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 optional)

NOTE:

- Vendor should preferably 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 may 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

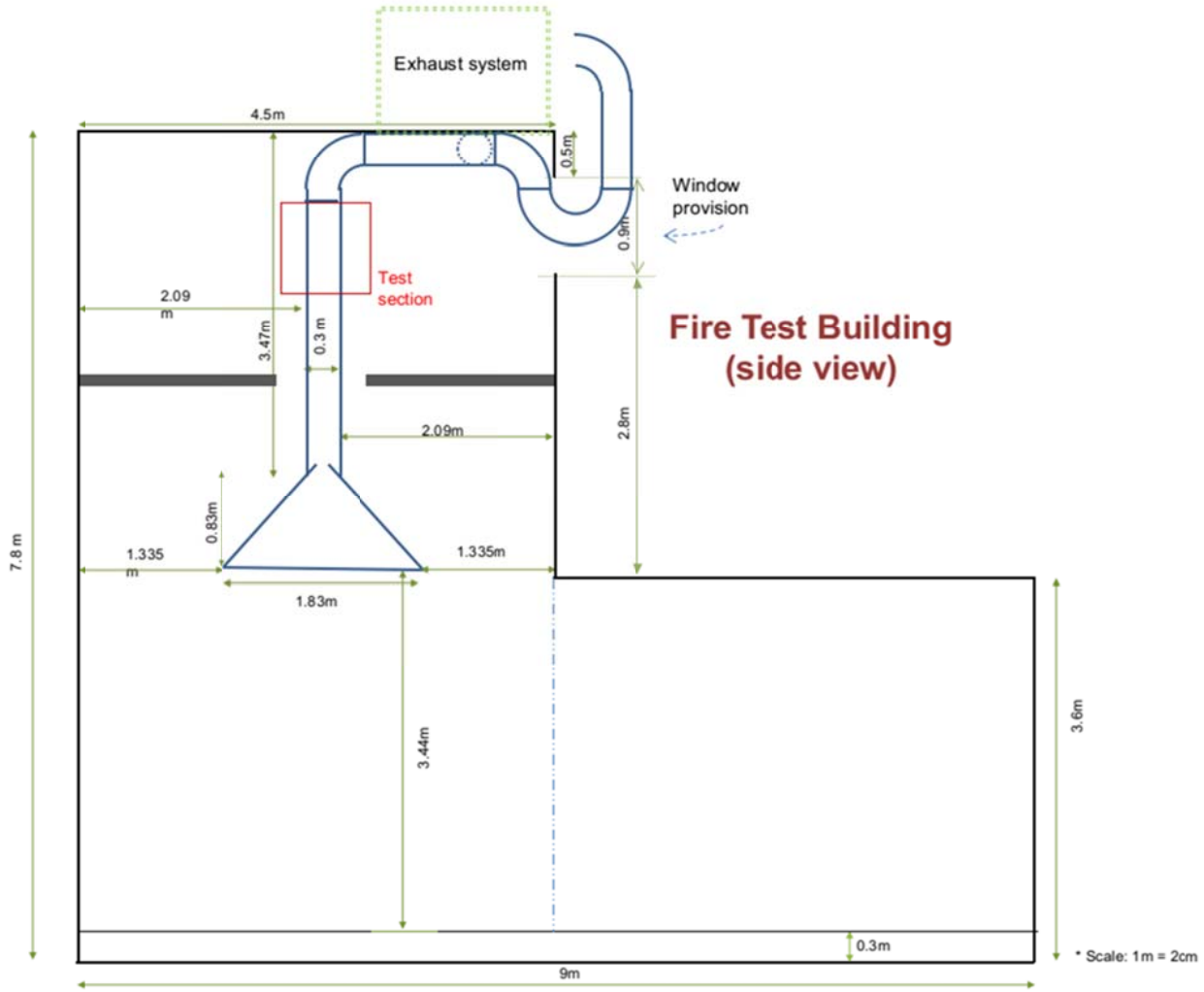

Illustration 1: Elevation of the building with the ducting details

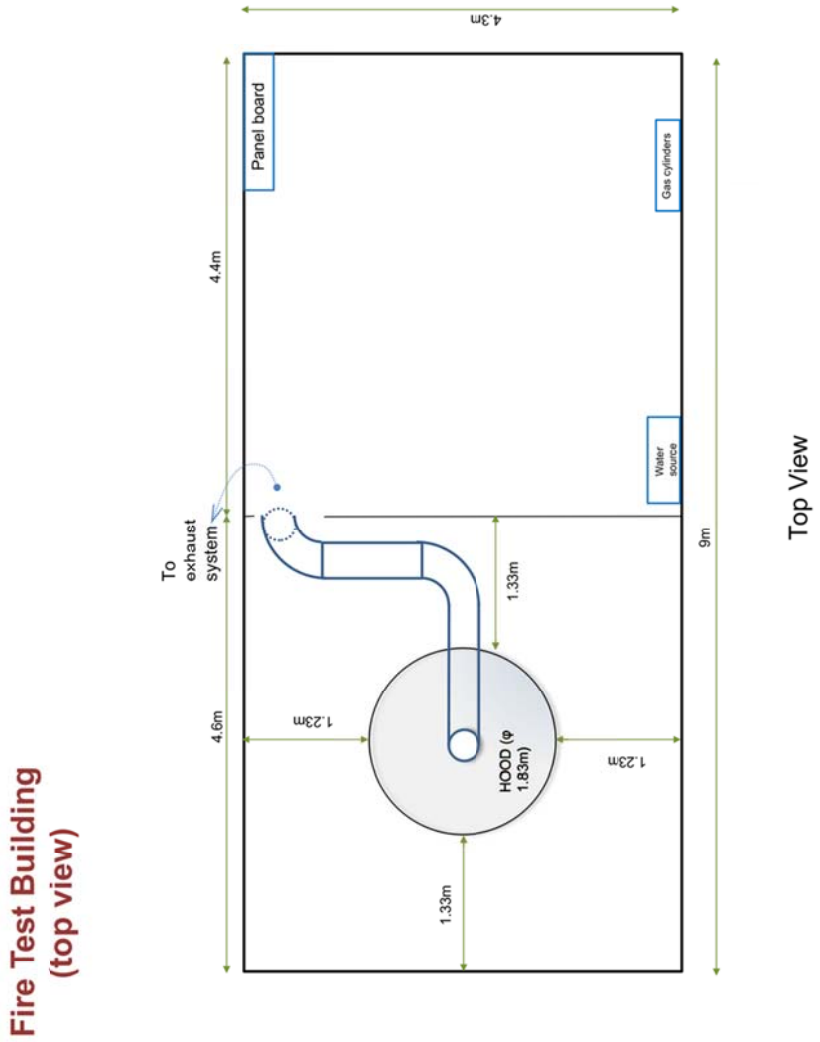

Illustration 2: Plan view of the building with the ducting details

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.

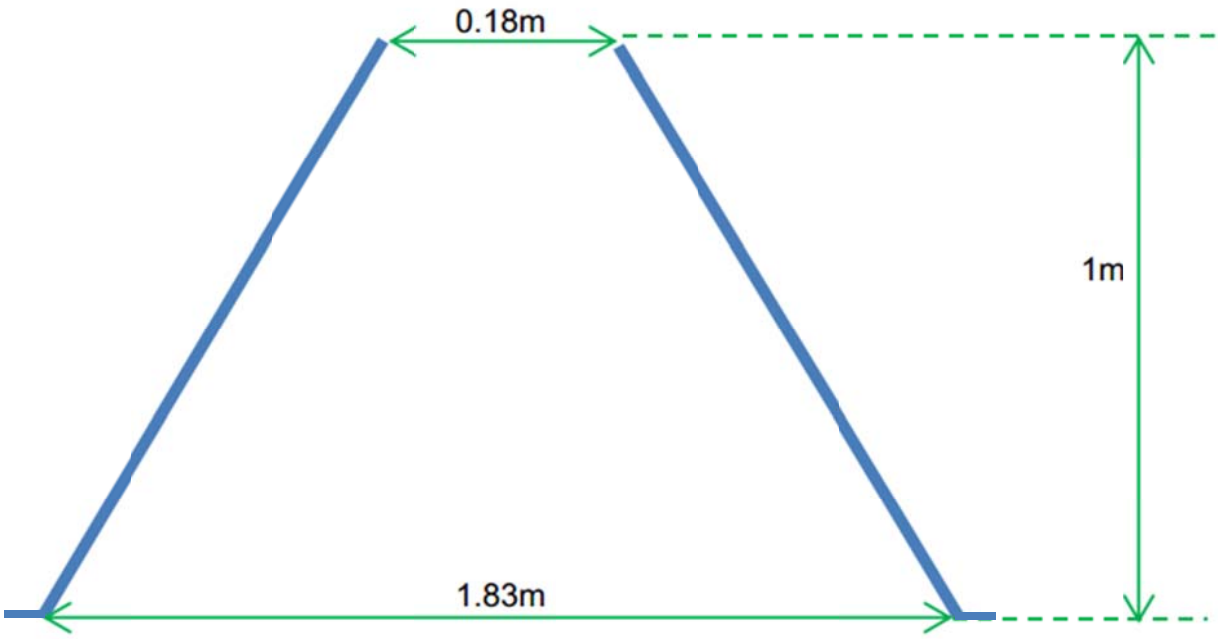

Illustration 3: Dimension of hood

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 90º bends and one 180º 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:

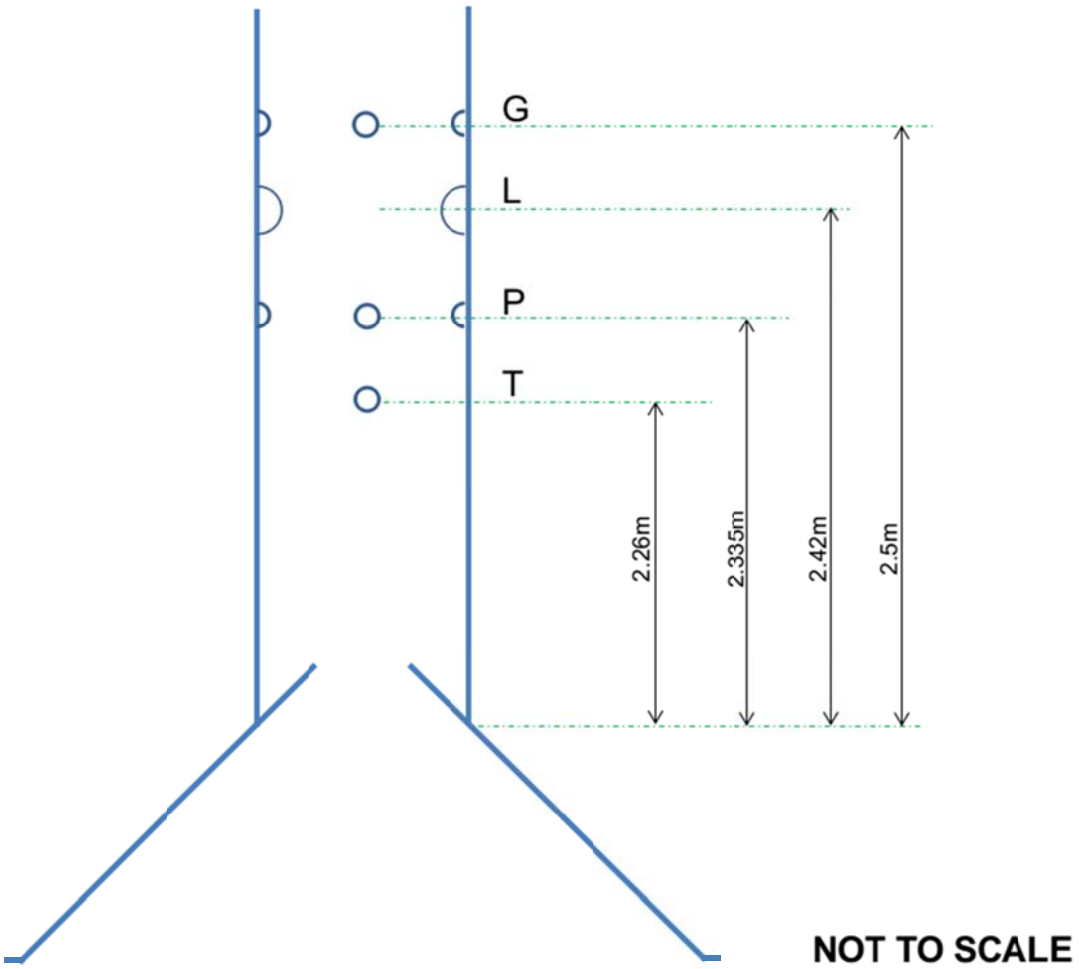

Illustration 4: Location of the ports. T - Temperature port, P - Pressure port, L - Laser smoke detection system and G - Gas sampling port

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.

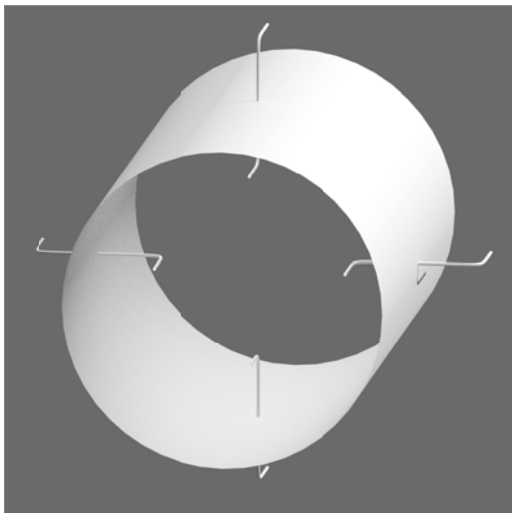

Illustration 6: Reference for Pitot tube arrangement

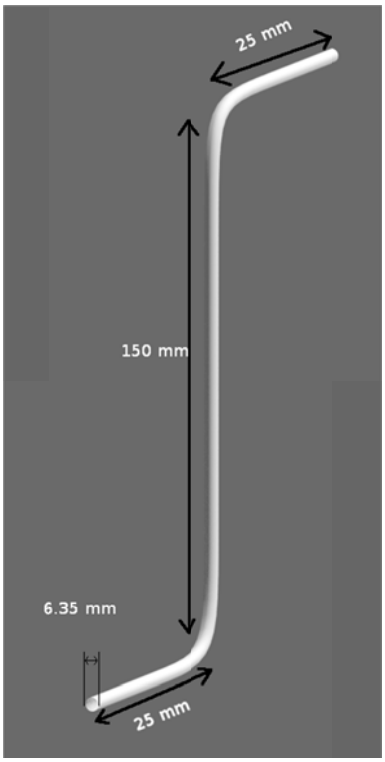

Illustration 5: Design of the Pitot tube

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.

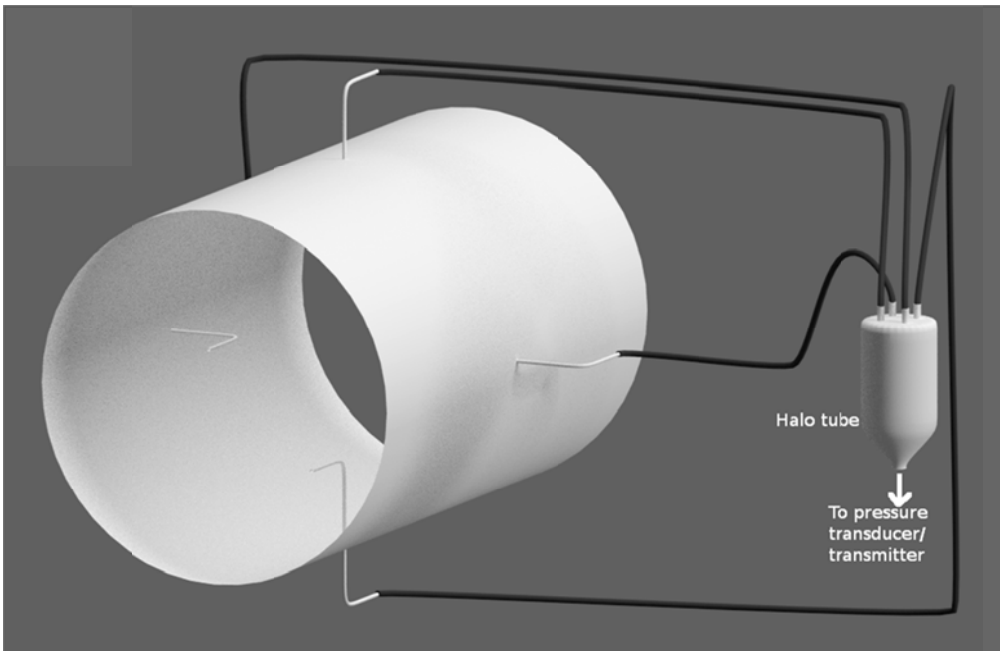

Illustration 7: Sketch of pressure pitot tubes connected to a halo tube

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 ¼ 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.

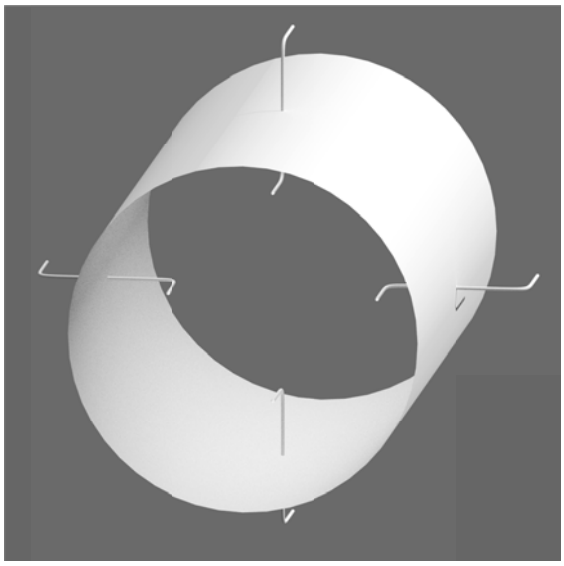

Illustration 9: Reference for gas sampling tube arrangement

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 105ºC. This must be achieved by electrical heating.

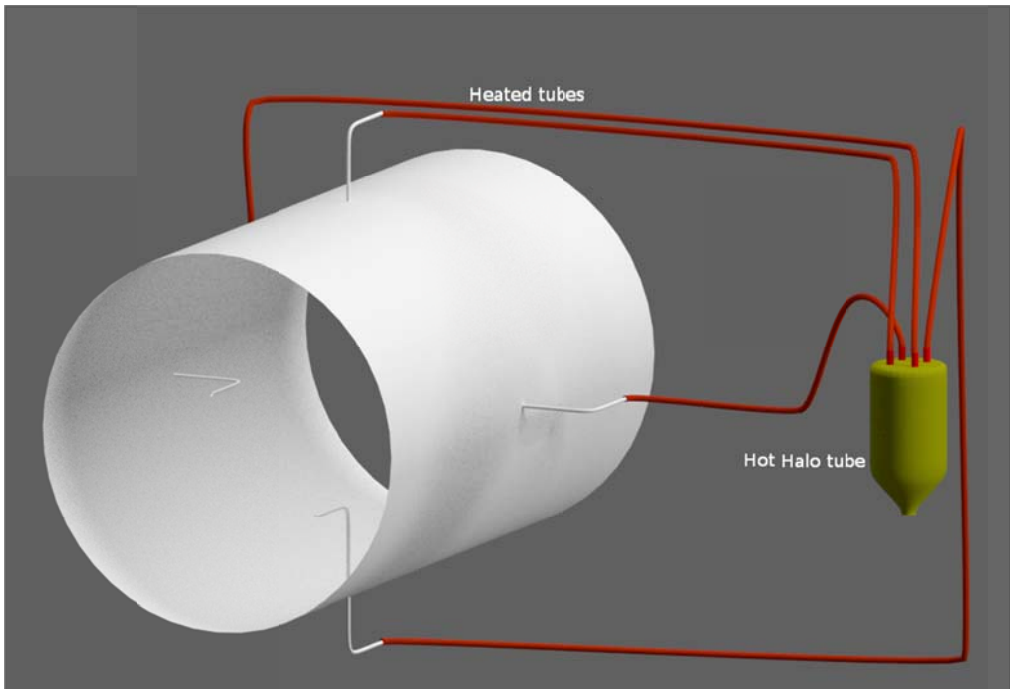

Illustration 10: Sketch of heated tubes collecting gas into hot halo tube

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 m^3 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 500ºC.

Type	Centrifugal pump
Motor make	ABB or Siemens
Max. flow rate	2.36 m^3 per second
Operating gas temperature	around 250ºC
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 0ºC, 50ºC, 100ºC, 150ºC and 200ºC 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 rage 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

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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
(*this is an optional component)

A set of 8 louvre barricades must 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.

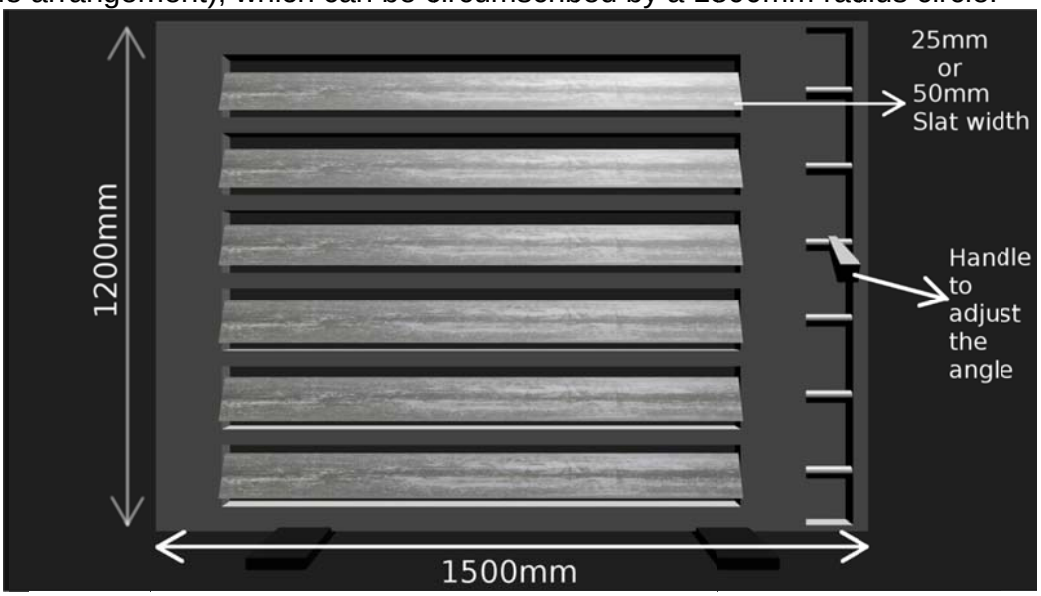

Illustration 11: Dimensions of the louvre barricade.

NOTE: This illustration is a rough schematic and NOT to scale.

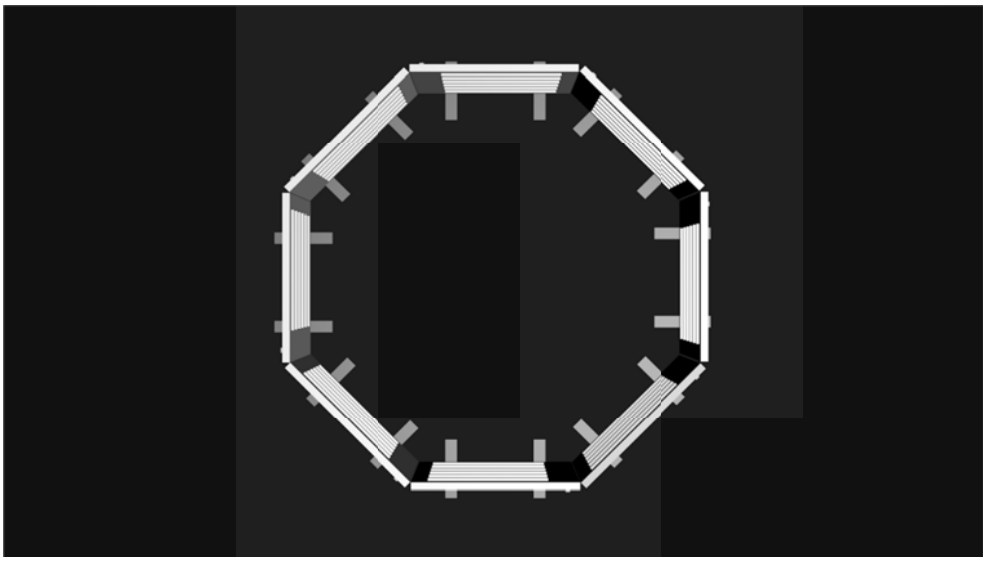

Illustration 12: Top view of the octagonal arrangement

Design of the barricade:

Each of the barricades, as shown in illustration 11, is 1200mm high, 1500mm wide and consists of 25mm or 50mm wide slats. The number of slats must be at least 100 or 50. Provision for adjusting the angle of all the slats simultaneously must be provided. The material of construction of the barricade has to be SS304. The material of construction for slat is anodized Aluminium alloy complying IS 21 (or an appropriate material capable of withstanding temperatures of 200°C) and the thickness of the slats needs to be at least 2mm. Support for slats are required to prevent from sagging.

The barricade must have the following features too:

- Each barricade must be capable of stably standing, independently.
- When standing there must not be any clearance between the ground and the barricade
- Each barricade, when attached to another, must not leave any clearance at the joint.

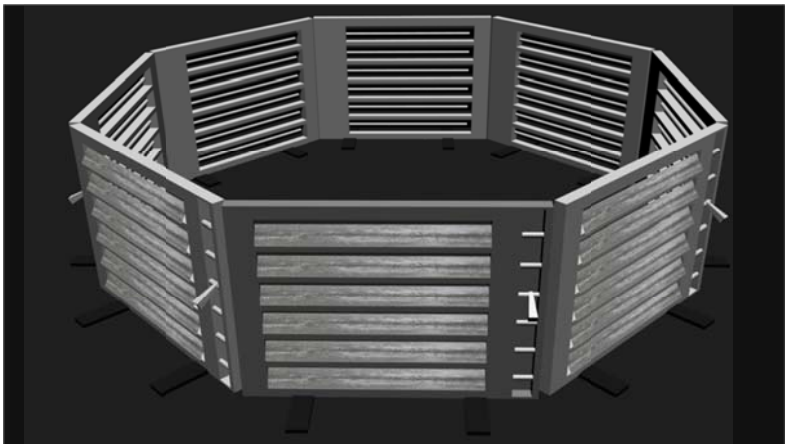

Illustration 13: A rendering of the view of the octagonal arrangement of the louvre barricade