



**NATIONAL CENTER FOR COMBUSTION RESEARCH
AND DEVELOPMENT (NCCRD)
INDIAN INSTITUTE OF TECHNOLOGY MADRAS
CHENNAI – 600036, INDIA**

Ref. No. ICS/11-12/013/DSTX/TSUN

Date: 1 Sep. 2015

Due date: 22 Sep. 2015

Item name: COMBUSTION ANALYSIS SYSTEM

1. Quotations are invited in duplicate for the items shown overleaf (in Annexure I). The quotations duly sealed and superscribed on the envelope with reference no. and due date, should be addressed to the undersigned so as to reach on or before the due date mentioned above.
2. The quotations should be valid for sixty days from the due date and the period of delivery required should also be clearly indicated.
3. The total cost of the equipment in terms of CIP Chennai should be clearly mentioned.
4. Terms of warranty and guarantee should be explicitly mentioned.
5. Packing and delivery charges, customs and clearance duty should be clearly stated.
6. Goods shall not be supplied without an official supply order.
7. Local firms : Quotations should be for free delivery to this institute. If quotations for ex-godown delivery charges should be indicated separately.
8. Firms outside Chennai: Quotations should be for F.O.R. Chennai. If F.O.R. consignor station, freight charges by passenger train / lorry transport must be indicated. If ex-godown, packing, forwarding and freight charges must be indicated.
9. The rate of sales / general taxes and the percentage of such other taxes legally leviable and intended to be claimed should be distinctly shown along with the price quoted. Where this is not done, no claim for sales / general taxes will be admitted at any stage and on any ground whatsoever. The taxes leviable should take into consideration that we are entitled to have Concessional Sales Tax (CST) applicable to non-government educational institutions run with no profit motive for which a concession sales tax certificate will be issued at the time of final settlement of the bill.
10. Payment : Specify the mode of payment and if advanced payment has to be made. Every attempt will be made to make payment within 30 days from the date of receipt of bill / acceptance of goods, whichever is later.
11. IIT Madras is exempt from payment of excise duty and is eligible for concessional rate of customs duty. Necessary certificate will be issued on demand.
12. IIT Madras has the right to accept the whole or any part of the tender or portion of the quantity offered or reject it in full without assigning any reason.
13. In case of any technical queries/clarifications, please contact Prof. A. Ramesh, Dept. of Mechanical Engineering, IIT Madras, Chennai, E-mail: aramesh@iitm.ac.in; Phone: +91-9444462154.
14. The sealed quotation may be sent to

Prof. S. R. Chakravarthy

NCCRD Office

No. 201, Rarefied Gas Dynamics Lab (Behind Aerospace Engineering Dept.)

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Annexure I

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**TECHNICAL SPECIFICATIONS OF COMBUSTION ANALYSIS SYSTEM FOR
USE IN SI AND CI ENGINE RESEARCH**

Pre-Qualification Requirements:

- The vendor must have supplied at least 20 systems of same model of base equipment which includes the sensors and all relevant electronics and indication system to reputed automotive research and development laboratories of government funded institutions or research and development divisions of leading automobile industries during the past 1 year. The vendor should provide the details of organizations where such systems have been supplied.
- The vendor should be the manufacturer of the system supplied. If the manufacturer is a company outside India then the vendor should be the sole subsidiary of the manufacturer in India and due proof of the same has to be enclosed with the quotation. No agents/representatives will be accepted.
- The vendor should have their Service Centre in India and trained personnel for after-sales service. Vendor has to submit the complete details of the service set up.
- The vendor should clearly indicate the terms of warranty along with their quote.
- Other standard manufacturer's piezo resistive transducers, piezo electric sensors, charge amplifiers and angle encoders must be compatible with the supplied Combustion analysis system (Hardware and software).

Scope of Supply

The proposed system shall consist of the following major equipment:

1. Piezoelectric sensors (1 no.) suitable for cylinder pressure measurement on any modern turbocharged automotive SI and CI engine. The vendor should ensure that the offered sensor can be flush mounted on the above mentioned engine's cylinder head. Any special tools needed have to be offered and prices are to be indicated separately.
2. Charge amplifier with at least two channels for the above type of piezoelectric sensor.
3. Piezoresistive sensors capable of being used on the intake manifold (1 no.) and exhaust manifold (1 no) for measurement and referencing the cylinder pressure values along with the required cooling adaptors. The sensors could have their built in amplifiers or suitable amplifier to be provided.
4. High resolution crank angle encoder(1 no.).
5. Suitable High speed data acquisition hardware for I C engine research
6. Software for data acquisition and IC engine combustion analysis using the cylinder pressure, manifold pressure and crank angle data.
7. Accessories for the above.
8. One trolley to accommodate the above systems.



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Detailed Specifications

1. Piezoelectric sensor for SI and CI engine in-cylinder pressure measurement:

- a) Un-cooled pressure sensor capable of flush mounting on the cylinder head
- b) Mounting thread: M5x0.5 mm

Sensor Specifications	
Measuring Range	0-250 bar
Overload	300 bar
Sensitivity	Greater than 15 pC per bar
Linearity	$\leq \pm 0.4$ % FSO
Operating Temperature range	-20 to 350 °C

2. Charge Amplifier:

- a) Number of independent piezo electric charge inputs: 2

Channel Specifications	
Sampling Frequency Range	0-100kHz per channel
Measuring range	0 - 14,000 pC range selectable for accuracy
Linearity	$\leq \pm 0.01$ %/FSO
Drift Compensation	To be provided
Output voltage	0 to 10V

3. Piezoresistive sensor for SI and CI engine intake and exhaust manifold pressure measurement:

- a) For intake / exhaust manifold pressure measurement.
- b) Cooling adapter to be provided.
- c) 2m Viton cable to be provided along with the sensor.

Sensor Specifications	
Measuring Range	0 - 10 bar
Overload	20 bar
Sensitivity	<0.1% FSO
Linearity	<0.2% FSO
Operating Temperature range	-20 to 200°C



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4. Angle Encoder:

Specifications	
Crank angle signal resolution (deg)	0.1, 0.5, 1.0 (selectable)
Speed range	0-10000 rpm

5. Piezo resistive Amplifier:

- Suitable amplifier for piezo-resistive pressure sensor to be provided.
- The amplifier for the piezo-resistive sensors should preferably be of the built-in type, integrated with the sensor connector.

Channel Specifications	
Operating Range	-55°C to 125°C
Linearity	<0.2% FSO
Output voltage	0 – 10V

6. Combustion Analyser

- At least 8 high speed analog input channels compatible with analog voltage input. The 8 channels must be configurable as per user requirement anytime, any combination of Piezo amplifier input + other voltage input = 8 at any time should be possible.
- Stored data of all channels should be available in both time domain and crank angle domain
- 2 additional Analog inputs for current clamps for injection / ignition signals should be available
- 8 Digital Input Channels with Sampling rate not less than 2.5 MHz.
- 1 additional digital channel for crank angle encoder or from crank angle adapter for Hall Effect/VR Sensor should be available.
- CAN interfaces should be provided to interface with standard engine control hardwares such as those supplied by ETAS.
- USB port/any suitable means for storing the measured data to a mass storage device must be available.
- Continuous Streaming mode
- Limit value monitoring with data storage.



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Channel Specifications		
1	Input voltage range	-10 ... +10 V
2	ADC resolution	Minimum 14 bit
3	Sampling rate	At least 800kHz per channel
4	Crank Angle Inputs	Support any Optical encoder giving TTL / 12V signals as well as Signals from the Trigger wheel with Hall sensor or (inductive) VR sensor.
5	Filter for cylinder pressure	5-40kHz
6	Operating Temperature Range	-35°C...50°C
7	Power Supply	Compatible with AC power supply. Required adapters to be provided by the vendor

7. Software:

- For combustion study in both diesel and gasoline engines
- Combustion noise and real time knock calculation should be available
- Compatible for continuous monitoring and measurements during transient loading of the engine.
- Data acquisition when engine starts and stops
- Limit value monitoring for selected data storage.
- 0.01deg. resolution at the time of TDC determination.
- Software shall display and record the signals from cylinder pressure, intake and exhaust pressure, current clamps, crank angle encoder and any universal voltage signal.
- Following derived data should be available: Peak pressure, Indicated mean effective pressure, Combustion stability, Misfiring, Friction losses, Knocking, Combustion noise, Crank angle at peak pressure, Overall efficiency, Combustion efficiency, Qualitative exhaust values, Quality of ignition system, Qualitative exhaust values, Gas exchange losses, Energy balance, Filling of cylinder, Residual exhaust gas in cylinder, Backflow, Gas exchange losses, Ignition delay, ignition or injection point and start of combustion

8. Accessories:

- Ethernet port for connecting combustion analyzer with ECU calibration tool/ software
- Ethernet cables
- Power adapter
- Connecting cables (each 10m long) for connecting the system with piezo pressure transducers to be provided.
- Tightening tool and drilling tool to be quoted separately.



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Installation, Commissioning and Training:

- a) The installation and commissioning of the equipment at site would be the responsibility of the vendor. Mounting of all sensors to the test engine would be the responsibility of IITM.
- b) Training on the complete system including software shall be given by the supplier.

Delivery Schedule

The system should be supplied within 12 weeks from the date of technically and commercially clear Purchase Order.

Warranty

The vendor should provide a warranty for at least 12 months from the date of commissioning of the setup.

For any technical clarifications, please contact:

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