



**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: 14 July 2016

Due date: 4 Aug. 2016

Item name: OPEN CALORIMETER (1 no.)

1. Quotations are invited in a **two bid system** for the items shown overleaf (in Annexure I). The offers / bids should be submitted as Technical bid and Financial bid. The Technical bid should consist of all technical details / specifications only. The Financial bid should indicate item-wise price for each item and it should contain all Commercial Terms and Conditions including Taxes, transportation, packing & forwarding, installation, guarantee, payment terms, pricing terms etc. The Technical bid and Financial bid should be put in separate covers and sealed. Both the sealed covers should be put in a bigger cover. The Tender for supply of “ _____ ” should be written on the left side of the Outer bigger cover and sealed.
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. The sealed quotation may be sent to

Prof. S. R. Chakravarthy

NCCRD Office

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

Chennai – 600036, Ph. (O) +91-44-22575025

OPEN CALORIMETER

1 unit of open calorimeter of the following specification is required at the fire test facility of NCCRD, IIT Madras. The calorimeter components comprise of:

COMPONENT	QUANTITY	SPECIFICATIONS
Collection hood	1	Refer to section A
Duct	1	Refer to section B
Exhaust system	1	Refer to section C
Instrumentations	Refer to section D	Refer to section D
*Louvre barricade	8	Refer to section E

(* This component is an optional. Quoted price for this will not be included for comparing bids)

NOTE:

- Vendor should have previous experience in the field of manufacturing of smoke exhaust equipment and flow property measurement devices
- Open calorimeter should confirm the specification of ISO 24473
- Where dimensions are stated in the text or in figures, they shall be followed within a tolerance of +/- 0.5 % typical and +/- 1 % maximum. An exception is the case of components which are intended to fit together, where the joint tolerance shall be appropriate for a sliding fit.
- Warranty on the system must be at least 2 years.
- Vendors are expected to design, manufacture, transport, install and commission the open calorimeter as per the specification.
- The contract is considered to be complete upon successful installation and commissioning of the calorimeter.
- *Clarify any technical details before quoting by contacting us*
- Please share the list of existing installations in India along with contact information of previous clients. The feedback from the previous clients will be considered.

CONTACT DETAILS

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1) INTRODUCTION

Open calorimeters are used for studying the combustion products from various types of fuel sources. The various parameters measured for a fire are the heat release rates, types and composition of gases released, smoke concentration and temperatures of smoke.

The basic construction of an open calorimeter consists of a large conical hood to collect the gases produced by combustion of fuel burnt, and are sucked in through a duct for analysis. Thermocouples are used for temperature measurement, transducers are used to measure pressure in pitot tubes, gas analyser is used to measure the concentration of various gases released. The general interest lies in measuring the concentration of Oxygen, Carbon dioxide, Carbon monoxide, unburnt hydrocarbons, etc.

The difference in Oxygen concentration in the gases collected and the ambient atmosphere is crucial for calculating the heat release rate. This concentration difference is taken to be proportional to the heat release rate.

The sketch of the open calorimeter is shown in section 3, "Schematics". The details of construction of the individual components are listed at various sections.

2) REFERENCES

ISO 24473: 2008 document will be the reference for construction of open calorimeter.

3) SCHEMATICS

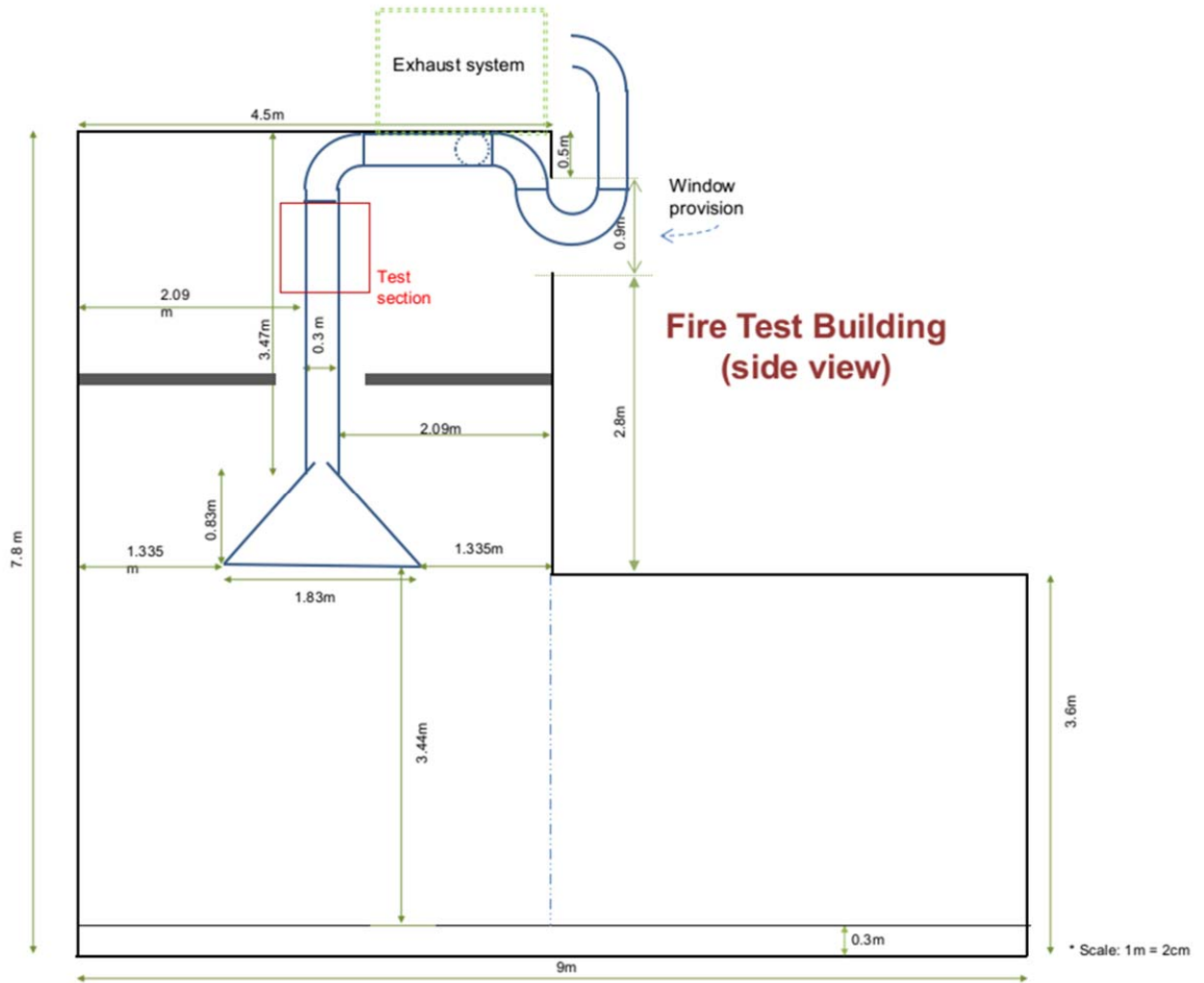


Illustration 1: Elevation of the building with the ducting details

**Fire Test Building
(top view)**

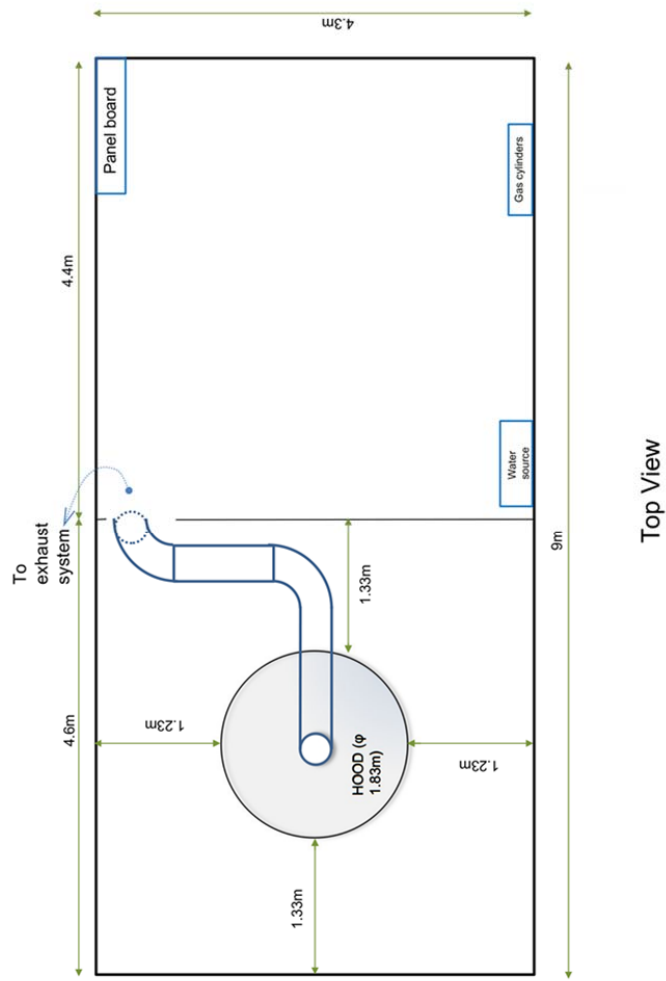


Illustration 2: Plan view of the building with the ducting details

Section A Specifications of the hood

The shape of the hood is frustum. The diameter at the base is 1.83 m, diameter at the top is 0.18 m and the height is 1m. Thickness must be 6mm. The material of construction must be SS304.

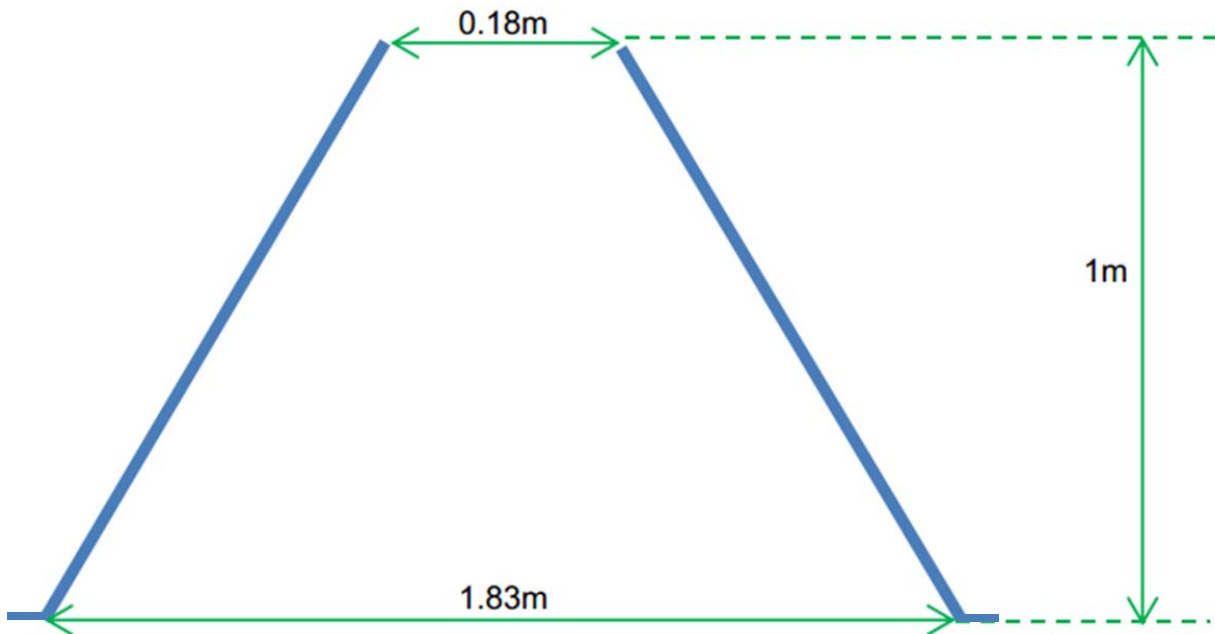


Illustration 3: Dimension of hood

At the base of the hood, provision to mount 8 equally spaced thermocouples must be made.

Section B Specifications of the duct

The hood is attached to the duct of inner diameter 300mm. Refer the schematics for the length and alignment of the duct. Approximate length of the duct is 15m, with five 90° bends and one 180° bend. The thickness of the duct must be maintained at 6 mm along the vertical portions of the duct and 2 mm along the horizontal portion. The material of construction must be SS304.

The test section, marked in red in illustration 1 is supposed to house various test equipment and provision to accommodate them have to be made in the duct. The following illustration 4 is the sketch of various provisions that are to be provided:

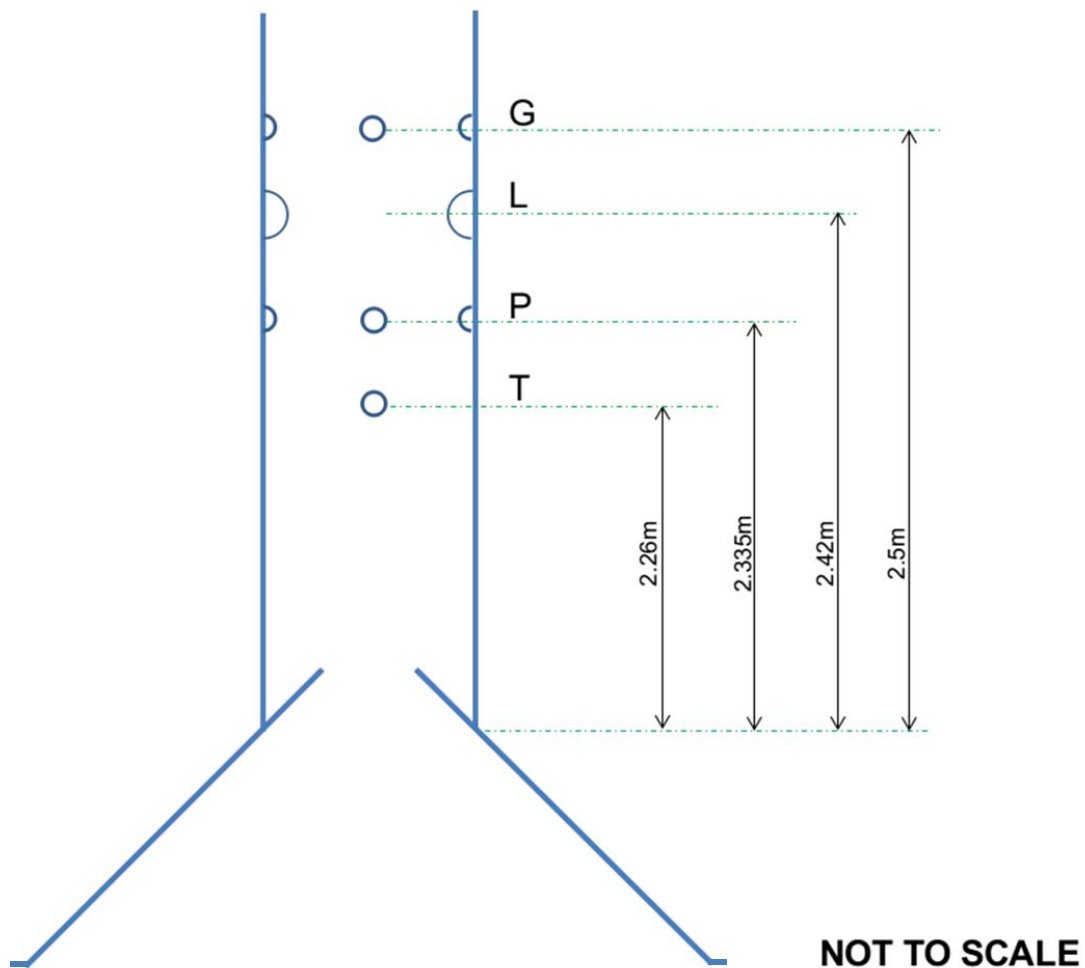


Illustration 4: Location of the ports. T - Temperature port, P - Pressure port, L - Laser smoke detection system and G - Gas sampling port

The point of contact between the hood and the duct will be used as a reference datum and will be called as the junction. Details of the ports are as follows:

- At a distance of 2260 mm from the junction a hole must be made to accommodate a feed-through device (example- Swagelok bored-through fitting). The internal diameter of the feed through device has to be appropriate to house a thermocouple. This is temperature port, T.
- 75 mm above the hole specified previously, 4 equally spaced holes have to be made to accommodate feed-through devices. This is Pressure port, P.
- A hole must be made and a SS304 half coupling has to be welded in the middle of any of the above mentioned 4 holes. This is also a part of Pressure port, P
- Provision for laser based smoke detection and estimation must be made after the above mentioned port 'P' at a distance of 2242mm from the junction. This port is for Laser smoke detection system, 'L'.
- At a distance of 2500 mm from the junction, 4 equally spaced holes have to be made to accommodate feed-through device.

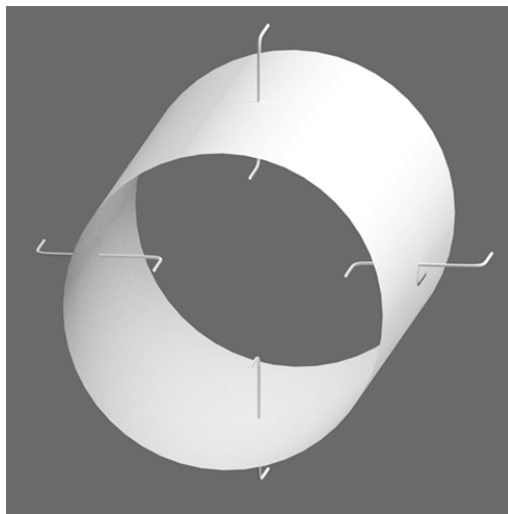


Illustration 6: Reference for Pitot tube arrangement

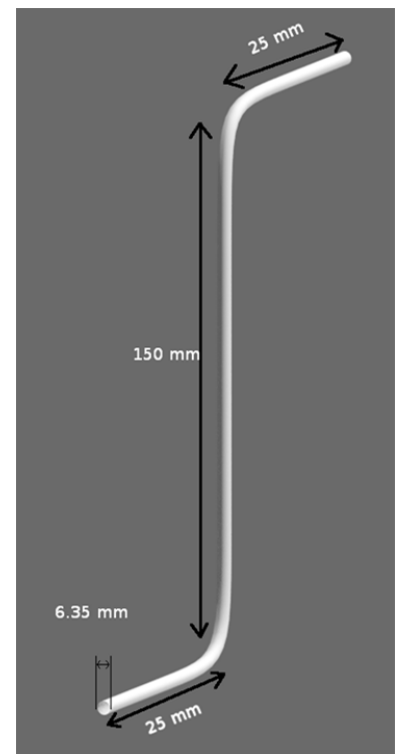


Illustration 5: Design of the Pitot tube

The 4 equally spaced holes, at port 'P', have to house dynamic pressure pitot tubes. Illustration 6 can be used as reference. The image is not to scale. Appropriate feed through devices are needed (example- Swagelok bored-through fitting) to attach the pitot tubes to the duct, which are also not depicted.

The design of the Pitot tube is as shown in the illustration 5. The material of construction is SS316. The wall thickness needs to be maintained below 1mm.

The outlets of the four dynamic pitot tubes are to be connected to a single connection of halo tube. A halo tube is one which has multiple inlets but a single outlet. It acts as a mixing chamber. Differential pressure transducer is attached at the end of the halo tube.

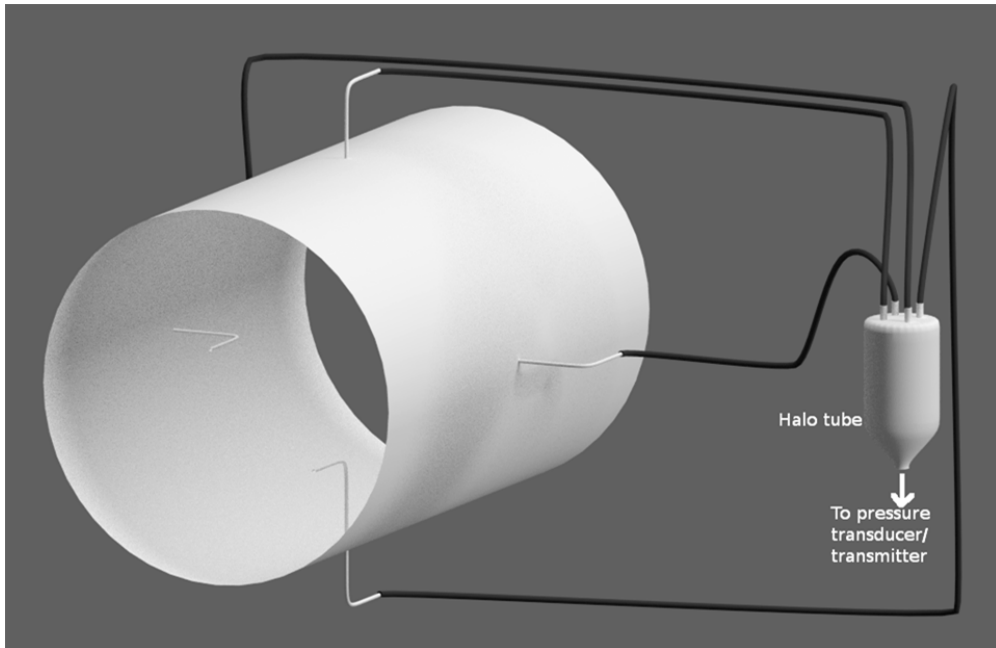


Illustration 7: Sketch of pressure pitot tubes connected to a halo tube

The static pressure Pitot tube has to be attached at the welded half coupling placed at the centre of any of the four dynamic Pitot tube. The diameter of the hole for the static Pitot tube has to be $\frac{1}{4}$ inch (6.35 mm).

The gases are sampled out through tubes positioned at 4 locations at port 'G'. Please refer to illustration 8 and 9 for the schematics of the tubing, dimensions and its arrangement. The material of construction is SS316. Appropriate feed-through devices (example- Swagelok bored-through fitting) are needed for the sampling port. The gases collected are combined in a halo tube. Appropriate end fittings are required for connecting hoses to the halo tube.

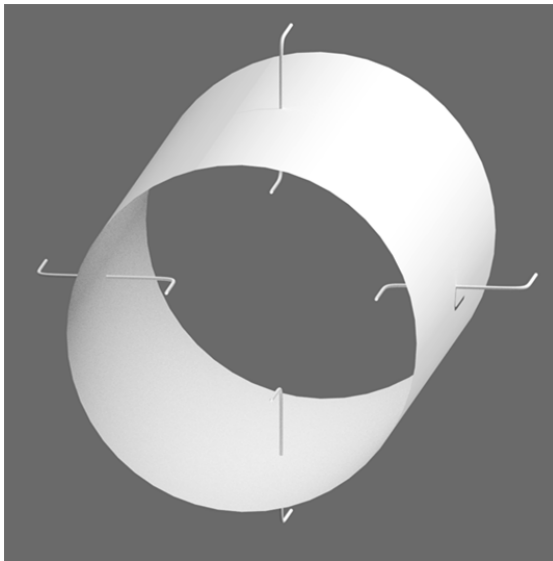


Illustration 9: Reference for gas sampling tube arrangement

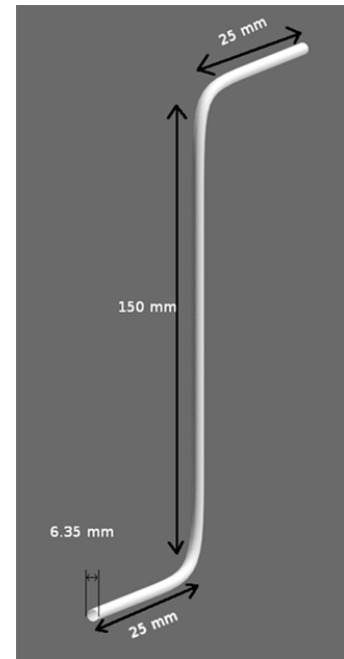


Illustration 8: Design of the gas sampling tube

Tubes connecting the gas sampling port to the halo tube and the halo tube must be heated and maintained at 105°C. This must be achieved by electrical heating.

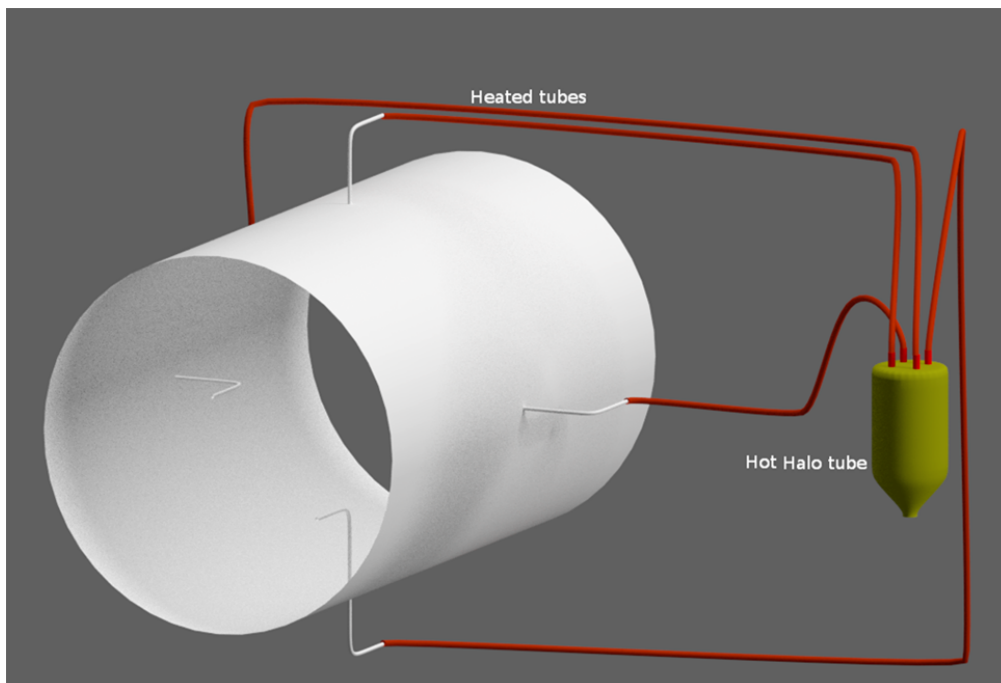


Illustration 10: Sketch of heated tubes collecting gas into hot halo tube

Section C

Specifications of the exhaust system

As part of the exhaust system, a centrifugal blower has to be mounted at the end of the duct on top of the building, as mentioned in the schematics. The motor driving the blower has to be either SIEMENS or ABB made and include a variable frequency drive. The maximum flow rate of the pump has to be 2.36 m³ per second. The static pressure in the pump can be up to 100 inches (2540 mm) of water column. The exhaust is open to the ambient atmosphere. The blower exhaust system must be able to handle temperature in the order of 500°C.

Type	Centrifugal pump
Brand	ABB or Siemens
Max. flow rate	2.36 m ³ per second
Static pressure	100 inches (2540 mm) of water column.
Operating temperature	around 500°C
Additional features needed	variable frequency drive

Section D Instrumentations

Thermocouples

A total of 9 thermocouples are needed to be installed in the open calorimeter. Eight equally spaced thermocouples are to be installed at the mouth(or base) of the hood, and one at feed through device provided at port 'T'.

The specification of the thermocouple is as follows

Type	K-type
Additional specification	Inconel sheathed, exposed junction type
Quantity needed	9
Length	600 mm
Outer diameter	3.02mm

Thermocouple has to be calibrated by an ISO 17025 accredited lab. It has to be calibrated at 0°C, 50°C, 100°C, 150°C and 200°C before delivery. For each thermocouple, 15m long cable must be provided, with suitable terminals to connect to a data acquisition unit.

Pressure transducers

Pressure transducers or transmitter are to be used for measuring the differential and absolute pressures. A transducer typically produces voltage in the range of 0 – 5 V DC. A Transmitter produces a loop current, typically of 4 – 20 mA DC.

Differential pressure transducer/transmitter specification:

Range	0 – 1 inch(25.4 mm) of a water column
Accuracy	0.075% of full scale
Quantity needed	1

Absolute pressure transducer/transmitter specification:

Range	0 – 20 psia (absolute psi)
Accuracy	0.075% of full scale
Quantity needed	1

For each pressure transducer/transmitter, 15m long cables must be provided with suitable terminals to connect to a data acquisition unit

Laser based smoke measurement

Smoke concentration is measured using light intensity extinction method and He-Ne laser has to be used as the light source. The maximum power output of the laser has to be 0.5 mW. The system is expected to be modular, with provision to open, remove, and alter components, and also for easy maintenance. 15m long cables must be provided, with suitable terminals to connect to a data acquisition unit, to transfer the data from the photodiode. Two non-dispersive filters are to be provided for calibration of the smoke measurement. The optical density of the filters is to be anywhere between 0.1 and 0.9.

***Section E**
Specification of louvre barricade for air flow control
(*this is an optional component)

A set of 8 louvre barricades are to be placed directly underneath the hood. Please refer to illustration 11, for the dimension of each of the louvre barricade. These barricades, which are eight in numbers must be arranged in an octagonal fashion (refer to illustration 12 for the top view of the arrangement), which can be circumscribed by a 1800mm radius circle.

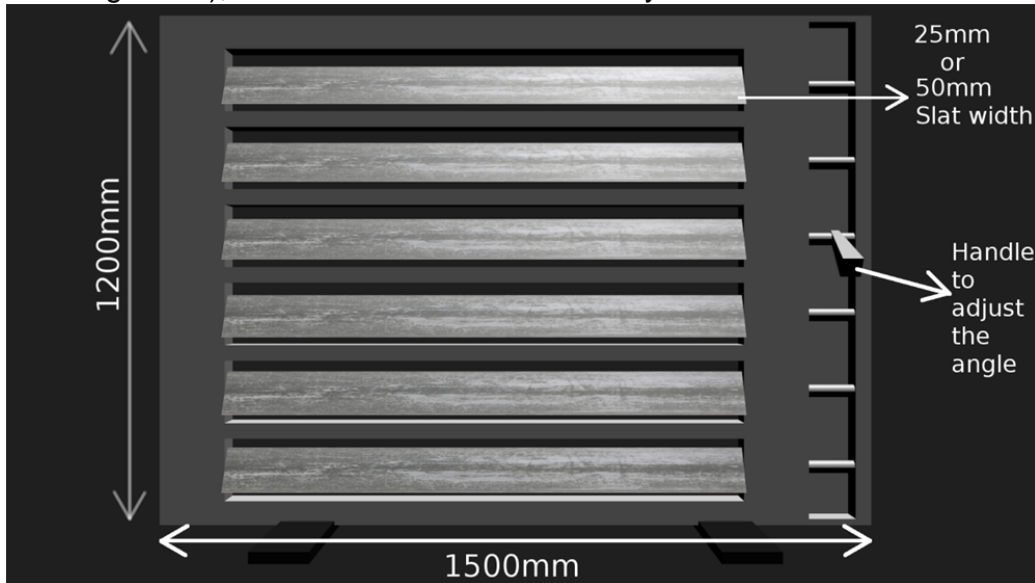


Illustration 11: Dimensions of the louvre barricade.

NOTE: This illustration is a rough schematic and NOT to scale. Actual design may vary

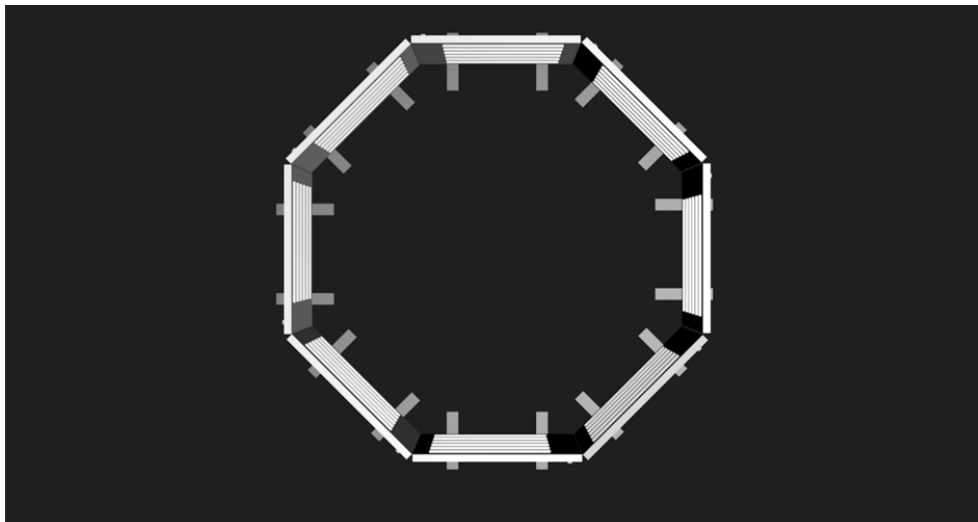


Illustration 12: Top view of the octagonal arrangement

Tentative design of the barricade (vendor can offer alternate design to meet the purpose of air flow control during experiments):

Each of the barricades, as shown in illustration 11, is 1200 mm high, 1500 mm wide and consists of 25 mm wide slats (could be in segments). The number of slats per barricade must be at least 30. There should be provision for adjusting the angle of slats simultaneously or in group to allow control of air flow (completely blocked to fully open). The material of construction of the barricade should be able to withstand temperatures of about 300°C for about 60 minutes without warping or distorting. The slats should be adequately supported to ensure smooth operation and prevent sagging. Each barricade must be capable of stably standing, independently. When standing the ground clearance should not exceed 10 mm. Each barricade should weigh no more than 20 kgs.

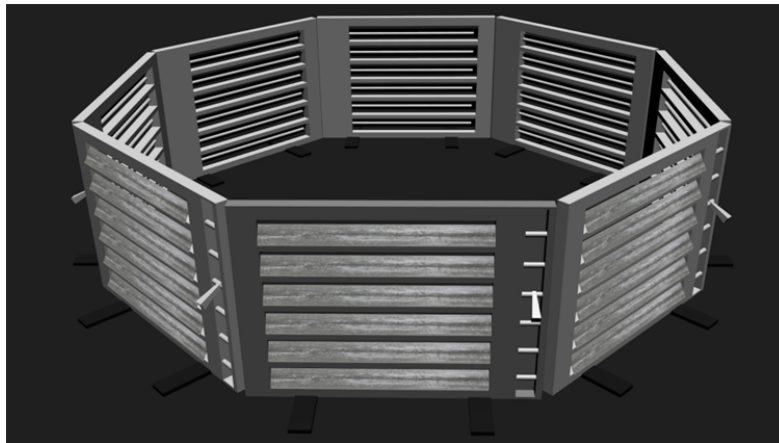


Illustration 13: A rendering of the view of the octagonal arrangement of the louvre barricade