

Revised incorporating Pre-bid meeting replies.

TECHNICAL SPECIFICATION AND SCOPE OF SUPPLY FOR ESTABLISHING ENGINE TESTING FACILITY FOR 1500 hp DIESEL ENGINE ALONG WITH ACCESSORIES
Scope : Design, Manufacturing , Supply , Installation, Commissioning and Performance prove out of 1 No. Engine Testing Dynamometer & Accessories suitable for testing 1500 hp Diesel Engine of specification indicated in this tender on TURN-KEY BASIS.
 The Technical specification is as per Annexure -1 & S and terms and conditions as per Annexure-2 enclosed.
BEML is developing and manufacturing 1500 hp diesel engine at its Engine Division – Mysore. After completion of design and manufacturing activities, the engine to be tested for Development, Performance test and Endurance test as per the specified test cycles. The details of which are furnished in this tender.

1.00	Hydraulic Dynamometer suitable for testing of 1500hp capacity Diesel Engine with CRDI system for the test cycles indicated in the Tender.		
Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
1.1	Type	Computer Controlled Power absorption type Hydraulic dynamometer for Testing of Diesel Engines.	
1.2	Quantity	1 No.	
1.3	Application	<p>For Testing of 1500 hp Developmental Engine at BEML Engine Division - Mysore. The dynamometer system shall be capable of absorbing and measuring power of engine indicated in the tender. The dynamometer system offered should have the capacity and features to conduct the following test cycles indicated in the tender.</p> <p>a) Engine Mechanical and Combustion development test, Engine calibration and performance demonstration as per Annexure - B</p> <p>b) Engine Performance test as per ISO 1585 (As per Annexure - C)</p> <p>c) Driving cycle test (As per Annexure - D): 400 Hrs x 2 Engines.</p> <p>d) Duty cycle test (As per Annexure - E): 1200 Hrs x 2 Engines.</p> <p>e) Accelerated durability test (As per Annexure - F): 400 Hrs x 2 Engines.</p> <p>f) Resonance durability test (As per Annexure - G): 250 Hrs x 1 Engine.</p> <p>g) Apart from these we may have to conduct other test cycles based on the requirement during development and at the time of validation.</p> <p>h) Thermal cycling durability Test (500 Cycles) (As per Annexure - W).</p> <p>For overall Engine test setup & BIPO test (Break in Pass off /Run in test) refer Annexure-Y</p>	
1.4	Engines to be tested in the proposed dynamometer.	1500 hp power engines as per the specification indicated in the Annexure - A of tender.	
1.5	Place of installation	Engine Division - BEML Ltd., Mysore	
1.6	Note : The detailed Civil foundation drawing for installation of the dynamometer, associated water line work , Service trenches with cover plates etc., to be submitted by the firm within one month after PO for execution and site preparation by BEML Ltd. Further Foundation template and Hardware Etc, are to be supplied by the firm.		
1A	Dynamometer : (Supplier has to consider suitable Factor Of Safety while selecting the Dynamometer)		
1A1	Max. Power capacity of Dynamometer (in kW)	Suitable for testing 1103 kw rated power engine as per the Engine specification. The test cycles also calls for Engine shut down by overloading hence the dyno should have adequate overloading capacity.	
1A2	Max. Torque capacity of Engine (in Nm)	4800 Nm @ 1560 rpm to 1700 rpm	
1A3	Max. speed of the Engine	3525 rpm	
1A4	Moment of inertia of the dynamometer	Lesser the better. Firm to indicate. PI refer point 1D6	
1A5	Digital Controller:	Digital Controller: suitable for testing of 1500hp Engine for the cycles indicated in the Tender.	
1A6	Engine direction of rotation	Counter clockwise when viewed from flywheel end of the engine	
1A7	Power & torque characteristic curves of dynamometer	To be enclosed with technical bid. The torque and power curve of engine shall be plotted on the dyno curve. All testing points shall fall well within the envelope of dyno curves for accuracy of measurement.	
1A8	Speed measurement	The dynamometer should be equipped with non-contact type magnetic pulse pick-up sensor.	
1A9	Dynamometer coupling	<ol style="list-style-type: none"> To be provided one end suitable for connecting to Cardon shaft. The free end of dynamometer should have a suitable feature for barring-over (Manual rotation of the Engine crank shaft) of the engine. A suitable safety-system such as a micro switch linked to the test bed control system to ensure that the engine cannot be started with any barring-over tool left attached may be provided. 	
1A10	Inlet water pressure or flow switch	Firm to indicate Minimum inlet water pressure required for the safe working condition of the Dynamometer. Pressure/flow switch to be provided to give an alarm followed by engine shut down to safe guard against dry running of the dynamometer.	
1A11	Internal Protection against corrosion	The material of construction of parts coming in contact with water should be resistant to corrosion and cavitations.	
1A12	Electric Power requirement for Dynamometer system	Firm to indicate connected load including all accessories.	
1A13	Over all dimension of the dynamometer	Firm to indicate	

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1A14	Measuring Accuracy :		
1A14.1	Torque (Nm)	± 0.25% of the Measuring range	
1A14.2	Speed (rpm)	± 1 RPM	
1A15	Load Cell :		
1A15.1	Make	HBM /Sensotronics load cell to meet the capacity and accuracy requirement with calibration certificate	
1A15.2	Torque Measuring system	in Nm	
1A15.3	Working environment of Dynamometer	0 - 60 deg C	
1B	Sensors/ Devices:		
1B1	Instrumentation for the following variable	Measuring Accuracy / Range	
1B2	Engine speed	± 1 RPM	
1B3	Dyno speed	± 1 RPM	
1B4	Dyno torque	± 0.25% of the Measuring range	
1B5	SFC (g/Kw-Hr)	Format for SFC display: NNN.NN	
1B6	Relative Humidity Sensor and Display : Intake air Relative Humidity Measurement and Display. Suitable interface to connect with PC system.	±1% (Range : 0 to 100 %)	
1B7	Temperature Sensors RTD type (To be integrated with Test Cell Automation)		
	Description	Accuracy / Range	
1B7.1	Cell ambient temperature	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.2	Coolant temperature (engine outlet)	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.3	Coolant temperature (engine inlet)	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.4	Engine air inlet temperature	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.5	Compressor A inlet & outlet temperatures	As per ISO:1585 / 0 - 300° C (RTD type) - 2 Nos.	
1B7.6	Compressor B inlet & outlet temperatures	As per ISO:1585 / 0 - 300° C (RTD type) - 2 Nos.	
1B7.7	Charge cooler coolant inlet temperature	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.8	Charge cooler coolant outlet temperature	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.9	Oil temperature main gallery	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.10	Oil temperature oil tank	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.11	Oil temperature oil cooler in	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.12	Oil temperature oil cooler out	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.13	Oil (scavenge) pump inlet (or engine sump) temperature	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.14	Inlet manifold / plenum temperature	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.15	Spare-1	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.16	Spare-2	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.17	Spare-3	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.18	Spare-4	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.19	Spare-5	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B7.20	Spare-6	As per ISO:1585 / 0 - 200° C (RTD type)- 1 No.	
1B8	Temperature Sensors K- type (To be integrated with Test Cell Automation)		
	Description	Accuracy / Range	
1B8.1	Charge cooler air inlet temperature	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.2	Exhaust outlet temperature	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.3	Special Thermo couple sensors for Exhaust manifold skin temperatures measurement – up to 6 nos per bank, Total 12 Nos. (PI refer Page No.24 of Annexure-w)	As per ISO:1585 / 0-1000° C -12 No.	
1B8.3-a	Turbine housing inlet and outlet	4 Nos.	
1B8.3-b	Cylinder Heads	12 Nos.	
1B8.4	Fuel meter temperature	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.5	Oil (delivery) pump outlet temperature	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.6	Fuel spill temperature (fuel return)	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.7	Fuel temperature (HP pump in)	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.8	Spare-1	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.9	Spare-2	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.10	Spare-3	As per ISO:1585 / 0-1000° C (K-type) -1 No.	
1B8.11	Spare-4	As per ISO:1585 / 0-1000° C (K-type) -1 No.	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Qualities offered to be filled by the Firm.
1B9	Pressure Sensors (To be integrated with Test Cell Automation)		
	Description	Accuracy / Range	
1B9.1	Inlet air pressure (pre-filter)	As per ISO:1585 / -1.0 to +1.0 bar Pressure Transducer - 1No.	
1B9.2	Inlet air pressure (post-filter)	As per ISO:1585 / -1.0 to +1.0 bar Pressure Transducer - 1No.	
1B9.3	Ex Gas Back pressure (SS sampling tube of 1.5 meter at the sampling end to be provided)	As per ISO:1585 / -1.0 to +1.0 bar Pressure Transducer - 1No.	
1B9.4	Spare-4 for Vacuum pressure measurement	As per ISO:1585 / -1.0 to +1.0 bar Pressure Transducer - 1No.	
1B9.5	Spare-5 for Vacuum pressure measurement	As per ISO:1585 / -1.0 to +1.0 bar Pressure Transducer - 1No.	
1B9.6	Barometric pressure	As per ISO:1585 / 0 - 2 bar Pressure Transducer - 1No.	
1B9.7	Coolant system pressure (HT expand. tank)	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.8	Coolant system pressure (LT expand. tank)	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.9	Coolant pressure (engine outlet / Top hose)	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.10	Coolant pressure (coolant pump inlet)	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.11	Compressor A inlet & outlet pressures	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.12	Compressor B inlet & outlet pressures	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.13	Charge cooler air inlet pressure	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.14	Inlet manifold / plenum pressure	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.15	Exhaust outlet/Manifold pressure - P3 (SS sampling tube of 1.5 meter at the sampling end to be provided)	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.16	Exhaust gas pressure after the Turbo charger - P4 (SS sampling tube of 1.5 meter at the sampling end to be provided)	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.17	Fuel filter inlet pressure	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.18	Fuel filter outlet pressure	As per ISO:1585 / 0 - 5 bar Pressure Transducer- 1 No.	
1B9.19	Oil pressure oil cooler in	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.20	Oil pressure oil cooler out	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.21	Oil (delivery) pump outlet pressure	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.22	Fuel pressure (HP pump in)	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.23	Oil pressure main gallery	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.24	Oil pressure Piston Cooling Jet/Nozzle Gallery	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.25	Oil (scavenge) pump outlet pressure	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.26	Fuel return pressure	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.27	Spare-1 for pressure measurement	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.28	Spare-2 for pressure measurement	As per ISO:1585 / 0 - 10 bar Pressure Transducer - 1 No.	
1B9.29	Spare-6 for pressure measurement	As per ISO:1585 / 0 - 5 bar Pressure Transducer 1 No.	
1B9.30	Spare-7 for pressure measurement	As per ISO:1585 / 0 - 5 bar Pressure Transducer 1 No.	
1B9.31	Spare-8 for pressure measurement	As per ISO:1585 / 0 - 5 bar Pressure Transducer 1 No.	
1B9.32	Spare-9 for pressure measurement	As per ISO:1585 / 0 - 5 bar Pressure Transducer 1 No.	
1B9.33	Spare-10 for pressure measurement	As per ISO:1585 / 0 - 5 bar Pressure Transducer 1 No.	
1B9.34	Pressure Transmitters for measurement of pressure mentioned above with IRA/Druck/Reputed MAKE. The pressure sensors shall be fitted in the Transducer box and the necessary connecting hoses and cables required for pressure transducers to be supplied by the firm. The hoses should have end fittings suitable to 1/8 BSPT female thread at engine end. The necessary connecting hoses and cables required for pressure transducers are to be supplied by the Firm as per the site condition.		
1B10	Instrumentation - others (To be integrated with Test Cell Automation)		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
	Description	Accuracy / Range	
1B10.1	Time Totalizer: Electro-mechanical hour counter to be provided to measure the total number of hours run by the engine under test. The sensing would be through the magnetic pulse pick-up on the dynamometer or advanced. (Counting to start only if speed is more than 600 rpm)	As per Applicable standard	
1B10.2	Coolant flow (non-intrusive) for HT Circuit	As per Applicable standard / For HT line,1200 LPM(Approx) flow capacity of Non-intrusive type Flow meter to be supplied along with Dynamometer. For details, refer Annexure - W of the tender.	
1B10.3	Coolant flow (non-intrusive) for LT Circuit	As per Applicable standard / For HT line,1200 LPM(Approx) flow capacity of Non-intrusive type Flow meter to be supplied along with Dynamometer. For details, refer Annexure - W of the tender.	
1B10.4	Electronic Oil level sensor:	As per Applicable standard / The engine will be fitted with an external lube oil tank of capacity 70 L . The drawing of the oil tank will be shared after the order placement. The firm is required to design, manufacture, Install "Electronic Oil level sensor" and to integrate with Test cell automation system for oil level display, Alarm and Emergency stop options on real time basis.	
1B10.5	Additional analog and digital I/O – Channels, If required.	The firm has to provide adequate no. of ports and channels for interfacing and integration for all the instrumentation required to conduct the 5 types of test cycles wherever data logging/control are required under automation.	
1B10.6	Zero offset adjustment is to be made possible in the system during calibration of all kind of sensors.		
1B10.7	Each Temperature, Pressure and other sensors to be clearly identified with a name plate at both the ends. Each sensor should be supplied with Calibration Certificate mentioning measuring range, Serial No, type, date of calibration and due date of calibration. The calibration should be carried out for the complete measurement system from each transducer to display read out or channel logger is carried out.		
1B10.8	Scalability - The system should be scalable to accommodate additional data I/P and O/P modules, in future, at the user end without any interlocks. Provision should be available for increasing the No. of channels for augmentation.(Add-ON)		
1B10.9	Cable loom - 15 Mr.. Long	Firm should supply the cable loom of 15 meters from the test bed to control system.	
1B11	Alarm Annunciator.		
1B11.1	To be housed in Test cell Automation System for monitoring critical parameters of Engine Test Bed. This should consist of Audio, Visual alarms and initiation of Engine shut down actuation depending on the conditions defined. Fault reset facility also to be provided. All critical (user defined) and calculated channels shall have 4 Levels of Annunciation i.e. HI-LO Alarm and HI-LO Shut down. The action to be taken when a channel exceeds an Alarm shall be configurable for options like Idle, Coast-down, Fast stop and Shut down. False alarm reset to be provided.		
1B11.2	The Alarm Annunciator which shall include but not limiting the display of following alarms :		
1B11.3	Dyno Services : The dyno services shall include an alarm when a discrepancy between dyno and engine speed exist (e.g. due to shaft breakage)		
1B11.4	Engine Over speed: Engine under speed alarm is also needed since cell is going to use automated stop/starting of the Engine.		
1B11.5	Dynamometer water outlet temp high		
1B11.6	Eng. Lube. oil pressure low		
1B11.7	Eng. Lube. oil temp. high		
1B11.8	Eng. Water outlet temp. high and low coolant level		
1B11.9	Engine should be brought to idle when hardware alarm trips are activated from Engine Start / Stop Controller.		
1B11.10	Other parameters as per standard		
1B11.11	Data Logging and Signal Conditioning : The detailed test cycles and data logging requirements are defined in Annexure-B to G . Firm is required to study the requirement and quote & supply accordingly		
1B11.12	Parameter RTD type:	(sampling rate:: 10 Hz or better) : Firm to indicate	
1B11.13	Parameter Thermocouple type:	(sampling rate:: 10 Hz or better) : Firm to indicate	
1B11.14	For Pressure Measurement with transducers:	(sampling rate:: 10 Hz or better) : Firm to indicate	
1B11.15	For others	(sampling rate:: 10 Hz or better) : Firm to indicate	
1B11.16	In cell Display Panel	The In cell control panel shall provide parallel 1" Digital display for speed in rpm and torque in Nm, Power in kW and Main Gallery Oil Pressure in bar.	
1C	Test cell automation for Starter:		
1C1	The Engine has built-in Air starting system comprising Air compressor, storage tank, Air operated starting motor with ON-OFF mechanism on the equipment. Similar set-up will be arranged in the Test cell. The details of the ON-OFF mechanism will be shared during DAP, the same to be interfaced with the Test Cell Automation for programmed START and STOP of the Engine. The engine also has Electrical starter motor which is energised by the Electric cranker which is part of this tender. Engine is started by either Air starting or Electric starting through automation depending on the test cycle requirement. The test cell automation system should cater this requirement. Note: The Engine has lube oil priming system through an electric pump. This pump also to be operated through automation to ensure build-up of main oil gallery pressure. The engine to be started only after attaining the pre-requisite pressure at main gallery.		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
1D	Cardon shaft and Coupling		
1D1	1. Considering the Engine and Test Cycles to be tested, the firm has to offer 4 nos of Cardon shafts along with Torsional coupling 4 Nos, Adaptor plate at Dynamometer side 4 Nos as well as engines side 4 Nos suitable for testing of engine. 2. The Cardon shaft should have adequate factor of safety and to be supplied with manufacturers test certificate. 3. All hardware required for connecting the cardan shaft to adaptor plate and to the dynamometer and engine shall be supplied in full sets. 4. Suitable metal stand to be provided for keeping Mounting brackets and Adapter plates. 5. The intermediate centre support bearing (steady bearing) to be provided as per the design requirement. 6. The cardon shaft, adaptor plate and torsional coupling should be balanced to G6.3 (ISO 21940) grade.		
1D2	Type of cardan shaft	Universal joint on both ends with telescopic arrangement	
1D3	Make of cardan shaft	Voith/Twiflex/Gwb/kusel/Centa/Reich/GKN/Reputed make	
1D4	Extended length of Cardon (Approx.)	Suitable for testing Engine as per Engine -Dyno Mounting plan. The Fly wheel end of the Engine is shown in Annexure - R . The cardon shaft length collapse of approximate 100 mm shall be allowed.	
1D5	Cardon Shaft Guard & shaft support	1. Suitable safety guard (hinged type) for the Cardon shaft With close fitting ring segments to constrain shaft parts whirling in case failure occurs. 2. Screw jack/suitable support for supporting the Cardon shaft and the Cardon shaft Disc when the Cardon shaft is dis-engaged from engine.	
1D6	Moment of Inertia of the Engine for selection of cardon shaft.	1. Engine will be tested with flywheel. 2. Adaptor between flywheel and driveshaft to be designed and supplied by the firm. 3. Engine MI is 1.726 Kg m ² 4. MI of Flywheel is 1.05 kg m ² 5. MI of the Engine side Adaptor plate should be 1.48 kg m ² .	
1E	Cable boom with swinging arm and transducer box		
1E1	Cable boom with swinging arm and transducer box	The transducer box to be provided to house the pressure sensors and sockets for thermocouples & PT 100 sensors etc. This should be mounted on a swivel boom column. This swivel arrangement should be located suitably proximity to engine. The cable routing should be neat with identification tags at both the ends. The swivel arrangement should be sufficient enough to cover the engine bed. Consider articulated boom to offer more flexibility of location over engine.	
1F	ECU Interface for Communication		
1F1	Automation system must have TCP-IP interface between any make ECU / EDC system e.g. Leibherr / Heinzmann and other advanced electronic controlled FIE systems. Two way communication between ECU (CAN) and data acquisition system should be possible so as to read and write ECU data. Preferred communication is CAN interface communication of 2 No's. of ECU should be possible. (Min. numbers of ECU parameters to be logged to interface in the automation system is given in Corrigenum-1) Power supply to ECU: 24 V DC with 10 Amps out put with control switch shall be provided for ECU of CRDI System.		
1G	EXHAUST GAS BACK PRESSURE CONTROL SYSTEM - 1 No		
1G1	1. For measuring and adjusting the engine exhaust gas back pressure, necessary sensor and motorized butterfly valve to be supplied. The exhaust back pressure control valve to be mounted at a suitable location in the exhaust line. The butterfly valve opening to be adjusted by electrically operated press button / Potentiometer. 2.The exhaust back pressure sensor shall measure and display the exhaust back pressure in the test cell automation display panel for data logging 3.Material specification : Suitable for corrosion resistance and high temperature operation preferably stainless steel.		
1H	Engine mounting brackets		
1H1	Engine along with its mounting brackets shown in Annexure- R, to be positioned on to the test bed screw jacks/ Bespoke pillars. The firm should study the engine layout and design & supply the Brackets / Adapters if required for Engine mounting. Refer Annexure- R for Engine mounting details. Further details will be provided after placement of PO. The high density rubber mounts to be provided in between engine mounting bracket and the support bespoke pillars.		
1J	Dynamometer Maintenance Tool kit		
1J1	Maintenance Tool kit to consist of Tool box containing Special tools, Spanner, Allen Keys. Grease lubricating hand pump with grease, other tools required for day to day maintenance.		
1K	Digital Throttle Controller		
1K1	Type	Throttle lever position controller (Installation is required to test 520 kW mechanical type trial engine.)	
1K2	To consist of the following :		
1K3	Servomotor	The Throttle Actuator with latest servo system which is to be connected to the suitable gear box .	
1K4	Throttle actuation shall be Pull-Push type	Throttle travel 125 mm or more for linear & 90° or more for angular motion is required. Min actuation Force shall be 150 N.	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
1K5	Position feedback system for close loop control	Required	
1K6	Servo amplifier with power output to drive the servomotor.	Required	
1K7	Mounting of throttle actuator	The mounting arrangement of throttle actuator should be adjustable in height as well as position. The firm has to design and supply the throttle actuator mounting stand for up & down, sidewise and back & forth adjustment of the actuator(Through oblong slot) to suit the engine under test.	
1K8	Throttle actuation link	Suitable adjustable link between throttle control unit and Engine throttle with end adaptors to be supplied for the control of throttle.	
1K9	Technical specifications are as follows:		
1K10	Control accuracy :	+/- 0.05 mm or better	
1K11	Adaptation (range) :	0 – 100% corresponds to the adjusting range .	
1K12	Response time: (less than)	400 ms	
1K13	Diesel Engine Shut Down System	24 V DC with 10 Amps out put with switch in the control panel shall be provided for shut down of the engine. (Not for the Engine with CRDI System but for future requirements)	
1L	Dynamometer Calibration.		
1L1	To carry out periodic checking the accuracy of load cell of torque measuring system.	The firm shall provide 1 set of Calibration weights along with the Calibration arm, counter weight and Weight pan assembly. The weights should be traceable to national physical standard with calibration certificate.	
1L2	Water requirement for Dynamometer (Raw water will be provided by BEML Ltd)		
1L3	Minimum water flow required (lit/min)	Firm to indicate	
1L4	Minimum main water supply pressure (kg/cm2)	Firm to indicate	
1L5	Water filter at inlet to dynamometer	1. Suitable heavy Duty inlet filters are to be provided to arrest foreign metal particles, if any through water supply line. 2. Duplex filters to be provided to allow change over of a filter while running system to avoid unplanned shutdowns.	
1L6	Dynamometer water connections	Scope of the firm	
1L7	Operating conditions for the dynamometer system : The system and components should work in the following working environments/operating conditions.		
1L7-1	The control cabinet	Shall be dust and dirt free with IP54 protection with Panel AC	
1L7-2	Ambient temperature condition inside the Engine Test Cell	Max. 60 deg C	
1L7-3	Ambient temperature condition in the operator console room	Max. 35 deg C	
1L7-4	Ambient humidity condition	Humidity: < 85% RH.	
1L7-5	Power supply (Industrial power supply)	230 V +/- 10% , 50 Hz AC Single Ph 415V +/- 10%, 50 Hz AC Three Ph	
1L7-6	Pneumatic air supply (BEML scope)	5-6 Kg/cm2 (Dryer to be provided by the firm if dry air is required)	
1L8	Dynamometer and Engine Controller :		
1L8-1	Digital Dynamometer Controller (DDC) should have Manual & Auto selection.		
1L8-2	Auto or Manual selection either direct and from DAQ PC		
1L8-3	Bump less change of DDC mode		
1L8-4	Selection of different operating modes for different cycles in the scope for engine & Dynamometer.		
1L8-5	IDLE button in DDC to bring engine to idle		
1L8-6	Engine emergency Stop button with appropriate action. 3 no's (1 Control panel, 1 Inside Test cell & 1 outside test cell)		
1L9	Digital Dynamometer Controller and Engine Throttle Controller	Digital Dynamometer and Engine Throttle Controller for automatic control of Engine and dynamometer through PID loops in different modes of operation under close loop control with high control accuracy and stability. The system should be designed for manual mode of testing also. The system should have arrangement to test both CRDI engines and Mechanical FIP engines with throttle controller. Both Mechanical Governor FIP engine and Electronic (EG/CRDI) Controlled Governor Engines to be operated in manual as well as in automatic mode. The firm should supply engine controller to suit both the type of Engines. A selector switch on the control panel to be provided to select Mechanical Governed FIP or EG/CRDI Governed engine. The two selections should work without interference from each other. For testing of EG/CRDI Engine the firm to provide 0-5V input OR other input signal as required by the CRDI system adapted by the BEML. The exact requirement will be finalized during DAP. This is required to control the CRDI engine speed by the Test cell automation software. □	
1L10	Modes of control: (Dynamometer)	Control modes: Multi mode Dynamometer and Throttle control directly by Digital PID with closed loop. Dynamometer Control Modes: Constant position, Constant torque , Constant speed. Bump less mode transfer between different control modes. Facility for manual control from front panel is required for both Mechanical Governor FIP engine and Electronic (EG) Controlled Governor FIP Engines of different power in the manual as well as automatic mode are planned to be Tested in the Test Cell. The firm should supply engine controller to suit both the type of Engines . □	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
1L11	Modes of Control (throttle)	Throttle Control Modes : Constant position, Constant torque, Constant speed. Bump less mode transfer between different control modes. Facility for manual control from local front panel . The system should have necessary control features to conduct all the aforementioned engine tests.	
1L11-1	Any other special mode of operation if required for conducting the Engine test cycles specified in the tender same to be recommended , indicated and supplied as part of the scope.		
1L13	Safety interlocks:	All Safety interlocks are to be provided against over speed, high torque, low lube oil pressure etc., by automatic shutting down the Engine on the test bed.	
1L14	PC BASED INTEGRATED ENGINE TEST, DATA ACQUISITION, CONTROL AND		
1L14-1	Automation system to consists of PC having Window based GUI, programmable test cycles including start & stop, Post test data analysis package, Network connectivity, Integrated digital control and data acquisition, Logging & Alarm capability, Manual control console, User defined real-time calculation, Configurable scan channels, Flexible screen design, Powerful online graphics, Customer formulae interpreter, Channel selection option for logs as well as reports. Standard as well as customizable reports, Run time channel selection for online graphics, Run time print option of the online graphics.		
1L14-2	Standard PC:	Latest DELL / HP make business class PC based on real time 64 bit processor or higher system to be provided with A3 laser colour printer preferably HP/EPSON/CANON/KONIKA MINOLTA.	
1L14-3	Colour Monitor Size	3 Nos LED Colour Monitors: 2 No's of Monitors for installation in Consol corridor, and 1 for in-cell operation along with necessary accessories. The monitors shall be with minimum 22" size or higher for clear display of all parameters and key board & Mouse of with out cable. □	
1L14-4	Processor	Intel Latest version with high speed and response to meet the scope of tender requirements.	
1L14-5	RAM	8 GB or more suitable for the intended application	
1L14-6	Hard Disk	6 TB (The 6 TB storage can be provided with suitable configuration)	
1L14-7	Wireless Key board & optical mouse, USB ports	6 USB Ports/ As per std and Network Card	
1L14-8	Operating System	Licensed Windows 10 or higher / Latest at the time of supply	
1L14-9	Software	1. MS Office, PDF, Etc are with licensed version. Computer system should have the Antivirus / suitable protection. 2. Test cell Automation and other application software. As and when the software are upgraded same to be carried out on the system supplied for a period of 10 years from the date of commissioning at free of cost. All software Licenses to be submitted to BEML Ltd during installation. All back-ups and installation files are to provided to BEML Ltd after commissioning. □	
1L14-10	Test Bed Control system	The test bed control system shall integrate and manage all of the Engine, Dynamometer test equipment and facilities control, monitoring, data acquisition and safety systems. The main devices under automation includes the following: 1.The typical systems and equipment that are managed and operated by the test bed controller will include: • Dyno control • Engine control • Test Automation, Control and Data Acquisition • Safety systems • Sensor / transducer interface • Conditioning equipment required for specific tests • unlimited number of stages • stage and parameter configurable ramp times • multiple 2 stage software alarm sets (warning and shutdown) • multiple acceptance limits • stage based configuration of control loop parameters • conditional and unconditional stage jumps • subroutines • pre-test sequence validation • stage-based, time-based and operator triggered data logging • spreadsheet style (form-fill) and scripted sequence editor interfaces * Graphical and numerical visualization of all measured values * Result output files shall be in CSV, ASCii and ATF format. * Programmable data logging points as defined in the test cycle. * Flexible screen design and report generation as per BEML requirement. * Configurable test results and print formats * User friendly and interactive * Formulae interpreter * Add on modules for interfacing option * Channel selection option for logs as well as for reports The Test cell automation system should have requisite hardware and software to enable activation and logging from standalone in-cell instrumentation (e.g. smoke meter readings). The control system and acquisition software should also include support for real-time calculated channels (standard arithmetic, averaging and trig functions) which may be required for control feedback and/or logging as per standard input channels. The data acquisition system should be capable of logging all specified parameters at a rate of 10Hz and averaged values at specific sequence or operator-controlled time.	
1L14-11	RS232 serial interface for PC	As per the automation requirement + 4 spare ports.	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
1L14-12	System data back up through ghost image or other compatible media to safe guard the data due to disc crash.		
1L14-13	All inputs (for e.g. Pressures, temperatures & flow) to be recorded at a sample rate of 10 Hz per channel or more.		
1L14-14	Test cycles as mentioned in the Tender to be available in the automation library and selectable by the operator.		
1L14-15	Operating Desk	<p>Ergonomically designed operator control panel display screens for clear visibility of Set values, readings, Alarms and provision to change units, Operator interface, Graphical displays and condition monitoring displays etc.</p> <p>The cabinet should have lockable shelves to keeping the documents and special items securely.</p> <p>Suitable revolving chairs - 2 Nos for the test cell operators at the operating desk.</p>	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
1M	HD Camera with Audio Visual recording system		
1M1	<p>1. Supply and installation of Colour CCTV cameras with remote rotation, tilting and zooming with date & time stamp (to aligned with logged data) with the storage capacity of 30 days x 24 Hrs of recording. The viewing requirement is as follows:</p> <p>2. One each Camera At front, rear, RH, LH and top of the engine for close viewing and monitoring of the engine inside the test cell.</p> <p>3. One at front of the test cell looking down for the full view of the cell.</p> <p>4. One Portable Camera with adjustable, mounting to position anywhere for closer monitoring of any suspect area during development.(For monitoring leak paths, Dynamic oil levels and fluid site tubes.</p> <p>5. One Camera for console room.</p> <p>6. Firm has to supply complete Audio and Visual recording system with resolution and other features suitable for the application as explained above.</p> <p>7. Total Qty is 7 Nos or more for the coverage of the area as per the requirement.</p> <p>8. All accessories not indicated above but required for implementation of the system, is part of the scope.</p>		
1M2	HD resolution with Exclusive PC for storage and viewing with 30" size colour Monitor.		
1N	UPS and Voltage Stabilizers of reputed make to support computer and related control system for data logging purpose.		
1N1	Servo Voltage stabilizer : For supply of stabilized electric supply to the controller	Servo Voltage stabilizer - 1 No Suitable rating of NEEL make or reputed make. Firm to indicate the make.	
1N2	Uninterrupted power supply :	Uninterrupted power supply - 1 Nos 6 Kva UPS to support test cell automation system and CC TV system as per point No. 4.27 of Annexure - S. Champion make or reputed make, 30 min back up time. Firm to indicate the make.	
1P	Test Bed and Screw Jacks/Pillar mounts for mounting engine (BEML Scope): The following information and details are provided to help in making the Engine-Dyno mounting plan and overall layout of the test cell.		
1P1	Test Bed	1 No.	
1P2	Test Bed Type : Cast iron engine mounting test bed: Size: 2500 mm (L) X 1500 mm (W) X 200 mm Height with 'T' slots and 6 Nos. independently adjustable screw columns using flat hand wheels for height adjustment/fabricated pillar type with AV mounts will be installed by BEML. (Annexure- U)		
1P3	Test Bed mounting : The test bed will be mounted on anti vibration mounts/suitable mounts by BEML Ltd in the foundation pit.		
1P4	The height of dynamometer axis from the test bed surface shall be as per the mounting layout plan for the engine. The height of Engine drive axis shall be as low as possible from the bed surface for good stability. The total engine and Dyno mtg plan should facilitate setting the alignment (Radial run out and Face out shall be with in 0.5 mm or finer). Refer Annexure - R The dimension of the Test bed top surface from the FFL will be furnished by BEML after the order placement.		
2.0	Elevated platform and Pipeline work for Over Head Diesel Tank (Day Tank) for storage and supply of diesel.		
2.1	OVER HEAD DIESEL TANK - 700 L	1 No (BEML Scope)	
2.2	Scope: Diesel tank of 700 Lts capacity as per the drawing is available at site. Firm has to design, manufacture, supply and erection of elevated platform for installation and commissioning of the Diesel tank. Further firm has to carryout supply and installation of automatic level control system, fuel flow meter, complete with piping, fittings and accessories as per the layout drawing.		
2.3	Application : To provide uninterrupted supply of diesel to test cell during Engine testing . The diesel tank to be mounted on the Metallic high-rise Flat form at a height of approx. 4.5 m from floor level outside the test cell. Firm is required to design, fabricate and install a flat form structure with necessary railings around and access ladder. (Ref. Annexure - H)		
2.4	Supply Line to overhead diesel Day tank : 10 KL Overhead main Diesel Tank is installed outside the testing hanger and whose outlet is maintained at approx. 6 meters from floor level to ensure flow of Diesel to Diesel Day Tank Purely by gravity. Header Pipe line of 100mm dia is laid from 10 KL tank to the Entrance of test cell. The Diesel tank to be connected to the Header line as per the schematic layout for supply of diesel with the seamless pipe size of 40mm NB class B - IS 1239.		
2.5	Schematic arrangement of Diesel Tank with piping and accessories in the test cell is enclosed for reference for guidance. (Refer Annexure - H)		
2.6	Existing Diesel Tank configuration Drawing for reference & guidance (Ref. Annexure - H)		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
2.7	Item scope of diesel tank includes the following:		
2.7.1	Level sensor and Switch for level control (Diesel compatible)		
2.7.2	Control unit to receive feed back from float switch and operate solenoid valve for flow control. (Diesel Compatible) The level control system should be of reputed make and highly reliable to prevent the any malfunctioning and resulting in spillage of overflow of diesel.		
2.7.3	Buzzer and visual indicator for low & high level status		
2.7.4	Control panel with necessary Power supply unit for the system		
2.7.5	Digital Flow meter (flow rate 3 to 80 lit per min) in the inlet line to measure the cumulative flow of diesel. (Diesel Compatible) Make: Rotodel / Fludyne / graReputed make should be highly reliable.		
2.7.6	40 mm NB size/suitable size GI piping on the <u>inlet side</u> with necessary elbows, adaptors, couplings, flanges, gaskets, o rings etc., required for piping work.		
2.7.7	50 mm NB size/suitable size GI <u>overflow pipe</u> with necessary elbows, adaptors, couplings, flanges, gaskets, O rings etc., required for piping work up to the Floor Level.		
2.7.8	Installation and commissioning at site.		
2.7.9	Outlet piping : Out let 40 NB Flanged connection available on the Tank. Further pipeline work is firm's scope.		
2.7.10	Air breather : Air breather with mesh shall be provided on the top of the tank.		
2.7.11	Drain pipe : Drain pipe outlet of Dia 25 mm available in the tank. Further Firm has to do the piping work, valves and fittings Etc. The drain pipe to be connected to the over flow pipe to facilitate emptying of tank for maintenance purpose.		
2.8	General Points : Diesel Tank		
2.8.1	All pipes and pipe fittings shall be of MS steel and weldable and must be 100% leak proof. All fittings and components must avoid use of fuel system banned materials (e.g. Copper, Brass, Zinc-plating etc.)		
2.8.2	Pipes must be thoroughly cleaned before putting them to use.		
2.8.3	The firm must perform the leak proof test for the entire system while the system is in operation after installation and commissioning at site.		
2.8.4	The relevant design standards shall be complied for the scope of work.		
2.8.5	The joints (socket welded /threaded/flanged type) should be designed for long life and leak proof.		
2.8.6	The installation and commissioning work shall be part of the scope. The consumable required for piping work like sealants, welding rods shall be arranged by the firm.		
2.8.7	The warranty certificate for flow meter, float switch and solenoid valve shall be provided along with the supplies.		
2.8.8	The firm to submit GA drawing for approval before manufacturing.		
2.8.9	Any minor changes in the routing of pipes to suit the site conditions if necessary, during installation shall be carried out by the firm without extra cost.		
2.8.10	The pipes shall be painted with Primer followed by two coats of Blue colour paint to shade no RAL 5015 after necessary pre-treatment.		
3.0	Engine Cranker for starting of Engine.		
3.1	Engine Cranker	1 No.	
3.2	Scope : Design, Manufacturing, Supply, installation, commissioning and performance prove out of 1 No. of Engine Cranker for starting the engine as per the following specification and scope. (Refer the electrical circuit drawing for guidance- Annexure J)		
3.3	Brief description : The Engine cranker is an assembly of high current transformer and rectifier to convert 3 phase, 50 Hz AC supply input to DC output. This DC output shall be similar in characteristic to that of battery output for driving self starter motor of the Engine thus replacing the batteries.		
3.4	Type :	For starting engine with starter motor. Engine Cranker should output D.C. supply of 24 volts and 12 volts with a maximum capacity of delivering high current for starting Diesel engines up to 1500 hp capacity with the help of Single Starter.	
3.5	Operating condition	Engine Cranker Should be suitable for use in test bed applications, for starting engines. The Engine Cranker will be placed nearby diesel engine at engine test cell / engine test bed where ambient temperature varies up to 55 °C . The Engine Cranker must perform under this temperature condition.	
3.6	Input power supply (AC)	The input power is A.C. 415 volts 3 phase 50 Hz supply.	
3.7	Out put voltage (DC)	12 V and 24 V selectable (Any one at a time)	
3.8	Transformer	Double wound Delta/Star connected in indoor, panel mounted, step down isolation transformer.	
3.9	- Duty cycle :	15 starts per hour	
3.10	- Phase :	Three	
3.11	- Cycles :	50Hz ± 2.5Hz	
3.12	- Primary input :	415V + / - 10%	
3.13	- Secondary output-1 :	24V volt, max 825 amps	
3.14	-Voltage regulation	Within ± 5 V	
3.15	- Secondary output-2 :	12V +/- 3 volt. max, 416 amps.	
3.16	-Voltage regulation	Within ± 3 V	
3.17	- Cranking time max. :	Max Cranking time/duration is 10 Sec per start. Max No of starts in a 5 min period is 4 starts.	

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3.18	Rectifier :	Suitable number of silicon diodes should be used for rectifying AC voltage (each diode of capacity not less than 150A 400V PIV) with suitable heat sink. Ripple: less than 5%	
3.19	MCCB of suitable rating to be provided.	Required	
3.20	Tap selector switch should be provided at the input of the transformer. Selector switch or Bolt type links should be provided for obtaining the cranker output voltage range 12V /24V (Any one at a time)	One switch to select suitable tap due to input voltage variation . A second switch to select 12V or 24V output.	
3.21	Necessary instruments to be provided for checking / indicating the output voltage & amperes.	1)Volt meter with selector switch at input to measure line to line voltages : 0- 500 V, Analog 96 Sq. mm 2)Ammeter with selector switch at input to measure the currents : 0-50A /100A Analog 96 Sq. mm	
3.22	Suitable LED indicators to be provided for 3 phase input supply indication.		
3.23	Output cable : To connect cranker to starting motors on engine. The cable should be highly resistant to water & oil . The cable should be provided with 95 sq mm copper (tubular terminal ends long barrel type) lugs for connection .	6 x 16 sq. mm single core Teflon insulated flexible copper cable bunched into two such cables of 10 meter length each.	
3.24	Input cable: Flexible power supply cable □	Two nos. 10 sq mm Single core Teflon insulated flexible copper cable each of length 5 meters.	
3.25	The whole unit enclosed in sheet metal housing, painted with blue colour to code RAL 5015 or Light Grey, With wheels / trolleys for easy mobility in working area.		
3.26	The cranker should have Name plates with make, Ratings and other details.		
4.0 FRP COOLING TOWER			
4.1	Scope : Supply, Installation and Performance prove out of cooling tower as per the scope and specification below. (Ref . Annexure- L for the general arrangement) Note : BEML will construct cold water sump, Hot water sump and Pump deck of size specified in the drawing. (Ref. Annexure -K1). 8 Nos of RCC Columns will be provided in the cold water sump by BEML for installation of two numbers of cooling towers. The firm to design the cooling tower size/No of units accordingly. The layout of the sumps and RCC columns etc is as per annexure -K1.		
4.2	Cooling Tower : Two units of equal capacity		
4.3	Type	FRP cooling tower without FRP basin □	
4.4	Application	Raw water from cooling tower to be supplied to the following test equipments:(Flow rates also indicated) 1. Dynamo meter - 1060 LPM @ 3 bar 2. Coolant conditioner - HT Circuit - 960 LPM @ 2 bar 3. Coolant conditioner - LT Circuit - 450 LPM @ 2 bar 4. For other accessories like Combustion Air handling unit, additional flow rate of 530 LPM@ 2 bar(CAHU should have suitable arrangement for controlling water flow & pressure) Total supply to test cell is 3000 LPM	
4.5	Place of installation	In an Open area outside the Engine test cell. Refer the layout for approximate location of the sump and cooling tower arrangement.	
4.6	Design :	The design shall be strong to with stand the wind force and sun , durable for continuous duty application. It should be compact, minimum power consumption and low maintenance . Hot dip galvanized structural and stainless steel fasteners shall be used to make it anticorrosive.	
4.7	Type of flow	Induced Draft Counter Flow. Water is sprinkled from the top and air passes from the bottom to top and discharges waste heat at the top.	
4.8	Overall dimension	Suitable for the pillar structure in the cold water sump. The firm has to make suitable adaptation of cooling tower for mounting on to the pillar structure.	
4.9	Make	Paharpur/ Reputed make	
4.10	Design Parameters		
4.10.1	Flow rate	3000 LPM. (1500 lpm per cooling Tower)	
4.10.2	Cooling capacity / Heat Rejection Rate per cooling tower	135 x 10 ⁴ Kcal/Hr per cooling tower.	
4.10.3	Hot water temperature range	Max 70 °C	
4.10.4	Wet bulb temp	To be considered for Mysuru region	
4.10.5	Delta T	15 °C	
4.10.6	Inlet & Outlet Connection	Flanged	
4.10.7	Dry weight (Approx.)	Firm to indicate	
4.10.8	Operating weight (Approx)	Firm to indicate	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
4.10.9	Cooling Tower Colour	UV stabilized to withstand in open sun light. It should withstand against 60deg C. Blue colour is preferred	
4.11	Fan Specification		
4.11.1	Type :	Aluminium Alloy, Axial flow – Energy Efficient, Aerodynamic profile & durable.	
4.11.2	Mounting of fan	Direct mounting,	
4.11.3	Material of Fan Hub :	HDG(Hot dipped galvanized)/ Aluminium	
4.11.4	Fan guard	to be Provided with bird screen	
4.11.5	Fasteners	S.S 304	
4.11.6	Fan RPM :	Firm to indicate	
4.11.7	Type of Balancing :	Dynamic.	
4.12	Fan Motor		
4.12.1	Motor Power	Firm to indicate	
4.12.2	Protection.	TEFC , IP – 55 Protection Flanged with shaft	
4.12.3	Power supply	3 Ph, 415V , 50 Hz	
4.12.4	Make :	HINDUSTAN/ NEW INDIA/ Reputed make	
4.12.5	Class of Insulation :	F- insulation temperature rise limited to class B	
4.12.6	Air qty/fan	Firm to indicate	
4.13	TOWER PERFORMANCE:		
4.13.1	Wetted Surface Area : (Sq.Mts).	Firm to indicate	
4.13.2	L/G Ratio : (Approx.)	Firm to indicate	
4.13.3	Evaporation Loss as % of circulating water flow	Firm to indicate	
4.13.4	Drift Loss as % of circulating water flow	Should be minimum (Firm to indicate)	
4.13.5	Make-up water quantity as % of circulating water flow	Firm to indicate	
4.14	WATER DISTRIBUTION SYSTEM:		
4.14.1	Main Header & Distribution Pipes :	Firm to indicate	
4.14.2	Water distribution system	Non clog able Spray nozzle shall be fixed in the top to distribute hot water evenly over the honey comb fill media.	
4.14.3	Nozzles	Non clog type effective cooling	
4.14.4	FILLER : (Film Fill)	PVC corrugated honey comb type virgin quality in filler to increase the wetted surface area of water. There shall be channels between flutes to prevent the blockage and shall give large surface area per unit volume. The cold air shall meet cold water at the bottom of the fill providing maximum evaporation and heat transfer in the fill.	
4.15	MATERIAL OF CONSTRUCTION:		
4.15.1	Tower Casing	FRP .	
4.15.2	Tower Structure	Hot dipped Galvanized steel structure.	
4.15.3	Fill	PVC	
4.15.4	Nozzles	ABS/PP	
4.15.5	Fill support	HDG.(Hot dipped galvanized)	
4.15.6	Drift eliminators	PVC	
4.15.7	Drift eliminators support	HDG.(Hot dipped galvanized)	
4.15.8	Fasteners	Stainless Steel 304	
4.15.9	Header Pipe	GI /PVC	
4.15.10	Ladder For periodic inspection and maintenance of the cooling tower	HDG	
4.16	WATER DISTRIBUTOR :		
4.16.1	Water to be uniformly distributed through main header followed by sub header and final distribution droplets.		
4.17	AIR INLET LOUVER :		
4.17.1	All moving parts shall be easily approached from top for maintenance purpose.		
4.18	Electric Control panel and electric cable work		
4.18.1	Control Panel at suitable location : Pl refer the Annexure -S for details of electrical work.		
4.18.2	6 sq. mm – 4 Core Copper Armoured UG Cable – FINOLEX / POLYCAB. With necessary cable gland, lugs, double earth copper wire for fan motor .	As per the site requirement	
4.18.3	All the cables should be neatly routed. Cable tray/channelling/ducting to be provided to the cables .	As per the site requirement	
4.18.4	Smooth bends of long radius shall be used wherever required to reduce pressure drop. (The point pertains to water distribution pipeline.)		
4.18.5	The welded joints should be sound, neat and leak proof for pipes and bends. (The point pertains to water distribution pipeline.)		



Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
5	WATER PUMPS, PIPE LINE WORK AND WATER DISTRIBUTION SYSTEM		
	<u>Scope</u> : Supply, Installation, Commissioning and Proving the performance of the water pumps distribution system as per the following scope on turn key basis . Refer the Layout Drawing:		
5.01			
5.02	<p>BEML will construct Hot water sump, Cold water sump and the Pump deck as per the drawing Annexure K1. During the construction of sumps, Pipe inserts with Flange will be embedded in the concrete wall for further connectivity.</p> <p><u>BEML scope of work pertaining to cooling tower and water distribution system</u></p> <p>1. Construction of Sumps and Service trenches for Cooling tower. (Pl. refer the enclosed drawing Annexure – K1)</p> <p>1. Cold water sump: (a) Inner dimension is 8000(L) X 4000(W) X 3000(D) mm - Qty 1No. (b) No. of columns for cooling tower of 400 mm SQ= 8 Nos (c) No. of outlets for pump = 4 Nos x 5" NB Size x 1200 mm</p> <p>Length One end Flanged "ERW class – C pipe" insert to be embedded in the wall.</p> <p>2 Hot water sump: (a) Inner dimension 8000(L) X 3000(W) X 3000(D) mm - Qty 1No. (b) No. of outlets for pump = 4 Nos x 5" NB Size x 1200 mm Length One end Flanged "ERW class – C pipe" insert to be embedded in the wall. (c) No. of inlets from the Test cell(Hot water into the sump) = 2 Nos x 8" NB Size x 1200 mm Length One end Flanged "ERW class – C pipe" insert to be embedded in the wall.</p> <p>3. Pump Deck: (a) Inner dimension 8000(L) X 3000(W) X 3000(D) mm - Qty 1No. (b) Pump pedestal = 8 Nos, L= 1000 mm B=400,, H=Will be decided during DAP. (c) Galvalume elevated roof with side drops and central beam for mounting of chain hoist. (d) Access ladder to the Pump Deck. (e) Water evacuation pit in the Pump Deck with 0.5 hp Pump with flexible hose.</p> <p>4. Major Underground Trenches for routing of pipes</p>		
5.03	<p>The water distribution system is the scope of the Firm mainly consists of the following.</p> <p>a) Supply of cooling water from cold water sump to Engine Test Cell b) Hot water return line from test cell to hot water sump by gravity. c) All internal cold water supply & Hot water return connections to the test equipments above. d) Supply of hot water from hot water sump to cooling tower. e) Laying of pipe lines in the trenches with necessary supports, Carrying out minor wall openings for pipe line work, restoration and Electrical cables Etc are part of the scope of the tender.</p> <p><input type="checkbox"/></p>		
5.04	<p>Note: Considering the flow and pressure requirements at different points of use, Firm has to design pump capacity, Number of Pumps, Pipe size Etc through a consultant / Expert. All the anticipatory head loss to be considered in the above design of Pumps and Pipe sizes and layout.</p> <p>1) The scope should include design of entire Pumps, Pipeline, Water distribution system Etc considering the existing site conditions flow and pressure requirements as per standard norms. Bill of quantities(BoQ) with detailed specifications to be submitted along with Technical Bid.</p> <p>2) The firm to take up execution of all above works in consultation with Beml in accordance with the scope & specifications freezed. <input type="checkbox"/></p>		
5.05	Centrifugal Monoblock Pump Pump with HGD pump base for supplying cold water from cold water sump to Engine Test Cell	Centrifugal Monoblock Pump of suitable capacity and Nos. + Standby 1 No. Pump, 415V, 3 Phase, 50Hz. The total required flow rate of 3000 lpm, head to maintain approximately 3 bar for the Dynamometer and 2 bar for other test equipments inside the test cell. (Kirloskar / Grundfos/ Mather & Platt make). (Firm to indicate the Make, Model of the pump and enclose flow v/s head chart/curve along with the technical bid) Suitable pedestal for the installation of the pumps in the pump deck will be constructed BEML.	Firm to indicate
5.06	Centrifugal Monoblock Pump Pump with HGD pump base for supplying hot water from hot water sump to cooling tower.	Centrifugal Monoblock Pump of suitable capacity and Nos. + Standby Pump 1 No, 415V, 3 Phase, 50Hz. The flow rate and head of the pumps such as to balance the hot and cold water circuits. (Kirloskar / Grundfos/ Mather & Platt make). (Firm to indicate the Make, Model of the pump and enclose flow v/s head chart/curve along with the technical bid) Suitable pedestal for the installation of the pumps in the pump deck will be constructed BEML.	Firm to indicate

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
5.07	Pump Suction side :		
5.08	HDG Flanged connector for pump suction to be inserted in the concrete wall of cold water and hot water sumps at 0.3 m height from sump bottom	5" NB size x 4 Nos each in cold and hot water sumps are BEML Scope	
5.09	GI strainers at suction pipe inlet for cold and hot water line	To be fitted for each suction line.	As per the requirement
5.10	Y-type Suction Strainer for both Hot water & Cold water line	Suitable NB size Y - type suction strainer with necessary fittings, flanges, gasket, & fasteners.	As per the requirement
5.11	Eccentric reducers at suction side of hot and cold water pumps	Suitable for pump & pipe sizes to be supplied a per the requirement	As per the requirement
5.12	Butterfly valves (Hot water & Cold water) pump Inlet side	Suitable NB size - CI Butterfly valve with SS disc (Audco/Zoloto/Kitz/Kirloskar Make) , with necessary fittings, flanges, gasket, & fasteners.	As per the requirement
	Pump Delivery side :		
5.13	Non- Return Valve at outlet of Hot & Cold water pump.	Suitable NB size - CI (Audco/Zoloto/Kitz/Kirloskar Make) , with necessary fittings, flanges, gasket, & fasteners.)	As per the requirement
5.14	Butterfly valves at out let of Hot & Cold water pump	Suitable NB size - CI Butterfly valve with SS disc (Audco/Zoloto/Kitz/Kirloskar Make) , with necessary fittings, flanges, gasket, & fasteners.	As per the requirement
5.15	Enlarger/ connectors	as per the requirement	As per the requirement
5.16	Structural Supports for pipe laying on floor, wall & trench	As per the site conditions	As per the requirement
5.17	PIPE LINE WORK : Supply and Laying of TATA/JINDAL , M.S "C" CLASS ERW Black pipes as per IS1239 up to 6" NB pipe and IS3589 for beyond 7" NB, pipes. For IS3589 pipes , 6 mm wall thickness to be adapted. This is for cooling water supply and hot water line with necessary fittings , bends, flanges , gaskets, consumables and hardware required for pipe line work. Pipes to be painted with primer followed by two coats of sea green colour as per IS 2379 paint after installation at site.		As per the requirement
5.18	Note: The distance between the proposed pump deck and TC-10 service pit wall for pipe routing measures approximately 65 running meters(one way). The same to be considered for making Bill Of Quantities (BOQ) for pipe lines. For the water pipe connections within the test cell, the firm has to plan pipes of different sizes and make the BOQ accordingly. For the pipe connections between the hot pump and cooling tower firm has to consider appropriate length of pipes as per the design. Two cold water pipe lines to run from the pump deck to the test cell, one for the dynamometer and another for supply to the accessories. The pipe line should be of appropriate size. Two return hot water pipe lines to run from the test cell to the pump deck, one from the dynamometer and another from the rest of the accessories. The pipe line should be of appropriate size for gravity flow without any back pressure.		
5.19	The firm is required to draw two raw water supply lines in to the test cell considering the required flow rate and delivery points. Further inside the test cell branching in to different reduced diameter piping with flanged ends with control valve to be provided near to the point of use for following equipments. 5.18.1. Dynamo meter : Pipe line connectivity is firm scope. 5.18.2. Coolant conditioner - LT Circuit Pipe line connectivity is firm scope. 5.18.3. Coolant conditioner -HT Circuit : Pipe line connectivity is firm scope. 5.18.4. Lube oil conditioner : Providing Flanged connectivity at the point of use. 5.18.5. Combustion Air Handling Unit : Providing Flanged connectivity at the point of use. 5.18.6. Additional 1/2" x 2 points with valve to be provided for general use inside the Test cell. (Additional water line pressure/volume to be confirmed by BEML.)		
5.20	Similarly the firm is required to draw two return Hot water lines from test cell to the Hot water sump. The pipe line shall be laid in the U/G service pit. The return pipe line should be of bigger than the supply line diameter and slope downwards to 0.5 to 1 meter below the G/L in to the hot water sump. Return line connections are required from the following. 1. Dynamo meter : Pipe line connectivity is firm scope. 2. Coolant conditioner - LT Circuit : Pipe line connectivity is firm scope. 3. Coolant conditioner -HT Circuit : Pipe line connectivity is firm scope. 4. Lube oil conditioner : Providing Flanged connectivity at the point of use. 5. Combustion Air Handling Unit : Providing Flanged connectivity at the point of use.		
5.21	From hot water pump to cooling tower connection.		
5.22	Instruments		
5.23	Pressure Gauge at each pump outlet	Analog Type 0 – 10 kg/cm² of Reputed make. One in each cold & hot water line at out let of the pump	
5.24	Thermometers at out let of pump		
5.25	Cold water supply line & Hot water return line	Analog Type 0 -100 deg C range thermometer (Bimetallic/suitable) with calibration certificate.	
5.26	GENERAL POINTS		
5.26.1	The Material test certificate of the pipe supplied confirming to specified to IS:1239 and IS:3589 to be supplied along with the material.		
5.26.2	The firm should execute the subject work on a turn key basis.		
5.26.3	The firm should construct any super structure for mounting of cooling tower, pump etc if required over and above the provisions made by BEML for the purpose. The firm should install the pumps on the pedestal grouting with necessary hardware.		
5.26.4	A blow down connection 1/4" pipe with a suitable valve on hot water line at a suitable location to be provided.		
5.26.5	The cooling tower will be installed by the firm on the support columns inside the cold water sump. The pipe connection from the hot water pump to cooling tower is the part of scope of this tender.		
5.26.6	All the valves should be of Audco/Zoloto/Kitz/Kirloskar Make. Pump motors shall be Kirloskar/Siemens/reputed make .		
5.26.7	Pipe lines should be laid in the service pit/as per the requirement . The pipes should be supported on frame work fabricated from MS channel Frames , plates, clamps of suitable size.		
5.26.8	All the electrical cables should be neatly routed. Cable tray/channelling/ducting to be provided to the cables .		
5.26.9	Pipe lines shall have flanged joints at suitable distances wherever required forming as connectors of piping lengths.		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
5.26.10	Smooth bends of long radius shall be used wherever required to reduce pressure drop.		
5.26.11	The welded joints should be sound, neat and leak proof for pipes and bends.		
5.26.12	After completion of pipe line work , the line should be flushed with water to remove dirt and weld spatters etc. before connecting the pump. After flush cleaning dummy plates to be fitted to open ends of the pipe until assembled in the system to avoid foreign matter entering into the system.		
5.26.13	The pipe network shall be provided with air release valves at high points		
5.26.14	Pipeline passing under or through equipment foundations or walls of buildings or any other inaccessible structure shall be provided with steel encasing pipes for easy insertion and removal.		
5.26.15	All electrical items should be suitable for use on 400/440V , 50Hz , 3 phase , AC supply.		
5.26.16	Warranty :The supply and services should carry warranty of two years from the date of installation and commissioning		
5.26.17	Pl refer Annexure - S for Electrical work.		
5.26	Table - 1 : Scope of supply		
5.26.1	Material :		
5.26.2	Centrifugal Mono block cold water pump of suitable capacity with HDG base	Firm to Indicate the capacity and Qty	
5.26.3	Centrifugal Mono block hot water pump of suitable capacity with HDG base	Firm to Indicate the capacity and Qty	
5.26.4	GI Strainers/Mesh Filters at pipe suction.	Firm to Indicate the Qty as per the requirement	
5.26.5	Y - type suction strainer	Firm to Indicate the Qty as per the requirement	
5.26.6	Pipe Reducers/ Enlargers	Firm to Indicate the Qty as per the requirement	
5.26.7	CI Butterfly valve with SS disc one number each at the inlet and outlet of each pump.	Firm to Indicate the Qty as per the requirement	
5.26.8	CI Non Return Valve one number each at pump delivery line.	Firm to Indicate the Qty as per the requirement	
5.26.9	CI Butterfly valve with SS disc / Ball valve: One number each at inlet and outlet of 5 devices.	10 No. of suitable size + additional for vent pipes Etc.	
5.26.10	Structural Supports for pipe laying on floor, wall & trench	Lump Sum	
5.26.11	Cold water supply line to the Dynamometer with M.S " C " CLASS ERW Black pipes of diameter as per the design	70 meters	
5.26.12	Cold water supply line to the Accessories with M.S " C " CLASS ERW Black pipes of diameter as per the design	70 meters	
5.26.13	Hot water return line form the Accessories with M.S " C " CLASS ERW Black pipes of diameter as per the design	70 meters	
5.26.14	Hot water return line form the Dynamometer with M.S " C " CLASS ERW Black pipes of diameter as per the design	70 meters	
5.26.15	Hot water pump to Cooling tower pipeline	As per the requirement and Firm to indicate.	
5.26.16	All internal water supply and return piping to Dynamometer, Coolant conditioner - HT and LT	As per the requirement and Firm to indicate.	
5.26.17	All internal water supply and return piping provision to Lube oil conditioner and CAHU. 3" NB supply line and 4" NB return line.	3" NB Pipeline = 15 Meters 4" NB Pipeline = 15 Meters	
5.26.18	Analog Type 0 – 10 kg/cm 2 pressure gauge - One each at pump delivery line and 3 Numbers inside the cell	As per the requirement and Firm to indicate.	
5.26.19	Analog Type 0 -100 deg C Thermometer	4 Nos	
5.26.20	Electrical Control Panel and Electrical Cabling	As per Annexure - S	
5.26.21	Bends, flanges, gaskets, reducers, enlargers, bolting hardware and other fittings Etc	As per the requirement	
5.26.22	All other items not indicated above but required for execution of work as per the scope on turnkey basis to be indicated, quoted and supplied.	To be supplied as per the requirement.	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
6 EXHAUST GAS CONVEYING SYSTEM			
6.1	Test cell Exhaust gas conveying system - Heavy duty Flexible SS steel piping of suitable diameter for the specified exhaust flow rate of 6000 kg/Hr from engine (Twin Turbo outlet) to the existing main header in the service pit. All exhaust piping in the test cell to be properly heat insulated such that heat should not get dissipated with in test cell. Further details of exhaust system and connection to engine required (e.g. pipe supports, allowance for expansion, flexible sections, silencing). System must not exert unrepresentative loads or stresses on the mating engine components.		
6.2	Test cell Exhaust gas conveying system should be of Leak proof.		
6.3	Following Provision to be made in the exhaust gas conveying system. A) Fitment of smoke sampling probe of Smoke meter at specified location in the test cell. B) Fitment of EGBP valve assembly in the pipe line at required location in the test cell. PI refer Annexure - M for existing exhaust header layout.		
7 Electric wire rope Hoist (5T SWL) - 1 No.			
7.1	Type : Mono Rail Electric wire rope Hoist		
7.2	Make : Sigma Hoist Company Pvt Ltd./KONE/DEMAG / Indef / reputed make		
7.3	SWL Capacity : 5 ton capacity with creep, Hoist and LT motorized speed festoon cabling complete with control panel. Design as per relevant IS standard.		
7.4	The hoist to be mounted on existing 450 mm ISMB Monorail.		
7.5	Load testing to be conducted for 125% of SWL after installation and commissioning on site and Certification by competent authority to be arranged by the firm.		
7.6	The hoist should be compact (Low head room) providing maximum lift of 3500 mm or more. PI refer Annexure - N for monorail layout and hoist arrangement.		
8 ROOF EXTRACTORS FANS AND DUCTING SYSTEM :			
The roof extractor fans are required to exhaust the heat dissipated inside the Engine Test Cell and to draw fresh air for circulation.			
8.1	Item description	Heavy Duty Axial flow Roof Extractor fan, duct mounting type on flat roof of Engine Test Cell. Roof Extractor complete with all accessories like, fan/impeller, motor, casing, cowl etc	
8.2	Quantity	2 Nos	
8.3	Place of installation	TC-10, BEML Engine Division	
8.4	Location	To be mounted on two openings (Approx size is 1170 mm) provided in the ceiling at a height of 9 meters from FFL. The duct to be dropped to the false ceiling at a height of 6 meters from the FFL. PI refer Annexure - P for mounting arrangement of roof extractor fans and ducting work from accosting sealing to RCC roof.	
8.5	Capacity of each fan	40000 – 45000 m ³ /hr against 25 mm of water gauge	
8.6	Static pressure (Approx.)	25mm WG	
8.7	Dynamic pressure (Approx.)	7 mm WG	
8.8	Total Pressure (Approx.)	32 mm WG	
8.9	Fan speed	Firm to indicate	
8.10	HP of motor	Firm to indicate	
8.11	Impeller Diameter	Firm to indicate	
8.12	Fan casing Diameter	Firm to indicate	
8.13	Impeller Type	Cast Aluminium alloy/ suitable material having aerofoil section to operate in the working environment of 50- 55 ° c	
8.14	Ducting	MS 16 SWG - Zinc Coated GI sheets	
8.15	Weather Proof hood	Required	
8.16	Inlet bird mesh	An inlet bird screen must be provided. The duct inlet should flush with opening in the acoustic ceiling.	
8.17	Out let hood and bird mesh	To be provided with a hood and bird screen to prevent rain water and bird entering and leakages.	
8.18	Make	AEROVENT/Krujer / Flaktwood / REITZ/ACCEL/ Dustven /INDFAN / Almonard/ Nadi / Reputed make	
8.19	Electrical :		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
8.19.1	DOL Starter	Each roof extractor fan must be provided with a push button type starter of a reputed make. The control panel to be located in the console room of the test cell. The electrical wiring from Power Distribution Board (Located in console room) to the control panel of Roof Extractor Fan is the scope of the firm.	
8.19.2	Electrical accessories	Each Roof extractor fan must be directly driven by a reputed make induction motor with class (F) insulation and IP55 protection. Electrical system must be suitable for 415V , 50Hz & 3 phase AC supply at an ambient temperature of 45°C to 55°C . The control panel should be suitably located. Energy efficient IE2 and above motors are preferred.	
8.19.3	Supply and laying of electrical cables	Electrical wiring between fan and control panel should be neat with necessary ducting/trays etc.,	
8.19.4	Painting	All ducting, Fan casing, Hood etc., after pre-treatment must be double coated with aluminium paint inside and outside surfaces.	
8.19.5	Test Certificate	The test certificate of the fan conforming to specifications of the P.O to be submitted.	
8.19.6	Warranty	Two years from the date of installation and commissioning.	
8.19.7	Documentation (English)	The operation , maintenance and spare parts manual should be supplied in 3 sets along with the item.	
8.20	General:		
8.20.1	The necessary support structure for fan, ducts should be provided by the firm. (PI refer the Drawing)		
8.20.2	The entire work should be free from air and water leakages, seepages etc.,		
8.20.3	The complete installation , commissioning and performance prove out of the roof exhaust fans is in the scope of the firm.		
8.20.4	PI refer Annexure - P for the mounting arrangement.		
8.20.5	ROOF EXHAUST FAN REFERENCE PHOTOGRAPH		
9 FRESH AIR FILTERS AND LOUVERS			
9.1	Type of Filter	Flanged dry type fresh Air Filter (Pre filter) Industrial Type with necessary frame work.	
9.2	Place of installation	BEML Engine division, Mysuru.	
9.3	No of filter banks	2 (One for each window)	
9.4	No of filter modules per bank	12 Nos PI refer Annexure - P for the front view of the test cell with fresh air windows.	
9.5	Overall Size of each module (Approx.)	508 mm x 508 mm x 152 mm (20" x 20" x 6") overall size including flange. 445 x 445 mm Box size	
9.6	Filter flow capacity Approx. of each module	1500-2000 cfm	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
9.7	Particulate removal Efficiency	85 to 90 % for particle size of 100 micron Approximately	
9.8	Initial resistance (Approx.)	6.5 mm of water gauge	
9.9	Construction:		
9.10	Frame :	GI powder coated (Silver Colour) of gauge (16/20) for rigidity	
9.11	Filter Media: corrosion resistance & easily cleanable /washable.	Multiple layers of woven HDPE mesh. □	
9.12	Design :	The filter media should be pleated over tubular aluminium/steel spacers/suitable design to form deep folds. The structure should provide rigid support to the filter medium and maintain uniform spacing between the folds of the filter medium.	
9.13	Adhesive:	The filter media should be sealed to the sheet metal casing with suitable adhesive to make a leak proof rigid modular filter unit.	
9.14	Gasket :	Neoprene / Suitable gasket (bonded to the flange) to be provided on the underside of the flange.	
9.15	Mounting arrangement.	4 Nos - holes are to be provided on the filter flanges . The filters should be mounted in a frame having openings suitable for mounting filter modules . Studs may be welded to the frame to fix the filter modules with wing nuts. Alternative mounting arrangement meeting the requirement is also acceptable. The mounting arrangement should provide easy access for cleaning the filters.	
9.16	Test Certificate	The firm must supply test certificate of the filters conforming to specifications	
9.17	Louvers	2 Nos -To be supplied and fitted to provide aesthetic view for filter cut-out. Fixed type louvers made of Galvanized steel frame and anodized aluminium blades (approx. 1.6 mm thickness) to be fitted on the front side of the window. The louver panel may be hinged at one end for easy access to filter modules for cleaning	
9.18	Warranty	Two years from the date of installation and commissioning	
9.19	Documentation	The operation , maintenance and spare parts manuals in English to be supplied in 3 sets along with the equipment.	
9.20	Installation and commissioning	The installation and commissioning of louvers and filters is the scope of the firm	
9.21	Filter Module Photograph for Reference.	Louver Photograph for Reference.	
9.22	 		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
10	Automatic Fire detection and suppression system with alarm suitable for diesel engine test cell		
10.1	<p>Scope: Design, supply and installation of fire detection and suppression system for the proposed new test cell TC-10 and its control room. Fire suppression media: Clean agent / Inert gas / Water mist type actuated by pressurized N2 gas with detectors and auto discharge suppression system shall be installed. The system should be approved by the competent statutory agencies for engine test cell applications. PI refer Annexure - Q for test cell over all layout of test cells. The proposed area of coverage consists of following major items for the design of suitable fire suppression system.</p> <p><u>Inside the test cell</u></p> <ol style="list-style-type: none"> 1. Dynamometer - 1 No. 2. CI Test bed with screw jack/Bespoke pillar set - 1 No. 3. Fuel conditioner - 1 No 4. Fuel consumption measurement device - 1 No. 5. Coolant conditioners - 2 Nos. 6. Smoke meters - 1 No. 7. Blow by meter - 1 No. 8. Air flow meter - 2 Nos. 9. Engine under test - 1 No. 10. Engine Accessories 11. Roof extractor Fans (flow rate of each will be at 45000 m³/Hr) - 2 Nos. 12. Acoustic wall panel 13. Utilities like Fuel line, Water line, Lube oil line, Air line, Electrical power sockets and illumination lights Etc 14. Service trenches for Electrical & signal cabling, Fuel lines Etc 15. Fresh Air filter banks 16. Human occupancy - 1 or 2 sometimes. <p><u>Outside the test cell (Adjacent to Frontal area)</u></p> <ol style="list-style-type: none"> 1. Diesel tank of 700 Lt capacity - 1 No. 2. Engine Cranker 24V-800 Amps- 1 No. <p><u>Engine control room</u></p> <ol style="list-style-type: none"> 1. Human occupancy - 5 (Max) 2. Computer & printer system 3. Documents related to test cell and Engine and other equipments 4. Electrical panel & signal control systems and lightings 5. Split AC system 2TR - 2 Nos 6. False ceiling <p>The fire detection and suppression system should include but not limiting to the following.</p> <ol style="list-style-type: none"> 1. Addressable main alarm control panel. (Make: Honeywell/Bosch/Reputed make) 2. Heat detector, Flame detector, Multi sensor detector as per the design requirement. 3. Manual call points 4. Flasher hooter 5. Siren on rooftop 6. Response indicator 7. Back-up battery and charger 8. Input monitor model 9. Short circuit isolator 10. Auto dialling facility in the event of fire. <p>Fire safety system should consists of</p> <ol style="list-style-type: none"> a) Fire detector and alarm systems (Fire alarm panel with smoke, heat and Flame sensors, cabling etc.). b) Auto Fire suppression system with Control panel (make to be specified by the bidder). c) Soak pit, inlet and outlet cut off valves etc. Also to shut off electrical power to the equipments like Roof extractor Fan Etc as per the requirement, except lighting. 		
10.2	The system should be able to detect fire occurring at any location in the coverage area of the test cell and take the action appropriately.		
10.3	One set of spare and filled Gas cylinders should be supplied. In addition to this, In case of water mist type, Firm has to arrange one set of N2 gas cylinders exclusively for demo/trial test & return. The charges for the same to be included in the quote.		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
10.4	The firm has to submit the test certificates for the cylinders, valves, Nozzle, Sensors Etc. The firm has to ensure the Cylinder first charge for ready operation of the system.		
10.5	The complete maintenance of the system for its proper working during warranty period for 2 years is the responsibility of the firm.		
10.6	1. The system shall have facility to check proper functioning of the system periodically. 2. Manual override to disarm/disable the system when the smoke is expected in the test cell such as after engine re-build etc.		
10.7	Automatic switch over to battery in case of AC Power failure. Battery backup for 48 hours.		
10.8	The detection system shall be equipped with necessary feature for avoiding false alarm/call.		
10.9	This system should be proven and conform to NFPA & other relevant Standards applicable to Diesel engine test cell. The firm should indicate standards pertaining to each device supplied.		
10.10	The system should have necessary relays/ modules to switch off electrical power supply to the accessories like Roof extractors and Diesel cut off Etc, once the fire is detected. Fuel feed pipe line to test cell from the Diesel tank should include a manual emergency control valve and auto shut off valves controlled by Fire detection system.		
10.11	All devices, valves, cables to be neatly labelled and displayed. Caution boards, User instructions, Layout to be neatly displayed.		
10.12	1) The scope should include design of entire fire detection, Alarm and suppression system considering the existing and proposed set up as per standard norms, including other connected works as per the requirement & providing complete design with drawings ,Bill of quantities(BoQ) with detailed specifications of the system. 2) The firm to take up execution of all above works in consultation with Beml' in accordance with the scope & specifications frozen.		
10.13	The fire suppression media should be compliance inline with statutory requirements and environmental norms.		
10.14	Note: The Fire detection and the suppression system should cover inside of the Test cell TC-10 and console room of Test cell 10. Diesel tank area is excluded subsequent to pre-bid meeting		
11	ELECTRICAL ACCESSORIES, WIRING, FIXTURES AND LIGHTING Etc :		
11.1	PI refer Annexure -S for the specification and the scope of supply.		
11.2	1) The scope should include design of Power Distribution Boards, Power panels, Motor control Panels, Cable work Etc as per standard norms, including other connected works as per the requirement & providing complete design with drawings , Bill of quantities(BoQ) with detailed specifications and. 2) The firm to take up execution of all above works in consultation with Beml in accordance with the scope & specifications frozen. □		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Qualities offered to be filled by the Firm.
FUEL METER(SFC METER) AND CONDITIONER			
12			
	<p>SCOPE : Supply, Installation , Commissioning and Performance prove out of One Number of Engine Fuel Mass flow Meter(SFC) and Conditioner with accessories for use in Diesel Engine Test Cell.</p> <p>Note: All fittings and components must avoid use of fuel system banned materials (e.g. Copper, Brass, Zinc-plating etc.)</p>		
12.1			
12.2	Item	FUEL CONSUMPTION MEASUREMENT METER (SFC)	
12.3	Application	Measurement of fuel mass in kg/hr or g/hr. For computation specific fuel consumption in g/kw-Hr.	
12.4	Type of Fuel	High Speed Diesel	
12.5	Make	Horiba / AVL / CP-SIERRA	
12.6	Place of installation	Engine division, BEML Ltd, Mysuru	
12.7	Unit of measurement	g/kw-Hr	
12.8	Fuel flow rate	Fuel Consumption Measuring requirement is up to 320 kg/hr. The instrument capacity should cater the same.	
12.9	Measuring Range	320 kg/h	
12.10	Measurement uncertainty	Less than or equal to 0.12%	
12.11	Measuring frequency	10 to 20 Hz	
12.12	Ambient Temperature	15 to 45 °C	
12.13	Fuel supply pressure	Fuel is supplied from a tank of 700 Lt capacity installed at an elevation of 4.5 meters from the G/L. The fuel filter of 10 Micron filtration between the Diesel tank and SFC meter to be installed by the firm as per the requirement. In case the gravity head is found inadequate, the firm to make the necessary arrangement to supply at required pressure to fuel meter.	
12.14	Temperature Fuel supply to the SFC meter	15 to 40 °C	
12.15	Interfacing	The SFC meter to be interfaced with the test cell automation	
12.16	Calibration	The instrument should have necessary arrangement for the periodic calibration and Firm has to supply the tools and procedures for calibration. Firm has to submit the calibration certificate along with the supplies. Firm to mention the frequency of calibration.	
12.17	Warranty	2 Years from the date of supply and acceptance.	
13.0	Item	FUEL CONDITIONER (TEMPERATURE CONTROLLER) FOR ENGINE TEST CELLS Fuel Conditioning Unit With heater and chiller unit and Temperature display and Controller and integration with Test cell automation control system.	
13.1	Application	The FCU which is the scope of this tender is required to supply Diesel Fuel to Engine at the controlled Temperature and pressure. The FCU is also required to carry out air venting(Priming) of the fuel system (Between FCU & Engine) during initial start up of the Engine as well as auto air venting when air bubbles are detected in the fuel system.	
13.2	Type of Fuel	High Speed Diesel	
13.3	Make	Horiba / AVL	
13.4	Place of installation	Engine division, BEML Ltd, Mysuru	
13.5	Unit of measurement	°C	
13.6	Fuel flow rate	600 LPH	
13.7	Measurement uncertainty	Less than or equal to 0.12%	
13.8	Measuring frequency	10 to 20 Hz	
13.9	Ambient Temperature	15 to 45 °C	
13.10	Response time	30 to 60 Sec for the change of 10°C	
13.11	Fuel supply feed pressure to Engine Fuel Pump from FCU. Min/Max	0.5 / 1.3 bar	
13.12	Fuel supply Temp to Engine (Setting range) (With fast response /quick settling time)	15 to 60 °C (before range was 90°C) (Settable)	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
13.13	Return fuel Flow from Engine (Approx.)	300 LPH	
13.14	Return fuel pressure from Engine (Approx.)	2 bar	
13.15	Return fuel Temperature from Engine (Approx.)	Min . 90 °C	
13.16	Temperature control accuracy	+/- 1 deg. C	
13.17	Material of construction of FCU	For Fuel line & water line SS304/suitable material to be used to prevent corrosion. Material Compatibility: <u>No Zn or Cu material to be used</u> in the complete circuit as this can leach into the fuel causing problems with injectors. All fittings and components must avoid use of fuel system banned materials (e.g. Copper, Brass, Zinc-plating etc.)	
13.18	Calibration	Calibration of the FCU to be submitted along with the supplies. The firm has to indicate the frequency of the calibration and carryout the calibration during the warranty period as part of scope of the order.	
13.19	Warranty	2 Years from the date of supply and acceptance.	
13.20	Mounting	Suitable mounting depending on the configuration	
13.21	Painting	The unit should be neatly painted for long life. Blue (RAL 5012/5015) / Grey combination preferred.	
13.22	Spares parts and Consumable items during warranty period.	The firm is responsible for ensuring the FCU in optimum working condition during the warranty period of 2 years. The firm has to carry out the following activities in minimum time "without any additional charges to BEML" during the warranty period. During the warranty period the firm is responsible for Repair/ Replacement / Servicing of any part of the system which is defective/non-functioning/ non-performing. In addition to above during the warranty period the firm is responsible for supply & replenishment of consumable items like filters, strainers, cartridges, seals, etc., free of any charges to BEML. The firm has to plan for the visits required for servicing & replacement of consumables as per the manufacturers standard schedule for optimum working of the equipment.	
13.23	Installation, Commissioning & Performance prove out	Scope of the firm includes Installation, Commissioning and Performance prove out of the Equipment with necessary hoses, fittings, valves at the inlet to the fuel conditioner, air venting line and between fuel conditioner and Junction Box at Engine.	
ENGINE BLOWBY METER			
14	SCOPE : Supply, Installation , Commissioning and Performance prove out of Engine Blow by Meter with accessories for use in Diesel Engine Test Cell as per the following Technical specification.		
14.1	Qty	01 Number	
14.2	Application	To measure the engine crank case Blow by in lpm	
14.3	Make	AVL / HORIBA/CP-SIERRA /ABB	
14.4	Place of supply and installation	Engine division, BEML Ltd, Mysuru-570018	
14.5	Measuring range	Up to 1200 l/min	
14.6	Working principle	The Blow-by Meter determines the flow rate using the orifice measurement principle.	
14.7	Additional measurement	Crank case pressure with display.	
14.8	Measuring accuracy (Approx)	Better than ± 2 % of FS	
14.9	Outputs	analog ± 10 V, corresponding to ± 100 % F, RS232C	
14.10	Power Supply	Firm to indicate	
14.11	Power Supply cable	15 meter length to be supplied	
14.12	Working Environment Temp.	0 to 55 °C	
14.13	Design	IP 55 protection	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
14.15	Hoses :		
14.15.1	Inlet hose (From Engine to Measuring unit)	10 m length with necessary clamps to be supplied	
14.15.2	Exit hose (Out let of Measuring unit)	2 m length with necessary clamps to be supplied.	
14.15.3	Mounting arrangement for the measuring unit	Suitable mounting arrangement on wall with necessary hard wares to be supplied by the firm.	
14.15.4	Heated Sensor :	The necessary heating arrangement to prevent condensate formation shall be provided.	
14.15.5	Cable connecting measuring unit to the Test cell automation.	Approximately 20 m length to be supplied for Analog and Digital signal cable	
14.15.6	Calibration certificate.	To be provided. Traceable to NABL/ international standard. The validity and periodicity of the calibration to be mentioned in the certificate.	
14.15.7	Warranty	2 years from the date of commissioning and acceptance.	
14.15.8	Documentation : (In English)	Operation , Spare Parts and Maintenance manual in triplicate to be supplied with the equipment.	
14.16	General :		
14.16.1	The scope to consist all necessary accessories for installation, commissioning and working of the blow by meter.		
14.16.2	The firm should provide the protocol of the blow by meter for providing interfacing facility with Test cell automation system. BEML will forward these details to Test cell automation supplier for necessary action.		
14.16.3	The interfacing of the blow by meter to the Test cell automation system, for activation, data acquisition and displaying is the responsibility of the Automation supplier and firm to provide the necessary assistance during the integration & proving.		
14.16.4	The above are the minimum requirements. The firm shall indicate and supply the hardware and software essential for the working of the measuring unit as per the scope of supply and application and performance requirements.		
14.16.5	Minimum 2 Ltr capacity Lube oil catcher to be provided.		
ENGINE EXHAUST SMOKE METER			
15	ENGINE EXHAUST SMOKE METER		
	SCOPE : Supply, Installation, Commissioning and Performance prove out of Engine Exhaust Smoke Meter with accessories for use in Diesel Engine Test Cell as per the following technical specification.		
15.01			
15.02	Type	Variable sampling smoke meter for automatic measurement of the smoke and soot content in the Exhaust Gas of Diesel Engine	
15.03	Qty	01 Number	
15.04	Make	AVL / HORIBA/CP-SIERRA/ABB	
15.05	Application	For measuring FSN (filter smoke number) and mg/m ³ (soot concentration) of the Diesel engine exhaust gas.	
15.06	Place of <u>supply and installation</u>	Engine division, BEML Ltd, Mysuru The smoke meter is planned for the new test cell with Hydraulic Dynamometer and Computer Data Acquisition System. The general lay out of the proposed Engine Test is enclosed as Annexure - L	
15.07	Measurement principle:	Measurement of filter paper blackening	
15.08	Measurement range:	0 to 10 FSN and 0 to 32.000 mg/m ³	
15.09	No of channels	One	
15.10	Sampling Type	Partial Flow	
15.11	Size	Portable	
15.12	Working environment temp	15 to 45 °C	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
15.13	Resolution / Detection limit (Approx)	0.002 FSN or ~ 0.02 mg/m ³	
15.14	Serial Interfaces	RS 232 Serial Interface	
15.15	Power Supply cable for measuring unit	Length min 5 m to be supplied	
15.16	Interface connection cable between measuring unit and PC based Test cell automation	min 15 m length to be supplied	
15.17	Sampling Line	Heated Type - 5 m	
15.18	Sampling probe	Firm scope	
15.19	Power supply	230 V AC 50 Hz Industrial Power Supply	
15.20	Trolley for measuring unit / instrument carrier with wheels for mounting the measuring unit, accessories and consumables.	To be supplied	
15.21	Instrument controller	Instrument shall be connected and controlled with PC based Test cell Automation	
15.22	Activation of Measurement	Activation of Measurement and logging should be under the control of Test cell automation as per the programmed logging point of the test cycle.	
15.23	Power supply Cable Length	Min. 5 m	
15.24	Filter paper	Suitable for the measuring unit : 200 meter x 10 Rolls length to be supplied	
15.25	Calibration certificate	To be provided. Traceable to NABL/ international standard.	
15.26	Calibration during warranty period	The firm should carry out calibration of the smoke meter during warranty period. Periodicity of calibration : Once in 6 months till the	
15.27	Warranty	2 years from the date of commissioning and acceptance.	
15.28	Documentation : (In English)	Operation, Spare Parts and Maintenance manual in triplicate to be supplied with the equipment.	
15.29	General :		
15.29.1	The scope to consist all necessary accessories for installation, commissioning and working of the smoke meter.		
15.29.2	The engine test cell shall have automation software, data acquisition system and interfacing facility for smoke meter (Input/output ports and channels for interfacing)		
15.29.3	The interfacing of the smoke meter to the Test cell automation for activation, data acquisition and displaying is the responsibility of the firm.		
15.29.4	The above are the minimum requirements. The firm shall indicate and supply the hardware and software essential for the working of the measuring unit as per the scope of supply and application and performance requirements.		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
16	<u>AIR MASS FLOW METER</u>		
	<p>SCOPE : Supply, Installation, Commissioning and Performance prove out of One No of Engine Air Mass Flow Meter with accessories for use in Diesel as per the following technical specification.</p> <p>Note: The proposed engine is of twin turbo type. Air mass flow requirement of each Turbo is approximately 4000 kg/Hr. The combustion Air supply and measurement set-up requires two separate lines with Air mass flow meter in each line. One Air mass flow meter of 4000 kg/Hr is presently available with BEML Ltd and one number to be supplied by the firm. The Hardware items like flexible pipe and connectors, clamps Etc are required for both the lines to be supplied by the firm as mentioned below.</p>		
16.01			
16.02	Item	Air Mass Flow Meter 0-4000 KG/H	
16.03	Type	Thermal air mass flow meter or Latest technology	
16.04	Qty.	01 No.	
16.05	Make	AVL / ABB	
16.06	Application	For measuring engine intake air flow in the Engine Test Cell.	
16.07	Place of installation	Engine Test Cell No. 10 in Engine Division BEML Ltd., Mysore. (Ref Annexure - L for Test cell layout)	
16.08	Measuring Range:	0-4000 kg/hr	
16.09	Response time (Approx)	12 ms	
16.10	Environmental Protection	IP 67	
16.11	Measuring section side		
16.12	Air filter and all necessary accessories	1 + 1 Nos air filters to be supplied. This shall be suitable to achieve the required accuracy.	
16.13	Entry pipe (upstream tube) Length 10 x D	To be supplied.	
16.14	Exit pipe (downstream tube) length 5 xD	To be supplied.	
16.15	Suitable flexible pipe (pipe should not collapse due to inlet depression, hence stainless steel tube and silicone flexible joiners are preferred) to connect measuring unit to turbocharger connector.	Length : 10 mtr x 2 Nos to be supplied.	
16.16	The necessary flanges, o rings, clamps required for connecting filter to upstream tube, upstream tube to measuring unit, measuring unit to downstream tube and downstream tube to flexible hose and flexible hose to reducer pipes for Engine turbo connections to be supplied by the firm.	To be supplied.	
16.17	Air mass flow meter connectivity to Engine:	<p>Configuration 1: Air mass flow meter to Turbo charger connection through flexible pipe(Ref point No. 16.15) and suitable adapters / Reducers. Qty 02 Nos.</p> <p>Configuration 2: Air mass flow meter to Turbo charger through Air filter. The flexible pipe (Point No. 16.15) to be connected to Air inlet passage of the filter through a Suitable rectangular Air box/Adapter. Qty : 1 No.</p>	
16.18	Measuring accuracy (Approx)	1% of the measured value	
16.19	Operating temperature range	-10 to + 55 deg C	
16.20	Reproducibility (Approx)	0.25 % of the measured value	
16.21	Digital Evaluation unit:		
16.21.1	Function	The evaluation unit shall convert the flow rate dependent signal into a mass flow linear signal.	
16.21.2	Type	Desktop version of suitable size and display 6 digit to be supplied. Display unit in kg/ h with air temp indication in °C	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
16.22	Display		
16.23	Air mass flow	in kg/h	
16.24	Air Temperature	in °C	
16.25	Input Power supply	230 V A.C. , 50 Hz	
16.26	Analog out put	The analog measuring value shall be available as a voltage signal 0-10 V on the output of the evaluation unit.	
16.27	Digital Out put	Serial interface V 24 / RS 232 C shall be provided for data transfer to the particulate measuring system. Interfacing cable of length 10 m shall be supplied.	
16.28	Totalling measurement	The unit shall have totalling measurement function. With the totalling measurement function the mass flow is totalled for a time period defined by external start/stop signal.	
16.29	Connecting cable between Air mass flow meter and evaluation unit	15 m length to be supplied	
16.30	Calibration certificate		
16.31	The unit shall be supplied with Calibration Certificate traceable to national standards/international standards.	Third party calibration certificate like DKD / NABL / etc., to be supplied along with the air mass flow meter. The validity and periodicity of the calibration to be mentioned in the certificate.	
16.32	Total Items scope		
16.32.1	Item Description	Qty	
16.32.2	AIR MASS FLOW METER 0-4000KG/H	1	
16.32.3	ACCESSORIES MASS FLOW METER 0-4000 KG/H	1	
16.32.4	DIGITAL EVALUATION UNIT	1	
16.32.5	SERIAL INTERFACE & TOTALLING MEASUREMENT	1	
16.32.6	CALIBRATION CERTIFICATE	1	
16.32.7	FILTER CARTRIDGE	2	
16.32.8	Up Stream connectivity from Air mass flow meter to the Air filter : Suitable Ducts with necessary clamps, supports etc.	01 sets	
16.32.9	Downstream: All necessary ducting, flexible pipe, clamps and supports/stand	As per the requirement for two numbers air supply line.	
16.33	Warranty support for a total period of 2 years.	Required	
16.34	GENERAL:		
16.34.1	The scope to consist all necessary accessories for installation, commissioning and working of the Air Mass Flow Meter		
16.34.2	Interfacing with the Test cell automation system:		
16.34.3	The firm shall prove their equipment for the performance.		
16.34.4	The firm shall interface their equipment with the test cell automation system for data logging and display.		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
17	ENGINE COOLANT CONDITIONER - HT & LT :		
17.1	The 1500 hp Engine has two different coolant circuits. The HT (High Temperature) circuit is for cooling Engine water jackets, Charge Air Cooler 1. The LT (Low Temperature) circuit is for cooling Charge Air Cooler 2, Fuel cooler, Lube oil cooler. (PI refer the coolant circuit layout). Both HT & LT circuits are independent closed circuits with pump and separate radiators in the equipment. In the test cell for the purpose of testing the engines, water cooled heat exchangers are proposed in place of radiators to simulate the cooling effect. Accordingly LT coolant conditioner and HT coolant conditioner are to be designed and supplied as per the scope and specification given below.		
17.2	COOLANT CONDITIONER - HT	1 No	
17.2.1	Cooling Capacity :	600 Kw	
17.2.2	Make	AVL / CP-SIERRA / YANTRA SHILPA / HORIBA	
17.2.3	Coolant temperature range (Set Range)	Up to 130 °C	
17.2.4	Temperature control accuracy	± 2 °C	
17.2.5	Response time to achieve 10 °C	30 to 60 Sec (Faster the better)	
17.2.6	Cooling Medium	Raw water from cooling tower at temperature varying from 35 – 45 °C	
17.2.7	Raw water flow rate	As per the design, Firm to indicate.	
17.2.8	Raw water pressure	As per the design, Firm to indicate.	
17.2.9	Engine side coolant parameters		
17.2.10	Inlet temp to conditioner (hot water from engine) (Max)	125 ± 5 °C	
17.2.11	Outlet temp from conditioner (cooled water to Engine) (Max)	115 ± 5 °C	
17.2.12	Temperature drop across the Conditioner	Firm to indicate (Δ T shall be 10 °C Approx)	
17.2.13	Coolant pressure inlet to conditioner (Hot)	3.7 bar Approx	
17.2.14	Coolant pressure outlet from conditioner (Cold)	3.1 bar Approx	
17.2.15	Max pressure drop across the conditioner	0.6 to 0.75 bar at 870 LPM (Approx)	
17.2.16	Coolant flow rate from the Engine	960 LPM	
17.2.17	Coolant spec.	Normal water	
17.2.18	1 No. Non-intrusive type water flow meter and sight glass to supplied and installed in the water outlet pipe from the Engine to the HT conditioner for the above specified flow rate.	As per Annexure - W	
	COOLANT CONDITIONER - LT	1 No	
17.3			
17.3.1	Cooling Capacity:	400 Kw	
17.3.2	Make	AVL / CP-SIERRA / YANTRA SHILPA / HORIBA	
17.3.3	Coolant temperature range (Set Range)	Up to 100 °C	
17.3.4	Temperature control accuracy	± 2 °C	
17.3.5	Response time to achieve 10 °C	30 to 60 Sec (Faster the better)	
17.3.6	Cooling Medium	Raw water from cooling tower at temperature varying from 35 – 45 °C	
17.3.7	Raw water flow rate	As per the design, Firm to indicate.	
17.3.8	Raw water pressure	As per the design, Firm to indicate.	
17.3.9	Engine side coolant parameters		
17.3.10	Inlet temp to conditioner (hot water from engine) (Max)	82 ± 5 °C	
17.3.11	Outlet temp from conditioner (cooled water to Engine) (Max)	67 ± 5 °C	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
17.3.12	Temperature drop across the Conditioner	Firm to indicate (ΔT shall be 10 °C Approx)	
17.3.13	Coolant pressure inlet to conditioner (Hot)	3.1 bar Approx	
17.3.14	Coolant pressure outlet from conditioner (Cold)	2.5 bar Approx	
17.3.15	Max pressure drop across the conditioner	0.6 bar at 410 LPM (Approx)	
17.3.16	Coolant flow rate from the Engine	450 LPM	
17.3.17	Coolant spec.	Normal water	
17.3.18	Note:		
17.3.18.1	The Heat Exchanger is water to water type preferably shell and tube type, compact in size.		
17.3.18.2	Minimum 10% extra cooling capacity to be incorporated in the design to compensate for scaling and other unforeseen variables in the circuit function.		
17.3.18.3	The material of construction shall be SS304		
17.3.18.4	Both the conditioners shall have PID / PLC for close and quick control of the set temperature.		
17.3.18.5	The Temperature setting control,(step of 1 deg C) data logging and display shall be integrated to the test cell automation system.		
17.3.18.6	All water connections towards Engine and Raw water side to be carried out by the Firm.		
17.3.18.7	1 No. Non-intrusive type water flow meter and sight glass to be supplied and installed in the water outlet pipe from the Engine to the LT conditioner for the above specified flow rate.	As per Annexure - W	
18	Combustion Air Handling Unit ;Supply, Installation, Commissioning and performance prove out of Combustion Air Handling Unit (CAHU) for 1500 hp Engine testing with controlled air Pressure and Temperature without RH control, as per the specification.		
18.1	A complete set of combustion air handling unit (CAHU) to be supplied suitable to test the BEML diesel engine of 1500 hp power and this scope is considered as a turn-key project.		
18.2	The combustion air handling unit (CAHU) shall be with proper SS304 piping to be established with necessary valves and properly routed.		
18.3	The main components of combustion air handling unit are consisting of following sub units to condition the combustion air with required pressure and temperature requirement:		
18.3.1	a) Air Filter unit - Reputed make with minimum 10-micron filtration capacity. If possible, the filter design shall be adaptable to BEML make air filters and BEML make air filters shall be used after warranty period.		
18.3.2	Blower unit - Reputed make with multiple blower combination for economical and reliable operation of CAHU unit.		
18.3.3	Suitable PLC controller, Electrical Panel with control and modular type wiring of reputed make to be supplied.		
18.3.4	The unit shall be connected to Test cell automation system to control with suitable communication (Eg: LAN, CAN, Serial & Hybrid) and suitable software. The software shall be able to capture the data of all the tests with graphical form. Further these data shall be saved in a computer. Also, the software should represent / display the total unit of CAHU including all piping in 2-D layout with the parameter readings & able to represent the faults with appropriate colour for easy trouble shooting. All computer (PC) hardware and software shall be latest configuration.		
18.3.5	Hard SS304 Piping and Flexible piping with Valves, Clamping & proper routing		
18.3.6	Outer casing (Noise proof Canopy type) for complete unit		
18.3.7	Panel AC - Panel AC should be designed as per panel air volume and heat load in the panel (Temperature in panel to be maintained 23-28 °C as all seasons in BEML service floor climate about 45 °C max) or maintain the above temperature inside the panel and ensure the panel free from dust and water.		
18.3.8	Heater, as applicable - system to be designed by the supplier for air flow of 7000 kg/h considering the minimum and maximum ambient Temperature and Pressure.		
18.3.9	Reputed Temperature and pressure sensors before and after the unit to be installed.		
18.3.10	Lifting pocket for Crane and Forklift to be provided and marked clearly on CAHU.		
18.3.11	Leak proof joints to be ensured at all the places and there shall be an indication to be provided in case of air leak while engine is running.		
18.3.12	Suitable air inlet adapters to connect CAHU outlet with Engine inlet shall be provided by the firm with suitable clamps.		
18.3.13	Wiring Cables (From BEML Raw power supply point to CAHU & Engine Test Cell) - Modular type wire harness All the core cables are shielded properly, protected from bending, twisting, water, fire & dust. Outer cables are to be protected by metal / nylon conduit. Also necessary dummy caps to be provided (Thread type / clamp type & non detachable). All the cables shall be routed properly with suitable clamps.		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
18.4	Ramping cycles, ramping & controlling accuracy:		
18.4.1	The steady state and dynamic state tests (Speed and load sweep), Load curve etc., will be carried out.		
18.4.2	Power and torque accuracy should be maintained within ± 2 % limit of specified values as per power – torque curve.		
18.4.3	The following test Cycles to be prove out:		
18.4.4	Run-in, Full throttle performance, Part throttle performance, and Free Acceleration smoke test.		
18.4.5	PI refer the Attachment for various test cycles to be conducted.		
18.4.6	BEML will chose any of the above tests (One or more than one) during prove out trials.		
18.4.7	All the piping shall be treated externally and covered with suitable packing to avoid external damages. Quick coupling to be considered for easy maintenance.		
18.4.8	The CAHU unit able to run in auto mode as well as manual mode.		
18.4.9	The firm must consider the air flow losses due to length between the unit to engine inlet point and the losses due to bends additionally, if the losses more than 5% of full scale.		
18.4.10	All the serviceable and consumable parts should be easily available locally and ensured the supply of minimum 10 years.		
18.4.11	Facility to be provided to integrate CAHU with test cell automation system. Further necessary technical support to be provided during integration with automation system.		
18.4.12	Project to be made on Turn-Key basis, BEML will provide only raw Electrical power supply and cooling water with 20–40 °C variation in temperature.		
18.4.13	Installation / layout drawing to be submitted for BEML approval before start of installation.		
18.4.14	All kind of tool to be provided as a kit (With Box) for maintenance work.		
18.4.15	Technical manuals in English for parts, operation, maintenance and Troubleshooting of the equipment must be provided (3 sets in paper copies and in electronic format).		
18.4.16	3 years spares & Consumables supplied along with the instrument on FOC (Free of Cost) basis & list to be enclosed.		
18.5	SPECIFICATION OF CAHU UNIT	VALUE	
18.5.1	CAHU Capacity (Static & Dynamic)	Should be fully usable from 250 kg/h to 7000 kg/h	
18.5.2	Place of Installation	Engine Division Division , BEML Ltd., TC-12 is preferred .	
18.5.3	Temperature Range @ outlet	25 °C to 35 °C	
18.5.4	Humidity Control	Not required	
18.5.5	Engine Inlet Pressure Control Range @ outlet	900 to 1050 mbar	
18.5.6	Temperature control Accuracy (Static & Dynamic)	± 0.5 °C (Static) & ± 2.0 °C (Dynamic)	
18.5.7	Engine Inlet Pressure Control Accuracy (Static & Dynamic)	± 1 mbar (Static) & ± 5 mbar (Dynamic)	
18.5.8	Response time	≤ 5 msec	
18.5.9	Dynamic Pressure control unit response for transient cycles	≤ 250 msec	
18.5.10	Sound Pressure level in running condition	≤ 75 dB(A)	
18.5.11	Air Filter	Dry, Paper type, 10-micron filtering capacity	
18.5.12	Sensors (Reputed Make)	Pressure, Temperature, Exhaust pressure & Temperature before and after the unit (Near engine, after air flow meter) the CAHU unit.	
18.5.13	Over pressure safety to be inbuilt in system (In case the Engine Stops and CAHU is ON)		
18.5.14	Under pressure safety to be inbuilt in system (In case the CAHU Stops and Engine is running)		
18.5.15	System to made for considering 15 years of useful life		
18.5.16	CAHU Electrical Panel should have Panel AC for panel cooling as unit is at service floor		
18.5.17	Host communication should be with - LAN / Serial and Hybrid communication with Test bench PC		
18.5.18	CAHU Unit Location in service floor, its temperature can reach up to 45 °C to 48 °C.		
18.5.19	BEML shall supply Normal cooling tower water temp approx. 35 °C. for cooling the Chiller Unit		
18.5.20	CAHU control panel to be placed inside the test cell control room for user interface and one more to be on the main unit for easy servicing.		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
18.6	Combined Chiller Unit (Water cooled type):		
	<p>The Engine testing comprises thermal durability testing wherein chilled water @5°C to be supplied to the coolant circuit (Water Jacket) of the engine after engine stop during thermal durability test cycle. Refer Annexure-W for details of Thermal durability test cycle.</p> <p>The chiller unit, Buffer tank & connectivity to engine coolant circuit shall be as per the circuit in Annexure-X</p> <p>The 1000 Litre capacity Hot & Cold Buffer Tank with thermal insulation & necessary piping with Pump & control valves operated under Automation shall be part of the scope of this tender.</p> <p>The chiller unit will be supplied with Raw water from cooling tower approx 20-35 °C.</p>		
18.7.	CAHU ACCEPTANCE CRITERIA:		
18.7.1	Parts to be supplied as per deliverables and CAHU shall be installed & commissioned to meet the engine performance.		
18.7.2	The supplied CAHU system will be tested with minimum and maximum air flow capacity of engine with different test cycles and engine performance shall be proved.		
18.8.	BEML ENGINE SPECIFICATION:		
18.8.1	Engine Type: 4 Stroke, Direct Injection Diesel engines		
18.8.2	No. Of Cylinders: 4, 6, 8 & 12		
18.8.3	Cylinder Arrangement: Both Inline and V type		
18.8.4	Engine Cooling Type: Air & Water		
18.9 TRAINING:			
18.9.1	Vendor should train BEML Engineers at BEML, Mysore after completion of installation & commissioning on Calibration, Operation, Maintenance, and Diagnostic of both electrical and mechanical system		
18.9.2	At Free of cost onsite training shall be given to BEML engineers about principle of operation and functioning, operating procedure, troubleshooting and maintenance. Free Tele/online technical support shall be given for the warranty period.		
19. CALIBRATION CERTIFICATE:			
19.1	Calibration details of all applicable instruments to be provided with international traceable certificates like NABL etc.,		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
20 DELIVERABLES:			
SL NO	PART DETAILS / DESCRIPTION	QTY (Unit / Set/Kit / NO)	Bidder's Remark
	Combustion Air handling unit (CAHU) for Engine testing		
20.1	Air Filter unit with all accessories	1 set	
20.2	Blower unit with all accessories	1	
20.3	Dynamic Pressure & Temperature Control unit set with all accessories	1	
20.4	Suitable PLC controller, Electrical Panel with control	1	
20.5	Exclusive computer (PC) control with suitable communication (- Eg: LAN, CAN, Serial & Hybrid) and suitable software set	1	
20.6	Hard SS304 Piping set with Valves and Clamps (With all accessories)	1	
20.7	Flexible piping set with Valves and clamps (With all accessories)	1	
20.8	Outer casing (Noise proof Canopy type) with all accessories	1	
20.9	Modular Trolley (Movable with suitable brake to position the unit)	1	
21	Panel AC with all accessories, if required	1	
21.1	Heater & Chiller set as applicable including all necessary parts	1	
21.2	Humidity, Temperature and pressure sensors as required	1	
21.3	Independent valves (To create Air intake restriction)	1	
21.4	Lifting pocket for Crane and Forklift, as required	1	
21.5	Air inlet adapters to connect CAHU outlet and engine inlet with Suitable clamps	1	
21.6	Wiring Cables set (From BEML Raw power supply point to Engine Test Cell with required connectors, cable gland etc.) with all accessories.	1	
21.7	Set of all adapter / connectors / cables for integration of CAHU with dynamometer automation system, if applicable	1	
21.8			
21.9			
22	Installation / layout drawing	1	
22.1	Set of Tools for maintenance & Trouble shooting	1	
22.2	3 years set of spares & Consumables (List to be enclosed)	1	
22.3	Set of User manual - 3 Hard copies and 3 soft copies	3	
22.4	Set of Warranty / Calibration Certificates	1	
22.5	Training for BEML engineers @ BEML Limited, Mysuru	1	
Note: The above deliverables are generic, and this is a TURNKEY project and hence the firm shall consider all the required parts needs to prove out the CAHU performance.			
23 General Points:			
23.1	Firm shall provide the utility requirement details to BEML like electric power supply, Water, Compressed Air, Room dimension etc., well in advance / immediate after awarding the contract.		
23.2	The instrument colour shall be BLUE / GRAY as per BEML standard RAL5012/5015		

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
24.Scope of supply			
Sl No	Description	Qty.	Qty Offered
24.1	Material :		
24.2	Scope (CVZPF0193010) : Design , Manufacturing and Supply of Power Absorption Type Hydraulic Dynamometer for Testing of 1500 hp Diesel Engine along with Digital Controller, Instrumentation and Accessories, PC based Test Cell Automation System , Data acquisition & Display , Video Recording & Monitoring, Cardon Shaft, ECU Interface, Exhaust Back Pressure Controller, Adaptor Plates, Safety System etc.,	1 Set	
24.3	Scope (CVZPF0193012) : Elevated structural platform for installation of Diesel Tank, complete pipe line work and accessories.	1 Set	
24.4	Scope (CVZPF0193013) : Design , Manufacturing and Supply of Electric Engine Cranker for starting of Engine.	1 No	
24.5	Scope (CVZPF0193014) : Design , Manufacturing and Supply of FRP Cooling Tower.	2 Nos	
24.6	Scope (CVZPF0193015) : Design , Supply and Execution of Pumps and Pipe Line work for Cooling Tower, Engine Test Cell and Water distribution system.	1 Set	
24.7	Scope (CVZPF0193018) : Design , Manufacturing and Supply of Engine Exhaust gas conveying system.	1 Set	
24.8	Scope (CVZPF0193019) : Design , Manufacturing and Supply of 5T SWL Electric wire rope hoist.	1 No	
24.9	Scope (CVZPF0193020) : Design , Manufacturing and Supply of Roof extractor fans and allied ducting work.	1 Set	
24.10	Scope (CVZPF0193022) : Design , Manufacturing and Supply of Fresh air filters and louvers for Engine Test Cell.	1 Set	
24.11	Scope (CVZPF0193024) : Design, Manufacturing and Supply of Fire detection, Alarm and Fire Suppression system for Engine Test Cell.	1 Set	
24.12	Scope (CVZPF0193023) : Electrical accessories, Wiring, Electrical fixtures, Test Cell Lighting and allied work.	1 Set	
24.13	Scope (CVZPF0193025) : Supply of Engine Fuel consumption meter (SFC) and Conditioner	1 No	
24.14	Scope (CVZPF0193027) : Supply of Engine Blow by meter	1 No	
24.15	Scope (CVZPF0193028) : Supply of Engine Smoke meter	1 No	
24.16	Scope (CVZPF0193031) : Supply of Engine Air mass flow meter	1 No	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
24.17	Scope (CVZPF0193029) : Supply Engine Coolant Conditioner for HT circuit	1 No	
24.18	Scope (CVZPF0193030) : Supply of Engine Coolant Conditioner for LT circuit	1 No	
24.19	Scope (CVZPF0193032) : Supply of Engine Combustion Air Handling Unit along with common chiller unit.	1 Set	
24.20	Services :		
24.21	Installation, Commissioning, Integration and Performance prove out of Dynamometer and all other items in the scope, Calibration, User training and Final acceptance of the system.	1 AU	
24.22	Scope (CVZPF0193019) : Design , Manufacturing and Supply of 5T SWL Electric wire rope hoist.	1 No	
24.23	Scope (CVZPF0193020) :Design , Manufacturing and Supply of Roof extractor fans and allied ducting work.	1 Set	
24.24	Scope (CVZPF0193022) : Design , Manufacturing and Supply of Fresh air filters and louvers for Engine Test Cell.	1 Set	
24.25	Scope (CVZPF0193024) : Design, Manufacturing and Supply of Fire detection, Alarm and Fire Suppression system for Engine Test Cell.	1 Set	
24.26	Scope (CVZPF0193023) : Electrical accessories, Wiring, Electrical fixtures, Test Cell Lighting and allied work.	1 Set	
24.27	Scope (CVZPF0193025) : Supply of Engine Fuel consumption meter (SFC) and Conditioner	1 No	
24.28	Scope (CVZPF0193027) : Supply of Engine Blow by meter	1 No	
24.29	Scope (CVZPF0193028) : Supply of Engine Smoke meter	1 No	
24.30	Scope (CVZPF0193031) : Supply of Engine Air mass flow meter	1 No	
24.31	Scope (CVZPF0193029) : Supply Engine Coolant Conditioner for HT circuit	1 No	
24.32	Scope (CVZPF0193030) : Supply of Engine Coolant Conditioner for LT circuit	1 No	
24.33	Scope (CVZPF0193032) : Supply of Engine Combustion Air Handling Unit along with common chiller unit.	1 Set	

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
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25.ANNEXURES ENCLOSED WITH THIS TENDER:			
SI No	Annexure	Description	TO BE REFERRED FOR
25.01	Annexure-A	Engine Specification (Speed , Torque, Power Data)	For the selection of Dynamometer, Controller, Automation system Etc
25.02	Annexure-B	Engine combustion development Test	
25.03	Annexure-C	Engine performance test as per ISO1585	
25.04	Annexure-D	Driving cycle test - 400 Hrs	
25.05	Annexure-E	Engine duty cycle test - 1200 Hrs	
25.06	Annexure-F	Acceleration durability test - 400 Hrs	
25.07	Annexure-G	Engine resonance test - 250 Hrs	
25.08	Annexure-H	DIESEL TANK PLATFORM AND PIPELINE	
25.09	Annexure-J	ENGINE ELECTRIC STARTER	Electrical circuit may be referred for design.
25.10	Annexure-K	PUMP-PIPELINE-WATER DISTRIBUTION SYSTEM	To be referred for site location, routing of pipe line Etc
25.11	Annexure-K1	SUMP AND COOLING TOWER ARRANGEMENT	To be referred for sump & pump deck arrangement
25.12	Annexure-L	OVERALL GENERAL ARRANGEMENT OF PROPOSED TEST CELL	Physical Location and arrangement of the Test cell / Equipments Etc.
25.13	Annexure-M	EXISTING EXHAUST HEADER	Location of the Exhaust Header line in the service pit.
25.14	Annexure-N	ELECTRIC WIRE ROPE HOIST	1. Existing monorail arrangement. 2. Proposed Hoist arrangement
25.15	Annexure-P	ROOF EXTRACTOR FANS AND DUCTING	To be referred for Roof extractor fan and ducting arrangement.
25.16	Annexure-Q	EXISTING TEST CELL LAYOUT	To be referred for physical arrangement 12 engine test cells.
25.17	Annexure-R	RELEVANT VIEWS OF PROPOSED ENGINE	To decide on Engine - Dyno mounting plan, Cardon shaft length Etc.
25.18	Annexure-S	Electrical scope of work: Containing annexure S1, S2, S3, S4, S5 & S6.	For specification and scope of electrical work
25.19	Annexure-T	Drawings pertaining to S1, S2,S3,S5 and S6.	To be referred for general arrangement of PDB's, Electrical panels, Power Panels, Road cutting Etc.
25.20	Annexure-U	Engine Bed drawing (BEML Scope)	For reference and making Engine-Dyno installation layout
25.21	Annexure-V	HT and LT Cooling schematic circuit	For understanding of LT and HT coolant conditioners.
25.22	Annexure-W	Thermal cycle Durability test	For understanding test cycle
25.23	Annexure-X	Chiller Unit & Circuit for Thermal Durability Test	For understanding of chiller,buffer tank & pipe line circuit for thermal durability test
25.24	Annexure-Y	Test set up & BIPO test	For understanding test setup

Sl. No.	DESCRIPTION	SPECIFICATION	Compliance/Acceptance/Confirmation/Values/Quantities offered to be filled by the Firm.
26. Make of Major Items :			
The item used in the above supplies are to be reputed make known for performance , reliability & suitable for the application. The makes indicated for the major items to be complied with.			
Sl.No	Description	BEML requirement	Firm to indicate the make/s offered
1	Hydraulic Dynamometer	AVL/SAJ/SCHENCK/HORIBA/CP SIERRA	
2	Cooling Tower	PAHARPUR/UNITED/ADVANCE/REPUTED MAKE	
3	Smoke meter	AVL / HORIBA/CP-SIERRA/ABB	
4	Blowby meter	AVL / HORIBA/CP-SIERRA /ABB	
5	Air mass flow meter	ABB	
6	Fuel conditioner & Fuel consumption(SFC) meter	Horiba / AVL / CP-SIERRA	
7	Coolant conditioner	AVL / CP-SIERRA / YANTRA SHILPA / HORIBA	
8	Combustion Air handling unit	AVL / CP-SIERRA / HORIBA/ INSPIRED CONTROL	
9	Roof Extractor Fan	AEROVENT/Krujer / Flaktwood / REITZ/ACCEL/Dustven /INDFAN/ Almonard/ Nadi / REPUTED MAKE	
10	Electric wire rope Hoist (5T SWL)	Sigma /KONE/DEMAG / Indef / CARL STAHL/ REPU	
11	Cardan shaft	Voith/Twiflex/Gwb/kusel/Centa/Reich/GKN	
12	Water Pump	KBL/GRUNDFOS	
13	Electric Cable	Finolex / Polycab / Unistar / Havells / V-Guard	
14	Switch Fuse Units MCB / MCCB :	L&T, Siemens, BCH, Havells	
15	Split Air Conditioner	Voltas /Carrier / Blue Star/REPUTED MAKE	
16	ON – OFF push button With run /stop / trip indicators	L&T/ BCH/SIEMENS/ Reputed make	
17	Test Cell Lighting	Philips / Crompton Greaves / Havells/REPUTED MA	
18	3ph ind. Motor 4 pole TEFC 45 KW / 60 hp,Duty	Siemens / ABB / Crompton / NGEF	
19	V Belts	Ecodrive /Fenner/PIX Transmission/REPUTED	
20	Fresh air filter & louver	Aerovent/Arrow/ARW/Reputed make	
21	CLASS- C PIPES	TATA/JINDAL/APOLLO	
22	Butterfly Valve	Audco/Kitz/Zoloto/L&T/Kirloskar/Inter valve	
23	Pressure Gauge	Baumer/Fiebig/WAAREE/WIKA	
24	Balancing valve(water flow)	Advance/Zoloto/KSB/Grundfoss/Reputed make	
25	Digital fuel flow meter	Rotodel / Fludyne /Reputed make	
26	Load cell	HBM /Sensotronics	
27	Personal computer	DELL / HP/ADVANTEC/ SUPER MICRO	
28	Servo Voltage stabilizer	Power one micro System / Techser Power Solutions	
29	colour printer	HP/EPSON/CANON/KONIKA MINOLTA	
30	Non- Return Valve at outlet of Hot & Cold water pump	Audco/Zoloto/Kitz/Kirloskar/Reputed Make	
31	Fire suppression system components	Siemens / Honeywell / Rotarex / Morley/AGNI/FOGTEC/Reputed make	
32	Pressure sensors	IRA/Druck	
33	CCTV Camera	CP PLUS/BOSCH/SONY/SAMSUNG/AVTEC /HONEYWELL	