	PROJECT-KHURJA 2X660 MW	DRAWING NO-418150F9002 REV 00 DATE-11.10.2021	
	Blade Vibration Monitoring System Mandatory Spares		
Sl No.	Description of Items	Units of item	Quantity
1	Sensors	No.	20 % of full set or minimum 2, whichever is more
2	Brackets, Fixtures	No.	20 % of full set or minimum 2, whichever is more
3	Internal cabling	Length,M	20 % of full set or minimum 1 run of each type, corresponding to maximum length used in the system
4	External Cabling	Length,M	20 % of full set or minimum 1 run of each type, corresponding to maximum length used in the system
5	Special conduits/ vacuum pass thr	Length,M	20 % of full set or minimum 1 run of each type, corresponding to maximum length used in the system
6	Input card	No.	10 % of full set or 1 number, whichever is more
7	Output Card	No.	10 % of full set or 1 number, whichever is more
NOTE:-1. One Full set of BVMS means instrumentation etc for Four Nos LP Turbines for L0 stage.One LP Turbine includes 2 nos of L0 stage.			
2.During Calculation if offered Spare Quantity comes to fraction,Then it should be rounded to next Higher Integer.			

Prepared By
Anjani Kumar
sd

Checked By
Saswati
sd

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SUPERSEDES INVENTORY NO.

BLADE VIBRATION MONITORING SYSTEM (BVMS)

				NAME	SIGNATURE & DATE
TSX	LALIT KUMAR				
QAX	S K CHAUHAN		TRANSLATED BY	-	-
Member PSC	V K CHAUHAN		WORKED BY	AKG	19/2/15
STE	AKASH SHUKLA		CHECKED BY	BSR	19/2/15
AGREED DEPTT.	NAME	DATE & SIGNATURE	SUPERVISED BY	KBB	19/2/15

APPROVED : K.B.BATRA , AGM (CIE & TCX)

ST 2.60

INVENTORY NO. 2.6464

REV. 00 | 17/2/15

PREPARED : CIE | ISSUED : TSX | DATE : 17/2/15

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BLADE VIBRATION MONITORING SYSTEM (BVMS FOR LP TURBINE AT THERMAL POWER PLANTS)

1.0 Objective: This specification covers the design, supply & erection/ execution of BVMS system for Steam Turbines of various ratings.

2.0 Scope of supply: The scope of supply of BVMS system shall be as per the details given in this specification. However , project specific details will be covered in project data sheets which include

(i) Project rating

(ii) LP turbine drawings & details for mounting purpose.

(iii) Blade (operational data) detail and its Axial/radial movement range.

Project details shall be furnished along with enquiry.

3.0 Applicable codes & standards:

BHEL experience and Product catalogues.

4.0 Application Range:

Operating temperature Range for

a) Probes: 0 to 200° C
b) Preamplifiers: 0 to 90° C
c) Data acquisition system: 0 to 60° C

Rotor Speed: 3000 rpm (Over speed 3750 RPM)
Deflections: 3 µm to 30 mm
Blade count: Refer project data sheet

5.0 System Components: The system consists of sensors, preamplifiers, data acquisition system, software package, operator interface, rack, interconnecting cables and mounting accessories.
All equipment to make the system completely functional as per the requirements of this specification and to be provided by the bidder irrespective of whether it is explicitly specified or not.

5.1 Sensors and Mounting Accessories:
Sensors are required for blade tip timing which should sustain harsh, humid, low pressure, maximum 200° C temperature environment existing at LP Turbine last stage blades along with suitable cables and BNC connectors. Selection of sensor type, numbers & locations suitable for this application to be determined by bidder and shall be subject to BHEL approval depending upon functional requirements. Vendor to provide appropriate details in support of selected type of probes.

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			CHECKED BY	BSR	19/1/15

Additional requirements:

1. Dimensional details of blades will be given in project datasheets.
2. The sensors should withstand the last stage LP steam, vacuum and temperature environment which are typically from 0.1 to 0.2 Kg/cm^2 absolute.
3. The speed of rotation of the blades shall be from zero to 3000 RPM with 25% over speed
4. Integral cable shall be provided with sensors of minimum length of 20 m from sensor to preamplifier.
5. Multiple sensors with redundancy for mid chord measurements to be provided, catering to both the stages of the turbine
6. Conduited cables to be provided to protect from steam environment with Vacuum sealing at every outlet from Turbine casing.
7. Suitable holders and shims to be provided for holding sensors and conduited cables onto the casing to be provided to with stand vacuum pulling force.
8. Vacuum sealing provision at casing penetration.
9. Required tools and fixtures for installation of sensors, conduited cables and other peripherals up to the main system installed in control room.
10. The sensors should withstand without any signal distortion, the magnetic field of at least10 Gauss prevailing near the LP turbine. Suitable test reports to be submitted after order placement.

5.2 Preamplification:

Suitable number of Preamplifiers to process the signals from sensors. These shall be suitable for field installation near the turbine. Integral cable shall run upto these preamplifiers. Protection class shall be IP 65 or better.

5.3 Data Acquisition system:

1. System is required to take the analog signals from the preamplifiers and convert them into timing data which can be further analysed for useful information and software processing.

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2. Data acquisition system shall be furnished in form of 19 inches rack mounted in suitable cabinet. Size of cabinet to be informed in the bid. Cabinet will be placed in control equipment room of power plant.
3. Protection class shall be IP 32 or better.
4. System shall be suitable for operation at 230 V UPS supply. Load details to be furnished by the bidder.
5. OPC interface to be provided for connection to BHEL's DCS. Details shall be finalised during project execution. One signal of phase measurement shall be provided by BHEL.

5.4 Software Package:

5.4.1 Analysis – To monitor the following parameters for each blade:

1. Lean / deflection and tip clearance at leading edge, mid chord and trailing edge in mm
2. Twist (Between Leading Edge and Mid Chord, Mid chord and trailing edge and leading edge to trailing edge) in mm
3. Asynchronous component vibration amplitude, frequency and phase
4. Synchronous component vibration amplitude, frequency and phase
5. Inter Blade Spacing
6. Campbell Diagram

5.4.2 Real Time Display:

1. Instantaneous raw sensor output plot with refresh rate not more than one Second.
2. Sensor health status as per minimum voltage settings of sensor output.
3. Date, Time and minimum five more user configurable operating parameters from OPC list on all displays.
4. Time Plots of Blade Lean, Twist, Synchronous and Asynchronous Vibration, Phase, Amplitude, Damping Factor and Resonance Hz./RPM
5. Blade frequency Spectrum of each blade showing vibration mode
6. Campbell diagram of each blade and all blades together
7. Menu to enable sensor trigger settings

5.4.3 **Archiving of following Data:**

1. Blade Lean, Twist, tip clearance, synchronous and Asynchronous Vibrations and OPC data
2. Trigger for archiving shall be based on user defined time interval or change of any blade parameter or any data from the OPC list. This shall be defined during system configuration
3. Data to be stored with Date and time stamp in ASCII format along with user selected OPCdata
4. Rate of archiving of at least 1 Hr time interval
5. Trending on weekly, monthly and yearly basis
6. Automatic Archiving during transients like coast up and coast Down conditions
7. Format of archived data shall be compatible with MS Excel/ CSV format
8. System shall be capable of generating user defined plots during various modes of operation

5.5 **Remote Connectivity:**

1. It is intended to connect various sites (where BVMS is installed) with web enabled remote monitoring. Hardware for remote connected monitoring shall be placed at Haridwar, India.
2. Recommendation on hardware for remote connectivity to be provided by vendor. Optional price to be furnished by bidder.
3. All software required for remote connectivity to be provided by vendor.

5.6 **Hardware for rack mounted system:**

1. Rack Mounted, Industrial Grade, 64 bit PC based Data acquisition and processing system with minimum 8GB RAM. Processor: Intel i-7 or better,
2. 2.3 GHz or better processor, OS Windows 7 professional and MS Office suite for system
3. Minimum hard disc of 1TB each for rack mounted PC
4. LCD monitor of at least 19" for both rack mounted system
5. Minimum three Ethernet and three USB ports with the system
6. The minimum configuration of Hardware and Software of the entire system to meet the overall specifications of BVMS shall be offered.

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7. The system should work on 230 V AC +/- 10% power supply @ 50Hz.

6.0 Tests:

6.1 Routine Tests:

Following tests should be carried out by the vendor on each piece of sensor, preamplifier and data acquisition system.

1. Visual inspection and dimensional check
2. Functional test for sensor, preamplifier and data acquisition system
3. Burn in test for data acquisition system modules (for 48 hrs. at 55°C)

6.2 Type Tests;

Type Test reports shall be furnished for the following additional tests on electronic modules as per IEC 60068

1. Damp Heat Test
2. Temperature Cycle Test
3. Dry Heat Test
4. Vibration Test

Degree of protection test as per IS 13947 shall be furnished for preamplifier and data acquisition system.

7.0 Test Certificate:

Each piece of sensor/ preamplifier/ data acquisition system shall accompany with 3 copies of the tests certificate with:

i) Name of equipment

ii) Name of manufacturer

iii) Serial no & model no of equipment

iv) Date of testing

8.0 Training:

1. Training should be given at BHEL/Site for minimum FIVE working days on the hardware and software contents of BVMS along with a set of hard copy and soft copy of training manuals.
2. Vendor should enable BHEL Engineers to install and maintain the system independently.
3. For this all necessary installation and maintenance methodologies, debugging features to be provided.
4. Vendor should clearly bring out the methodology of estimating blade parameters like lean, twist, clearance, blade spacing, asynchronous vibration, synchronous vibration and Campbell diagram from raw sensor signal.

9.0 Configuration capabilities:

Configuration of the following as chosen by the user

1. Parameters for Real Time Displays
2. Parameters for Archiving of Data
3. Parameters for commissioning Report Generation
4. Parameters for Data Storage and archiving
5. Automatic status reports (periodically)
6. Web management of reports (periodically)

10.0 Accessories & Cables:

Offer shall include all the accessories required for normal operation of equipment. All types of special cables to be included in the offer.

11.0 Installation & Commissioning:

Supervision of installation of sensors, cables and complete system shall be in vendor's scope. Commissioning of complete system shall be in vendor's scope. Charges for the same should be quoted separately. Vendor shall be responsible for satisfactory functioning of the system. Commissioning report to be generated and to be verified by BHEL Engineer.

12.0 Predispatch inspection:

Inspection shall be carried out by BHEL Haridwar or their nominated agency. Vendor shall give minimum of 3 weeks notice for inspection along with internal test certificates. Manufacturer's Test Certificate required and shall be provided before dispatch.
Material shall be dispatched by vendor only after getting clearance from BHEL.

13.0 Documentation with and after bid:

Following documents to be furnished with bid-

1) Details of sensor type and quantity of sensors
2) System overview showing sensors, preamplifier, data acquisition system, workstation etc.
3) Deviations from specifications, if any.
4) Experience list for similar systems.
5) Complete technical literature including sensor catalogue, system catalogues etc.

Datasheets & wiring diagram of complete system (including sensors, sensor cabling, preamplifier, data acquisition system, mounting arrangement, operator interfaces and remote connection provision etc.) shall be furnished for BHEL approval. Operation & maintenance manual shall be furnished before supply of equipment.

14.0 Recommended spares:

Offer shall include recommended spares required for 2 years operation of equipment. These shall be quoted separately.

15.0 Warranty:

All supplied items to be provided with warranty for 18 months from date of dispatch or 12 months from erection and commissioning whichever is ~~later~~ earlier.

16.0
Cross referred standards: IS 13947 and IEC 60068

	BLADE VIBRATION MONITORING SYSTEM (BVMS)	
	PROJECT- KHURJA - 2x660MW	
	C & I ADDENDUM TO SPECIFICATION ST 51027	
	DOCUMENT NO- 418150F9001 Rev 00 Date-11/10/2021	
S. No.	**Clause No.**	**Description**
1	1.06.01 a(1)	The On-line integrated system shall consist of suitable number of Non-contact eddy current/inductive/magnetic sensors, including hardware, software for monitoring blade vibrations and health based on, but not confined only to blade vibration amplitude/frequency, for last stage and/or last but one stage free standing blades (both Turbine end & Generator end) of low pressure turbines.
2	1.06.01 a(2)	The required sensors suitable for steam environment should be mounted inside the turbine casing, directly seeing the free standing rotating blades in non-contact manner
3	1.06.01 a(3)	The system should be able to detect Synchronous and Asynchronous vibrations. The system should be able to track changes in amplitude, frequency of vibration of individual blade over the base level under various operating conditions including transient and steady state.
4	1.06.01 a(4)	The system should be helpful in identifying the individual blade having crack, prior to failure of blade (off-line analysis/assessment).
5	1.06.01 a(5)	The system should help in giving reliable and accurate blade health assessment to prevent unwanted shutting down of the unit for any corrective action based on above diagnostics.
6	1.06.01 a(6)	Processing of tip-timing data into easily understandable historical trends of blade vibration.
7	1.06.01 a(7)	Generation of reports on a schedule (preferably automatic) in minimum one week and reports to be sent to specified recipients via email.
8	1.06.01 a(8)	Report generation on demand into PDF or Microsoft Word and data export into Microsoft Excel.
9	1.06.01 a(9)	Importing plant process data (minimum 16 nos.) from OPC server, and displaying side-by-side with blade vibration data. In case this is not possible, the data shall be acquired through hardwiring using F type instrumentation cables from control cabinets located in Control Equipment Room.
10	1.06.01 a(10)	SUPPORT FOR 1 YEAR MONITORING AND BLADE ASSESSMENT REPORTS:To generate advisory report remotely, at least once a week and in case of change in behaviour/vibration pattern as per requirement., for the purpose of health assessment of blading and send report by email to NTPC, for a period not less than one (1) year from the date of commissioning of the integrated system.
11	1.06.01 a(11)	Display, analysis and data acquisition system at plant and enable display and analysis at Employer Corporate Centre.
12	1.06.01 a(12)	ADDITIONAL HARDWARE FOR REMOTE MONITORING, DISPLAY AND MULTI USER LICENCE:All hardware, software for display station at Site. For remote monitoring at Employer Corporate Centre, bidder shall supply the Software and Support (Hardware, Internet connection shall be provided by Employer). The data storage memory of the Hardware should be sufficient for at least six (6) months.

ANJANI KUMAR
DY Manager / CIE

Saswati
AGM/CIE

13	1.06.01 a(13)	The system should have provision to display all required process parameters at least 16 number e.g. LP Inlet Steam Pressure and Temperature, Extraction-1 steam pressure, Temperature, Extraction-2 Steam pressure and Temperature, LP rotor differential expansion, Axial shift, Load MW,MVAR, Vacuum, LPT exhaust hood temperature, Generator Voltage etc., as input, so as to enable correlation with process parameters.
14	1.06.01 a(14)	The system output should not get affected by magnetic field due to any other sources e.g. static charging while in operation.
15	1.06.01 a(15)	The signal cable should be properly protected and shielded.
16	1.06.01 a(16)	It shall be possible to transfer major data over soft link to third party systems e.g. OSI/PI etc.
17	1.06.01 a(17)	System/Software should have Multi-user license including for Remote location.
18	1.06.01 a(18)	Bidder shall take necessary precautions in fixing of sensors and brackets/ fixtures if required for fixing of sensors and cabling so that these items don't get loosened when turbine is under operation.
19	1.06.01 a(19)	Sensors, fixtures, cables and any other fitting material used shall be suitable for working in wet steam environment.
20	1.06.01 a(20)	The Bidder shall supply one (1) set of mandatory spares e.g. full set of sensors, brackets/fixtures, Internal cabling, I/O cards etc. for all stages (TE,GE), required for maintenance of the integrated system.
21	1.06.01 a(21)	During the working of the system supplied by the Bidder, in no case it should touch/foul the rotating blades or disturb the aerodynamic flow.
22	1.06.01 a(22)	TRAINING TO CUSTOMERS ON OPERATION AND MAINTENANCE OF BVMS: Bidder shall provide the required training to at least six (6) Employer persons on working of the system, operation and maintenance, data analysis, interpretation towards health monitoring of blades and troubleshooting of the system.

Prepared By

Anjani Kumar
Dy. Manager/ CIE

Checked By

Saswati Srivastava
AGM/CIE