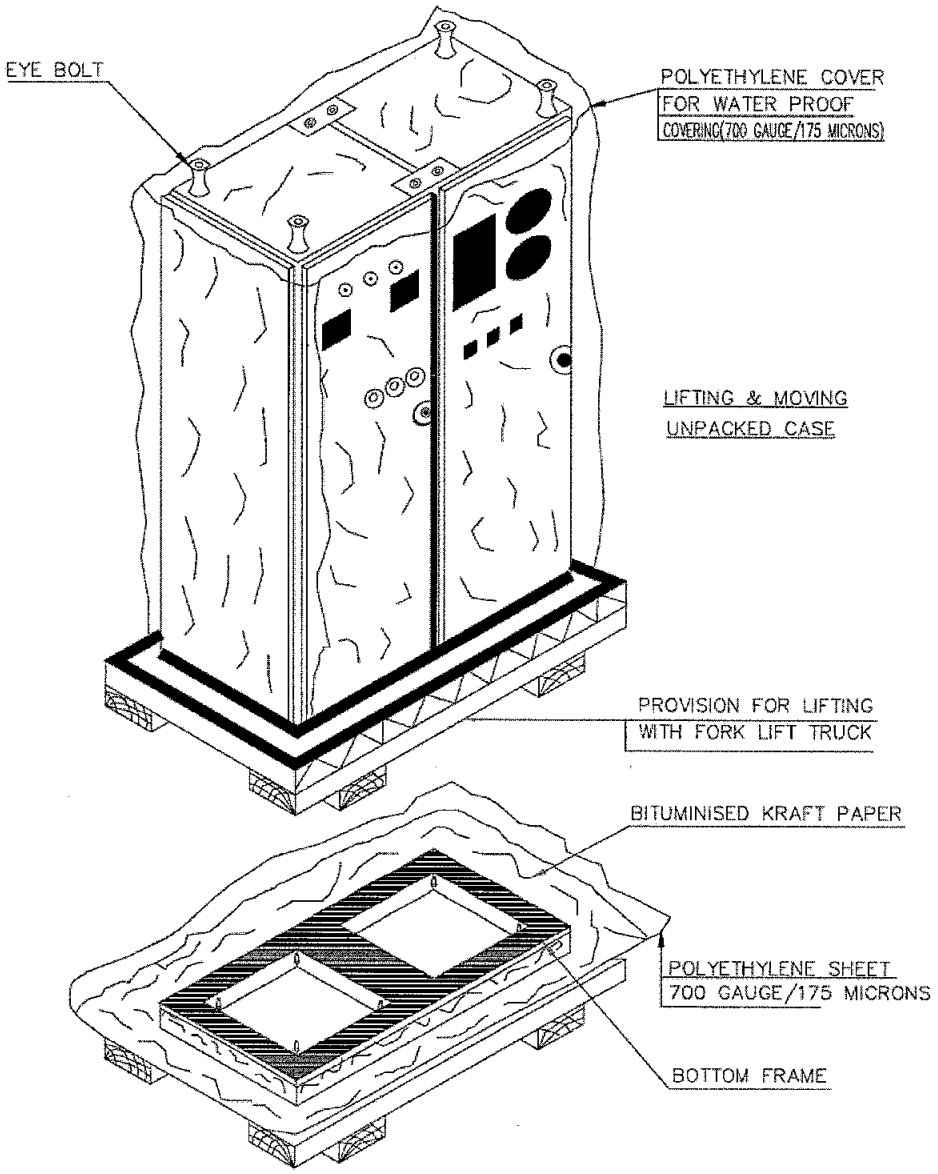
Additional points to be taken care for :
Easy spares [Initial and O&M] Traceability and Identification at units and as well as at sites:

(Recommendations from Corporate Systems & IT)

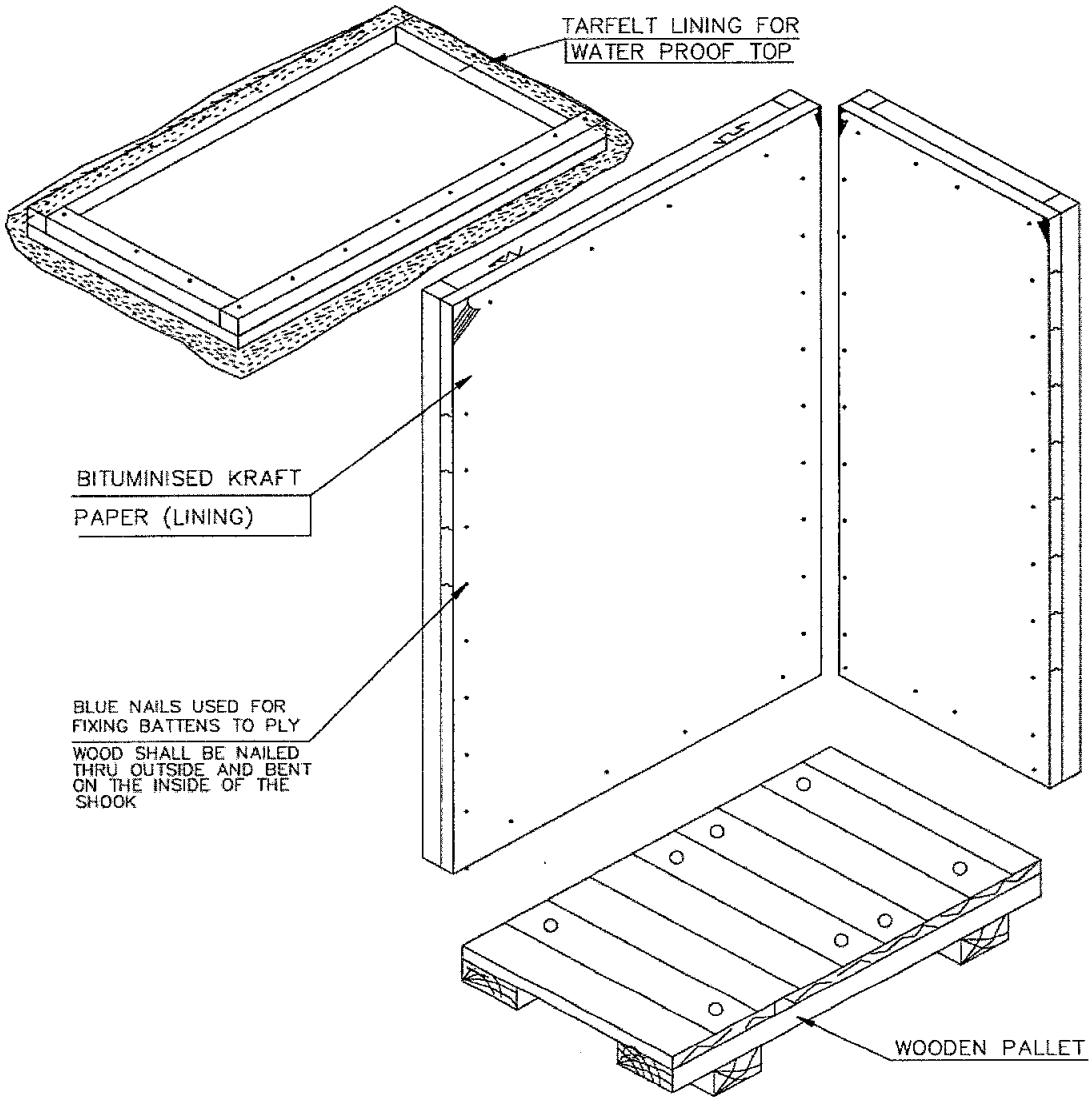
Sl	Activity
1	All Initial and O&M spares preferably supplied in one lot to site and progressive inventory till all spares are accumulated could be kept at units.
2	Spares (Initial and O&M) should be supplied in separate Boxes / Containers and not mixed in main supply boxes.
3	**i)** Initial spares Box / Container to be labeled as "INITIAL SPARES " in RED. Ref fig: 14 (Page-26). **ii)** O & M spares Box /Container to be labeled as" O&M SPARES " in GREEN. Ref fig: 14 (Page-26).
4	**iii)** Initial Spares Box to have red Color strip as per diagram. Ref fig: 14 (Page-26). **iv)** Majority of spares (initial and O&M) are for indoor storage at site. **v)** O&M spares box to have green Color strip as per diagram. Ref fig: 14 (Page-26).
5	**vi)** Spares (Initial and O&M) Packing list kept inside the boxes and affixed securely outside the box to contain **vii)** Custom name **viii)** Project / Power station Name **ix)** Customer PO No and date **x)** Sl no of customer PO. **xi)** Quantity total & dispatched. **xii)** Unit work order number **xiii)** All above to be developed from Unit IT System
6	**xiv)** All spares (Initial and O&M) items to have tags (wono, item customer order no, customer item.description)
7	**xv)** Supply of spares by Vendor should also be instructed for following point 2,3,4,5,6 mentioned above.

Action By : Sites on arrival of spares (Initial and O&M)Receipt .

	Activity
1	Material utilized if any from Initial and O&M spares , should have prior written approval of concerned MUs. Such MUs shall also confirm replacement dates which should be entered in the system for creation of repository.


EYE BOLT
POLYETHYLENE COVER
FOR WATER PROOF
COVERING(700 GAUGE/175 MICRONS)
LIFTING & MOVING
UNPACKED CASE
PROVISION FOR LIFTING
WITH FORK LIFT TRUCK
BITUMINISED KRAFT PAPER
POLYETHYLENE SHEET
700 GAUGE/175 MICRONS
BOTTOM FRAME

FIGURE–1


TARFELT LINING FOR
WATER PROOF TOP
BITUMINISED KRAFT
PAPER (LINING)
BLUE NAILS USED FOR
FIXING BATTENS TO PLY
WOOD SHALL BE NAILED
THRU OUTSIDE AND BENT
ON THE INSIDE OF THE
SHOOK
WOODEN PALLET

FIGURE–2

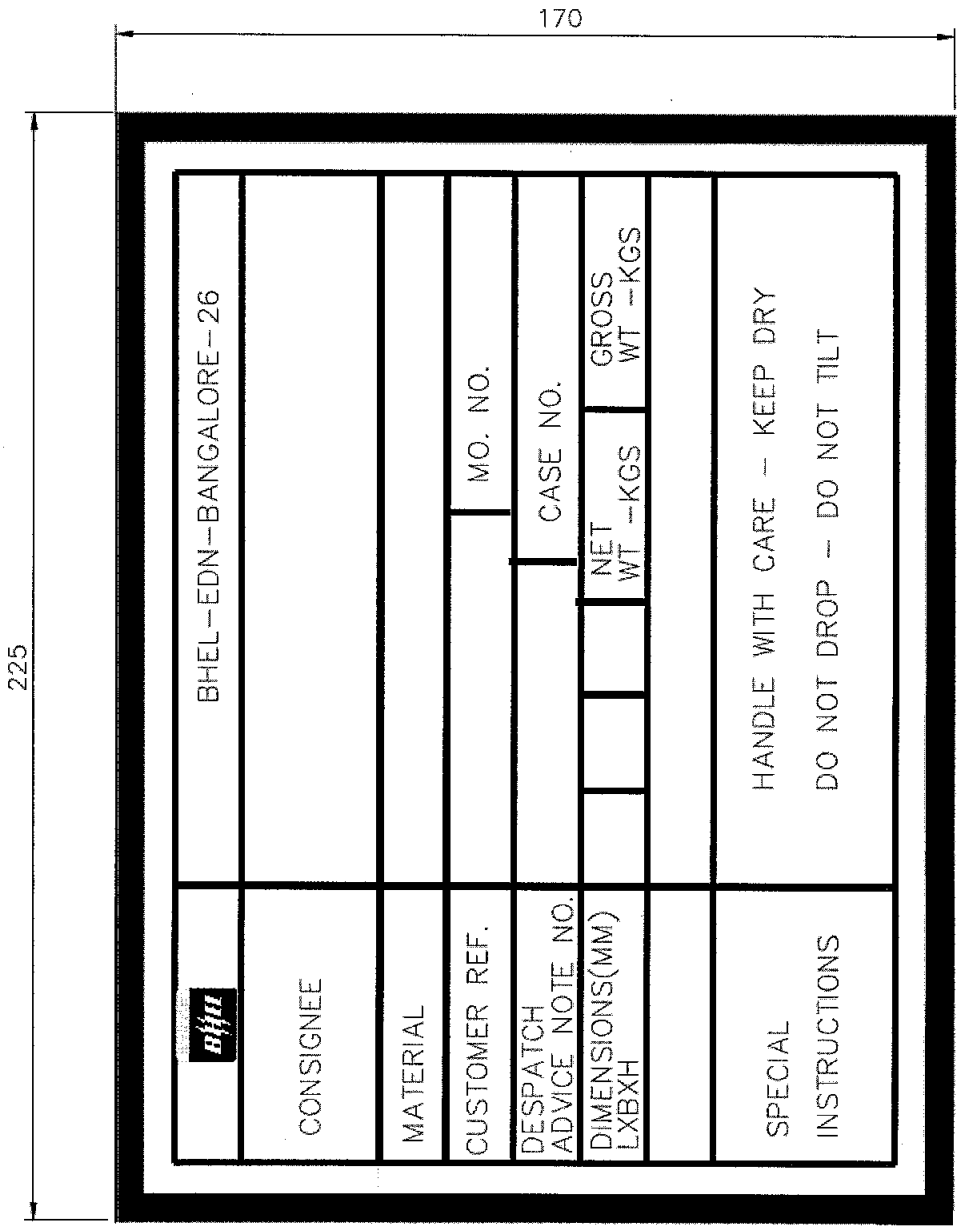


FIG-3 : MARKING PLATE

PLYWOOD SHOOKS BOLT TYPE WITH SILVER OAK BATTONS

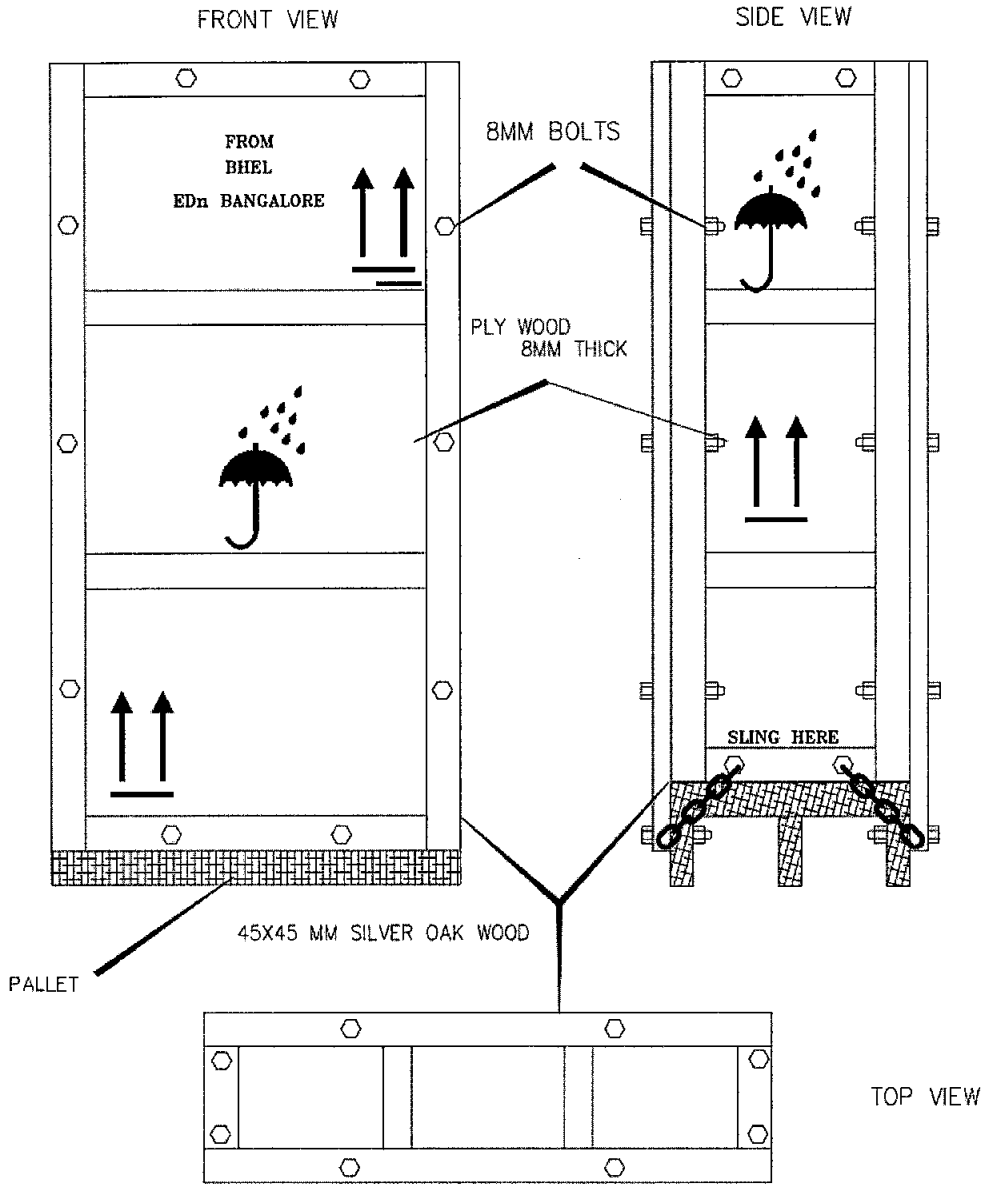
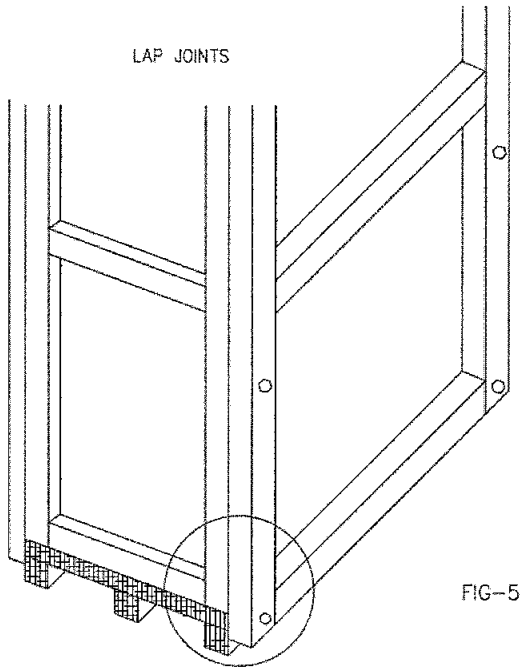


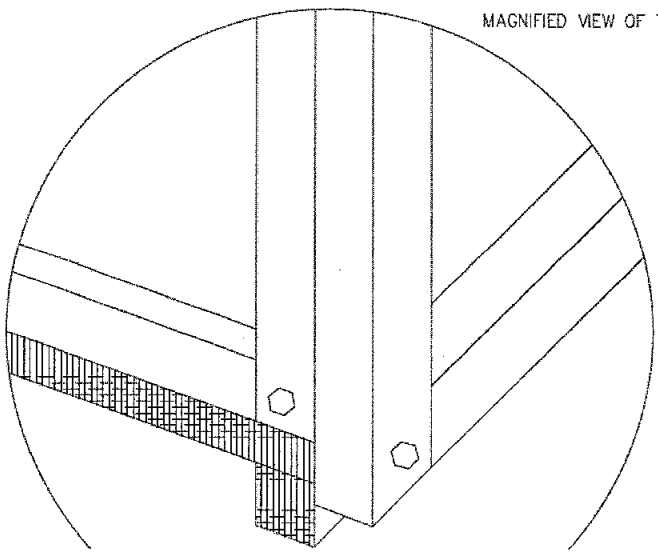
FIG-4

LAP JOINTS



FIG–5

MAGNIFIED VIEW OF THE LAP JOINT



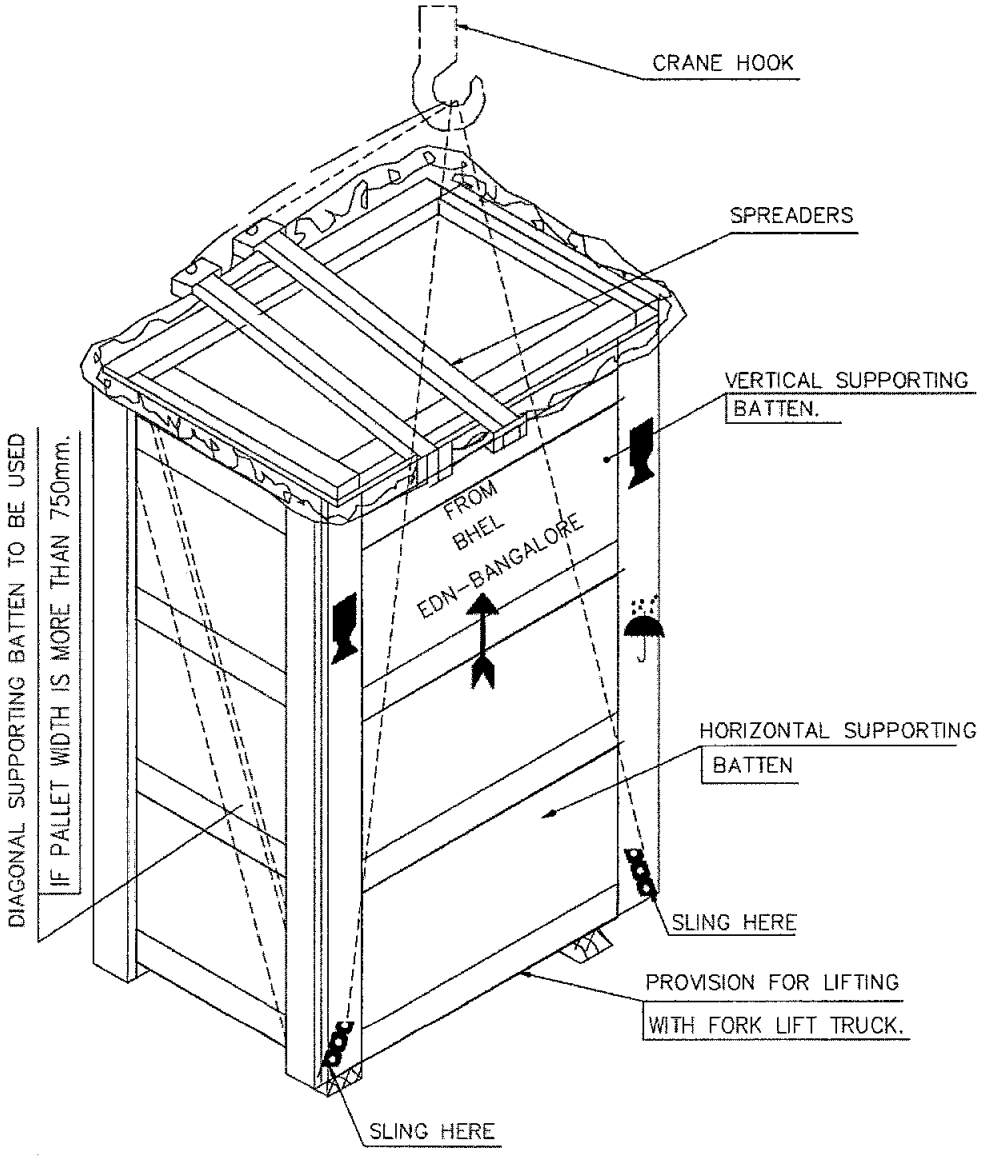


FIG-6 : LIFTING OF PACKED CASE

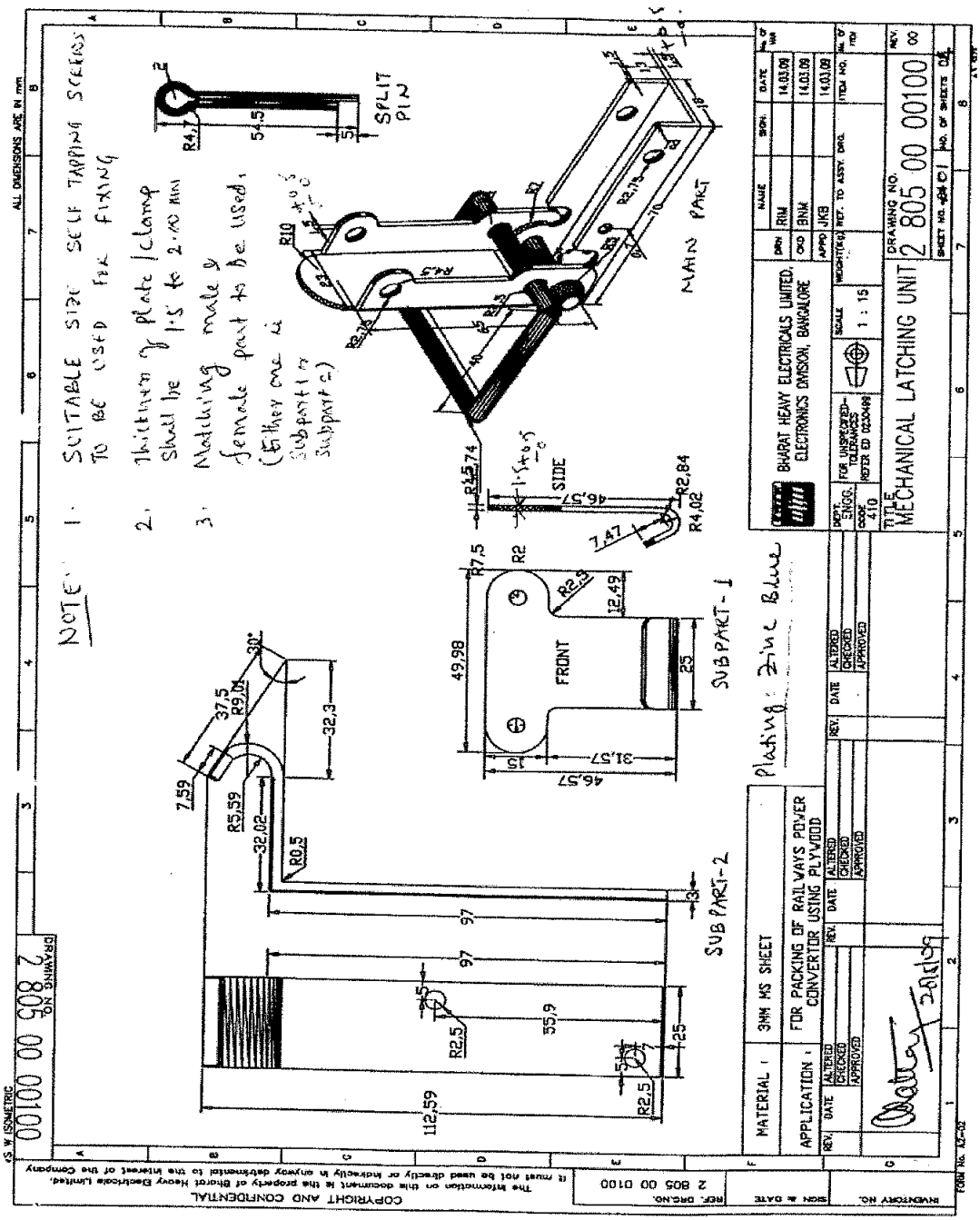
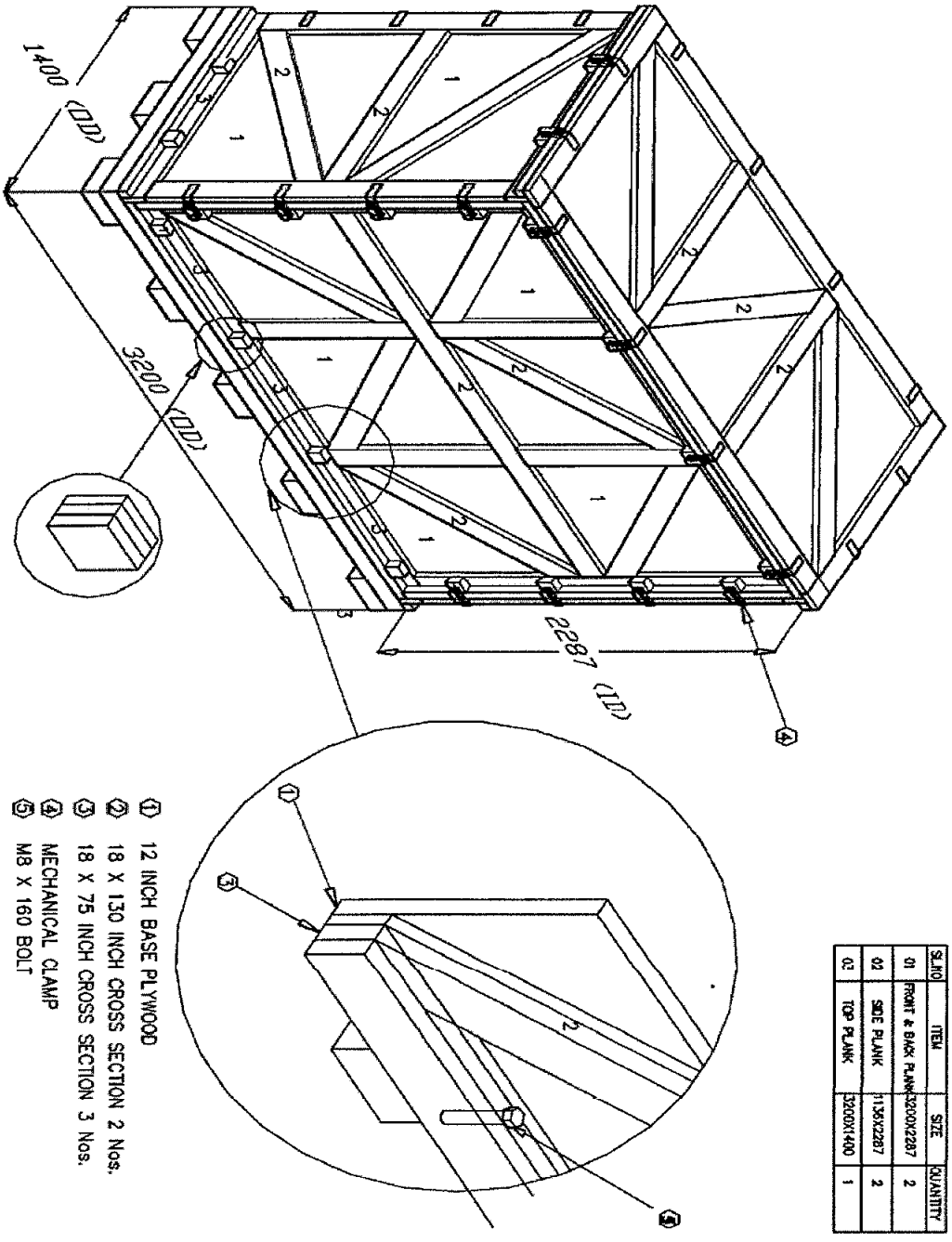


Fig- 7 : Mechanical Latching Clamp



SL.NO	ITEM	SIZE	QUANTITY
01	FRONT & BACK PLANK	3200X2287	2
02	SIDE PLANK	1135X2287	2
03	TOP PLANK	3200X1400	1

Fig - 8 : CLW Railway Panel Packing with Plywood & Plywood Support Battens

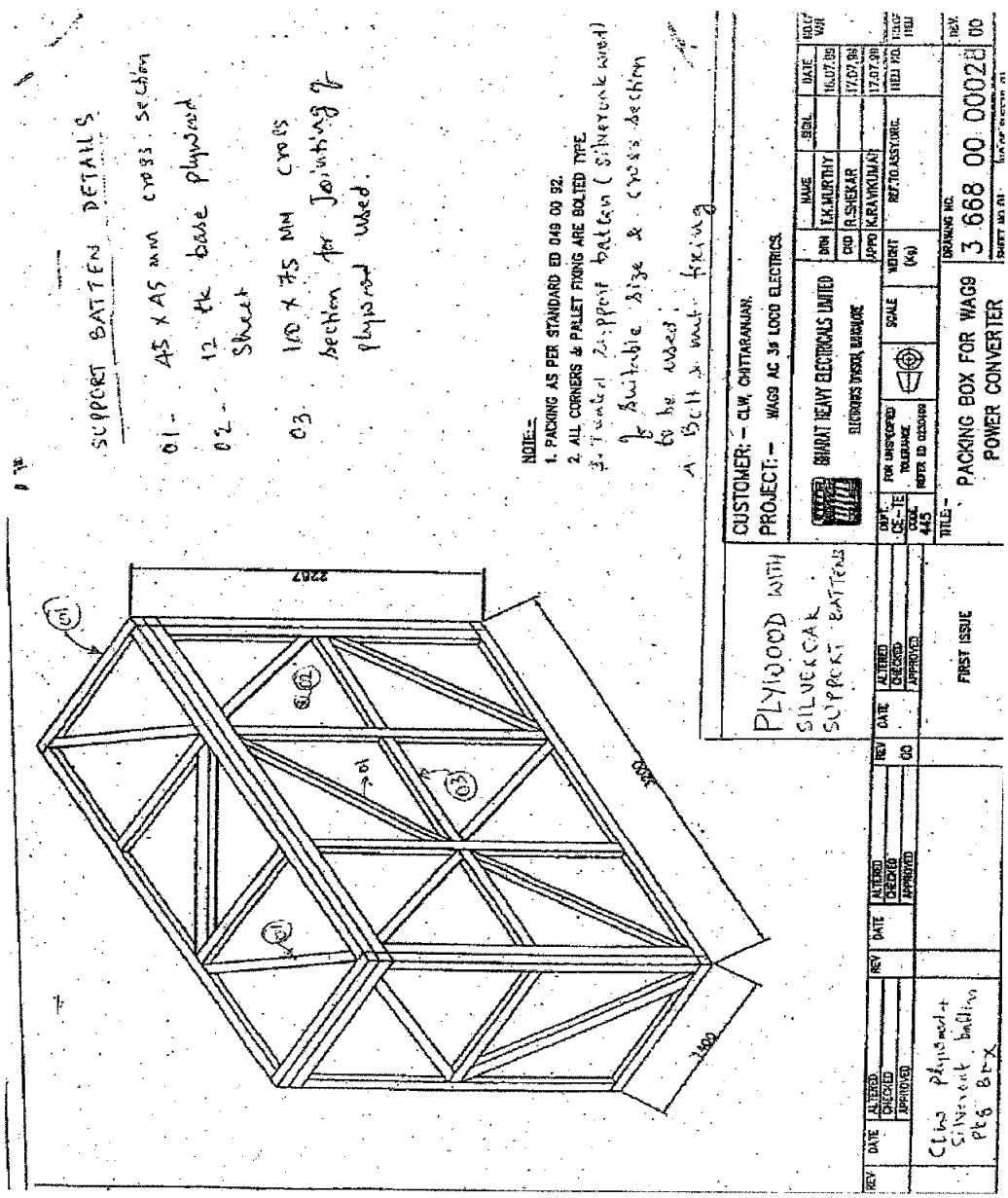
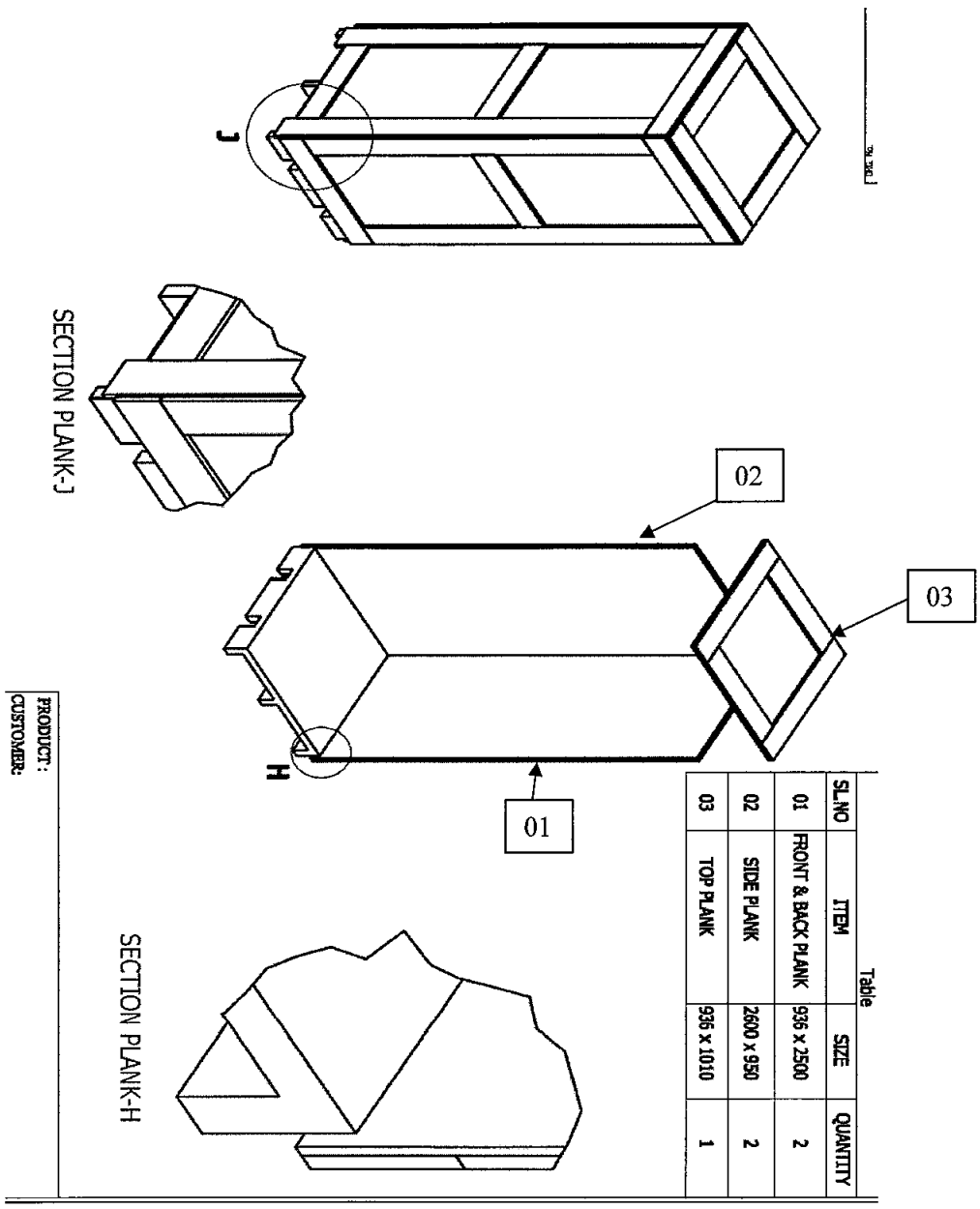


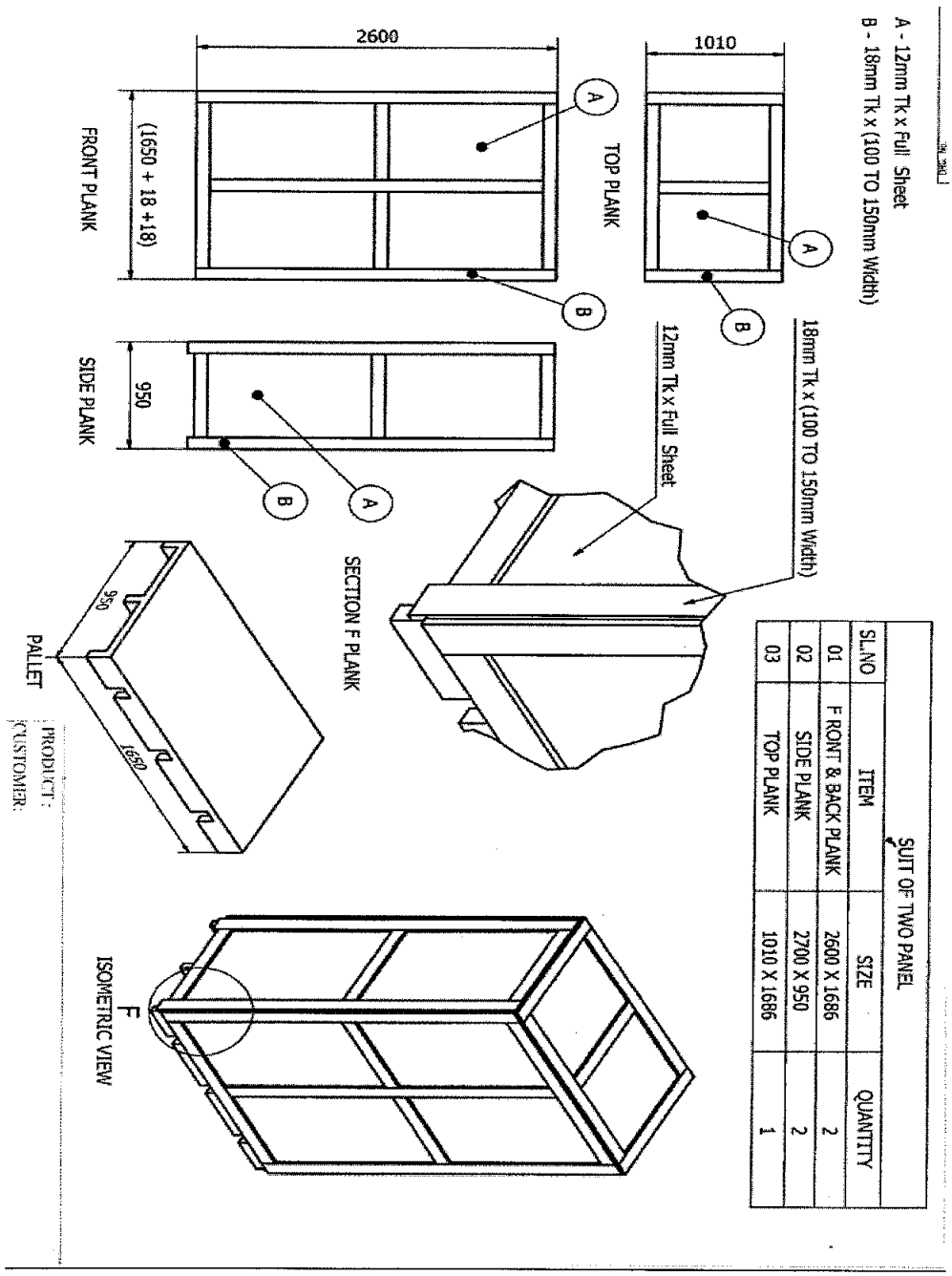
Fig – 9 : CLW Railways Panel Packing with Plywood & Silver Oak Battens



Table

SL.NO	ITEM	SIZE	QUANTITY
01	FRONT & BACK PLANK	936 x 2500	2
02	SIDE PLANK	2600 x 950	2
03	TOP PLANK	936 x 1010	1

Fig-10 : Plywood Packing for Single Suit Panel.



SUIT OF TWO PANEL

SL.NO	ITEM	SIZE	QUANTITY
01	F RONT & BACK PLANK	2600 X 1686	2
02	SIDE PLANK	2700 X 950	2
03	TOP PLANK	1010 X 1686	1

Fig - 11 : Plywood Packing for 2suit panel.

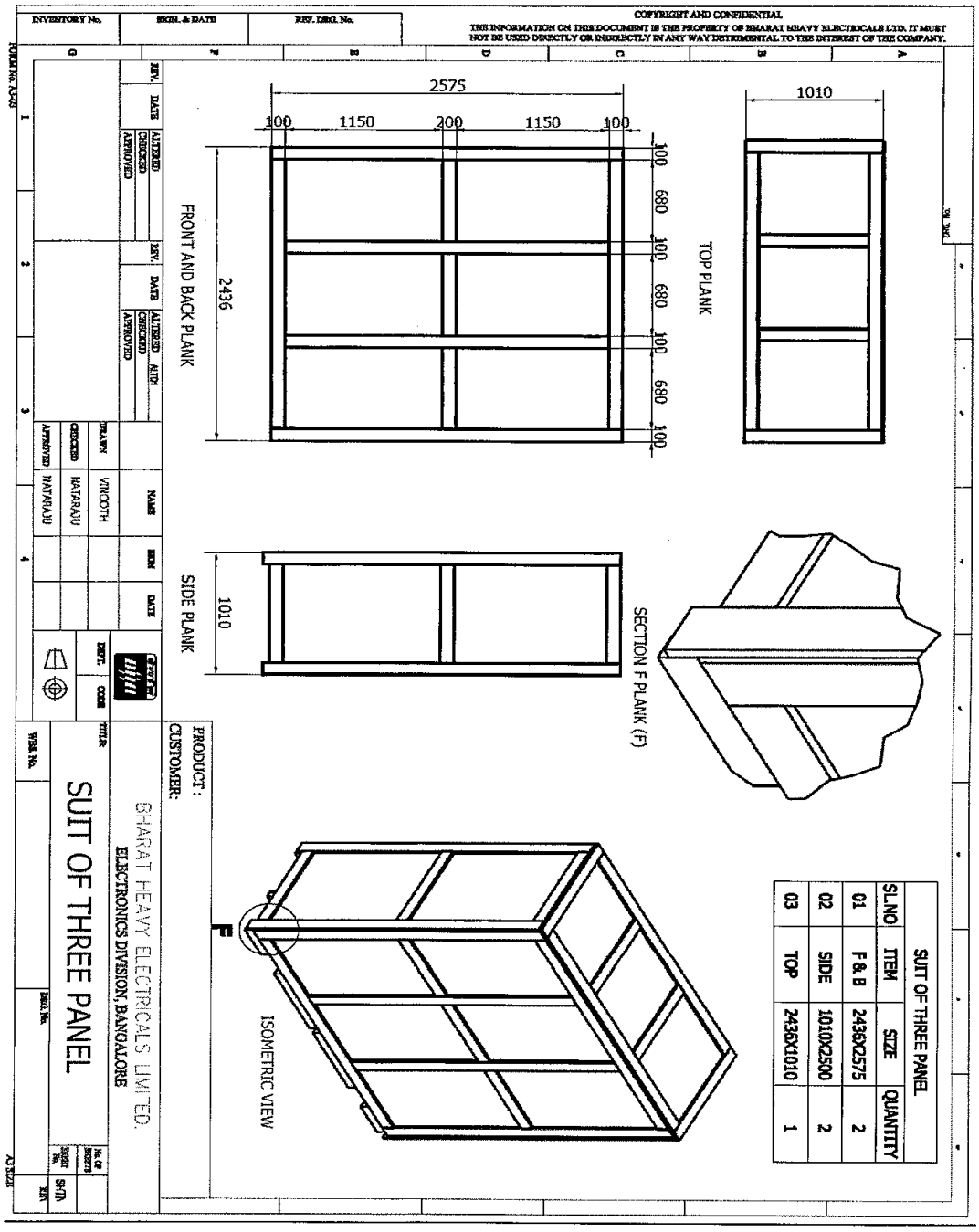


Fig – 12 : Three Suit Panel Packing

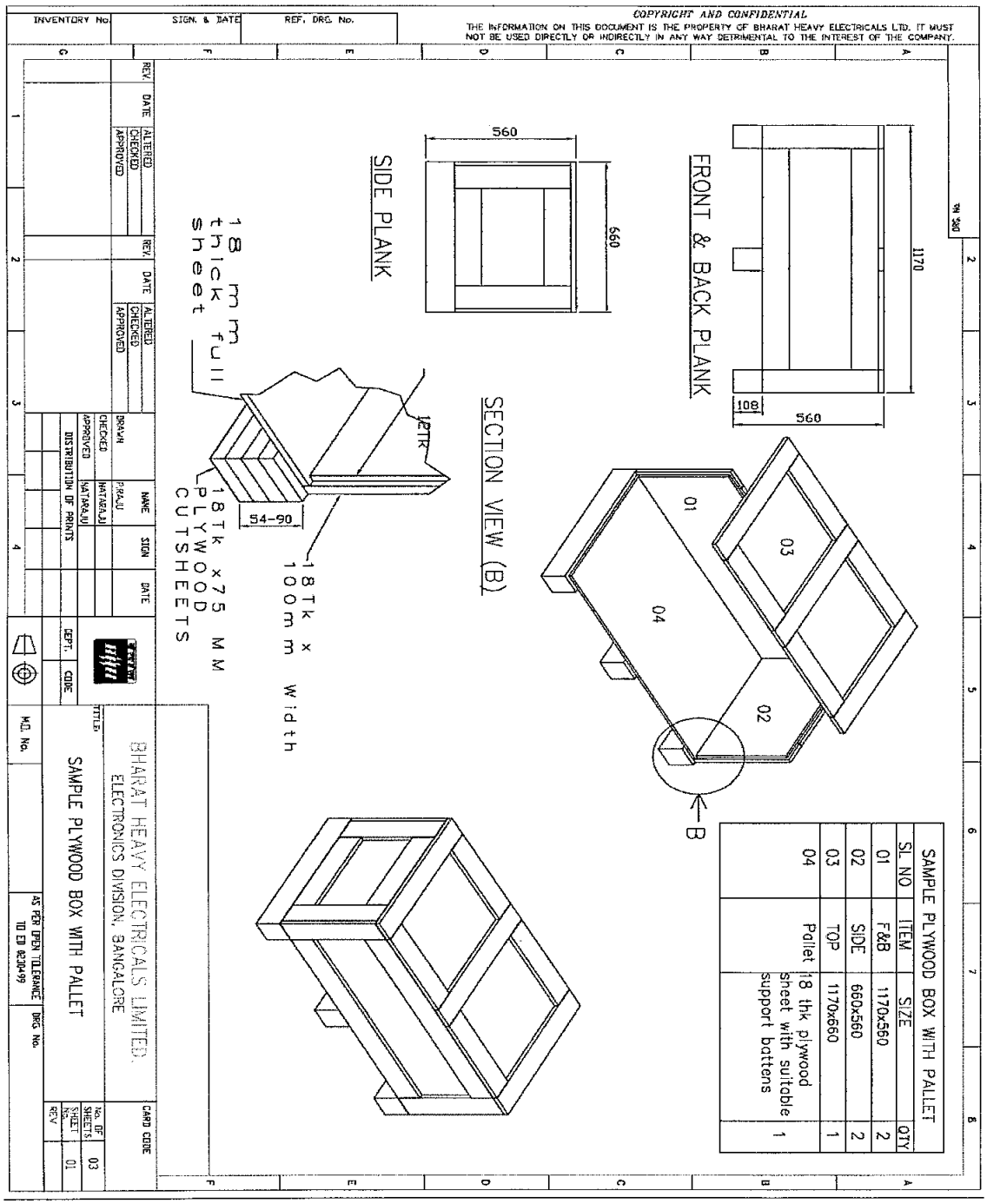


Fig – 13 : Plywood small case with Pallet

Easy spares [Initial and O&M] Traceability and Identification at units and as well as at sites:

Fig: 14