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P.SARVAHARANA
Assistant Registrar (Project Purchase)

Ref: ICS/11-12/013/DSTX/TSUN
Date: 21.07.2016

Tender No: ASE/SRCH/029/2016

Due Date: 11.08.2016, 3:30pm

Technical Bid Opening meeting on 12.08.2016 (Tuesday) at Admin Building Conference room, 2nd Floor, IIT Madras at 11.00 a.m to 12.00 p.m.

Dear Sir/Madam,

On behalf of the Indian Institute of Technology Madras, offers are invited for the supply of “**Fire Propagation Apparatus-1 No**” conforming to the specifications given in Annexure.

Instructions to the Bidder

- (i) **Preparation of Bids:** - The tenders should be submitted under two-bid system (i.e.) Technical bid and Financial bid.
- (ii) **Delivery of the tender:** - The tender shall be sent to the below-mentioned addresses either by post or by courier so as to reach our office before the due date and time specified in our Schedule. The offer/bid can also be dropped in the tender box on or before the due date and time specified in the schedule. The tender box is kept in the office of the “**Assistant Registrar, Project Purchase**” IC & SR Building 2nd floor, I.I.T. Madras, Chennai – 600 036, which is also the address for communication.
- (iii) **Opening of the tender:** - The offer/Bids will be opened by a committee duly constituted for this purpose. The technical bids will be opened first and it will be examined by a technical committee which will decide the suitability of the bid as per our specifications and requirements. The bidders are requested to attend the opening of **Technical bids schedule on 12.08.2016 (Tuesday) at Admin Building, Conference room, 2nd Floor, IIT Madras at 11 a.m. to 12 p.m.** In respect of opening of financial bid, those bidders who are technically qualified only will be called for.

- (iv) **Prices:** - The price should be quoted in nett per unit (after breakup) and must include all packing and delivery charges to various Departments/Institutions. The offer/bid should be exclusive of taxes and duties, which will be paid by the purchaser as applicable. However the percentage of tax & duties should be clearly indicated.

The price should be quoted without custom duty and excise duty, since I.I.T. Madras is exempt from payment of excise duty, and the custom duty will be paid at concessional rate against duty exemption certificate.

In case of import supply, the price should be quoted on EX-WORKS and CIP basis indicating the mode of shipment.

- (v) **Agency Commission:** - Agency commission, if any, will be paid to the Indian agents in Rupees on receipt of the equipment and after satisfactory installation. Agency Commission will not be paid in foreign currency under any circumstances. The details should be explicitly shown in Tender even in the case of 'Nil' commission. The tenderer should indicate the percentage of agency commission to be paid to the Indian agent. The foreign Principal should indicate about the percentage of payment and it should be included in the originally quoted basic price, if any.
- (vi) **Terms of Delivery:** - The item should be supplied to our various Departments/Institutions as per Purchase Order. In case of import supply, the item should be delivered at the cost of the supplier to our Institution. The Installation/Commissioning should be completed as specified in our important conditions.
- (vii) **Other Terms & Condition:** - please refer the specifications for other terms & conditions.
- (viii) IIT Madras reserves the full right to accept / reject any tender at stage without assigning any reason.

Yours sincerely,

P.SARVAHARANA

Assistant Registrar (Project Purchase)

IC&SR, I.I.T. Madras

पी. सार्वहरणा / P. SARVAHARANA
सहायक कुलसचिव (परियोजना क्रय)
ASSISTANT REGISTRAR (PROJECT PURCHASE)
आईसी एवं एसआर केन्द्र / Centre for IC & SR
आईआईटी मद्रास / I.I.T. MADRAS - 600 036

SCHEDULE

Important Conditions of the tender

1. The due date for the submission of the tender is **11.08.2016, 3:30pm.**
2. The offers / bids should be submitted in two bids systems (i.e.) 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 Open Tender for supply of " _____ " should be written on the left side of the Outer bigger cover and sealed.
3. **EMD:** - EMD of Rs.2,00,000/- (Rupees Two Lakhs) for Fire Propagation Apparatus to be submitted by the bidder. The EMD should be included in the financial bid which will not be opened for Technical evaluation. Enclosing the EMD in the Technical bid will automatically disqualify the tenderer. EMD should be in the form of DD in favour of "The Registrar, Indian Institute of Technology Madras" and payable at Chennai. The tender without EMD would be considered as UNRESPONSIVE and REJECTED. Photo/FAX copies of the Demand Draft/Banker's pay orders will not be accepted. No interest will be paid for the EMD and the EMD (Bid Security) will be refunded to the successful bidder on receipt of Performance Security.
4. **Performance Security:-** The successful bidder should submit Performance Security for an amount of 5% of the value of the contract/supply. The Performance Security may be furnished in the form of an Account Payee DD, FD Receipt from the commercial bank, Bank Guarantee from any nationalized bank of India will be an acceptable.

Only after submission of Performance Security, Purchase Order/Work Order will be released / L.C will be opened.

Performance Security in the form of Bank Guarantee:- In case the successful bidder wishes to submit Performance Security in the form of Bank Guarantee, the Bank Guarantee should be routed through the Beneficiary Bank to the end user bank. Otherwise, the Indian Agent of the foreign vendor has to submit a Bank Guarantee through a Nationalized Bank of India.

The Bank Guarantee should remain valid for a period of sixty days beyond the date of completion of all contractual obligations of the supplier including the warranty obligations.

5. If an Indian agent is involved, the following documents must be enclosed:
Foreign principal's proforma invoice indicating the commission payable to the Indian Agent and nature of after-sales service to be rendered by the Indian Agent.
 - ✓ Copy of the agency agreement with the foreign principal and the precise relationship between them and their mutual interest in the business.
 - ✓ The enlistment of the Indian agent with Director General of Supplies & Disposals under the Compulsory Registration Scheme of Ministry of Finance.
6. The offer/bids should be sent only for a machine that is available in the market and supplied to a number of customers. A list of customers in India and abroad with details must accompany the quotations. Quotations for a prototype machine will not be accepted.
7. Original catalogue (not any photocopy) of the quoted model duly signed by the principals must accompany the quotation in the Technical bid. No prices should ever be included in the Technical bid.
8. Documentary proof for the claimed position and repetition accuracies must be obtained from the principals and submitted along with the relevant pages of the standards.
9. Compliance or Confirmation report with reference to the specifications and other terms & conditions should also be obtained from the principal.
10. **Validity:** Validity of Quotation not less than 90 days from the due date of tender.
11. **Delivery Schedule:-** The tenderer should indicate clearly the time required for delivery of the item. In case there is any deviation in the delivery schedule, liquidated damages clause will be enforced or penalty for the delayed supply period will be levied.
12. **Risk Purchase Clause:-** In the event of failure of supply of the item/equipment within the stipulated delivery schedule, the purchaser has all the right to purchase the item/equipment from other sources on the total risk of the supplier under risk purchase clause.
13. **Payment:-** No Advance payment will be made for Indigenous purchase. However 90% Payment against Delivery and 10% after installation is agreed to wherever the installation is involved. In case of import supplies the payment will be made only through 100% Letter of Credit and (90% payment will be released shipping documents and 10% after installation wherever the installation is being done).
14. **Advance Payment:-** No advance payment is generally admissible. In case of specific percentage of advance payment is required, the Foreign Vendor has to submit a Bank Guarantee equal to the amount of advance payment and it should be routed through the Beneficiary Bank to the end user Bank. Otherwise, the Indian Agent of the foreign vendor has to submit a Bank Guarantee through a Nationalized Bank of India.

15. **On-site Installation:** - The equipment or machinery has to be installed or commissioned by the successful bidder within 15 to 20 days from the date of receipt of the item at site of IIT Madras.
 16. **Warranty/Guarantee:** - The vendors should provide a warranty for at least 24 months from the date of Commissioning of the setup. Any extended warranty offered for the same has to be mentioned separately.
 17. **Late offer:** - The offers received after the due date and time will not be considered. The Institute shall not be responsible for the late receipt of Tender on account of Postal, Courier or any other delay.
 18. **Acceptance and Rejection:** - I.I.T. 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.
 19. **Do not quote the optional items or additional items unless otherwise mentioned in the Tender documents / Specifications.**
1. **Disputes and Jurisdiction:** -
 - a. **Settlement of Disputes:** Any dispute, controversy or claim arising out of or in connection with this PO including any question regarding its existence, validity, breach or termination, shall in the first instance be attempted to be resolved amicably by both the Parties. If attempts for such amicable resolution fails or no decision is reached within 30 days whichever is earlier, then such disputes shall be settled by arbitration in accordance with the Arbitration and Conciliation Act, 1996. Unless the Parties agree on a sole arbitrator, within 30 days from the receipt of a written request by one Party from the other Party to so agree, the arbitral panel shall comprise of three arbitrators. In that event, the supplier will nominate one arbitrator and the Project Coordinator of IITM shall nominate an arbitrator. The Dean IC&SR will nominate the Presiding Arbitrator of the arbitral tribunal. The arbitration proceeding shall be carried out in English language. The cost of arbitration and fees of the arbitrator(s) shall be shared equally by the Parties. The seat of arbitration shall be at IC&SR IIT Madras, Chennai.
 - b. **The Applicable Law:** This Purchase Order shall be construed, Interpreted and governed by the Laws of India, Court at Chennai shall have exclusive jurisdiction subject to the arbitration clause.
 2. All Amendments, time extension, clarifications etc., will be uploaded on the website only and will not be published in newspapers. Bidders should regularly visit the above website to keep themselves updated. No extension in the bid due date/ time shall be considered on account of delay in receipt of any document by mail.

Acknowledgement:- It is hereby acknowledged that the tenderer has gone through all the conditions mentioned above and agrees to abide by them.

**SIGNATURE OF TENDERER
ALONG WITH SEAL OF THE
COMPANY WITH DATE**

**SPECIFICATIONS OF
FIRE PROPAGATION
APPARATUS
(FPA)**

Fire Propagation Apparatus

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

FPA			
Test section unit		Exhaust and analysis unit	
1	Heat flux gauge	1	Gas Analysis System
2	Load cell system	2	Thermocouple
3	IR heaters	3	Averaging pitot probe and pressure transducer
4	Ignition pilot flame	4	Exhaust blower
5	Water-cooled shield	5	Power controller
6	Air distribution chamber	6	Hood and duct
7	Air supply pipes	7	Digital data collection system
		8	Smoke measuring unit
		9	Mass flow controllers

Fire Propagation Apparatus

NOTE :

- Vendor should have previous experience in the field of manufacturing of smoke exhaust equipment ,flow property measurement devices,manufacturing of gas analysis equipments.
- FPA should conform the specification of ISO12136 or superior specification in case specification other than ISO12136 is specified.
- 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 FPA as per the specification.
- The contract is considered to be complete upon successful installation and commissioning of the FPA,which includes methane gas calibration (to find C factor of the equipment) and calibration of gas analyzers,smoke measuring unit and other sensors.
- 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 along with technical specifications.
- Provide detailed cost breakup of all 16 components as per table (titled FPA) on the previous page (page 2) of this document
- The price of any imported components should be quoted without custom duty.The imported item shall be reconsigned to IIT to avail custom duty exemption.

CONTACT DETAILS

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Fire Propagation Apparatus

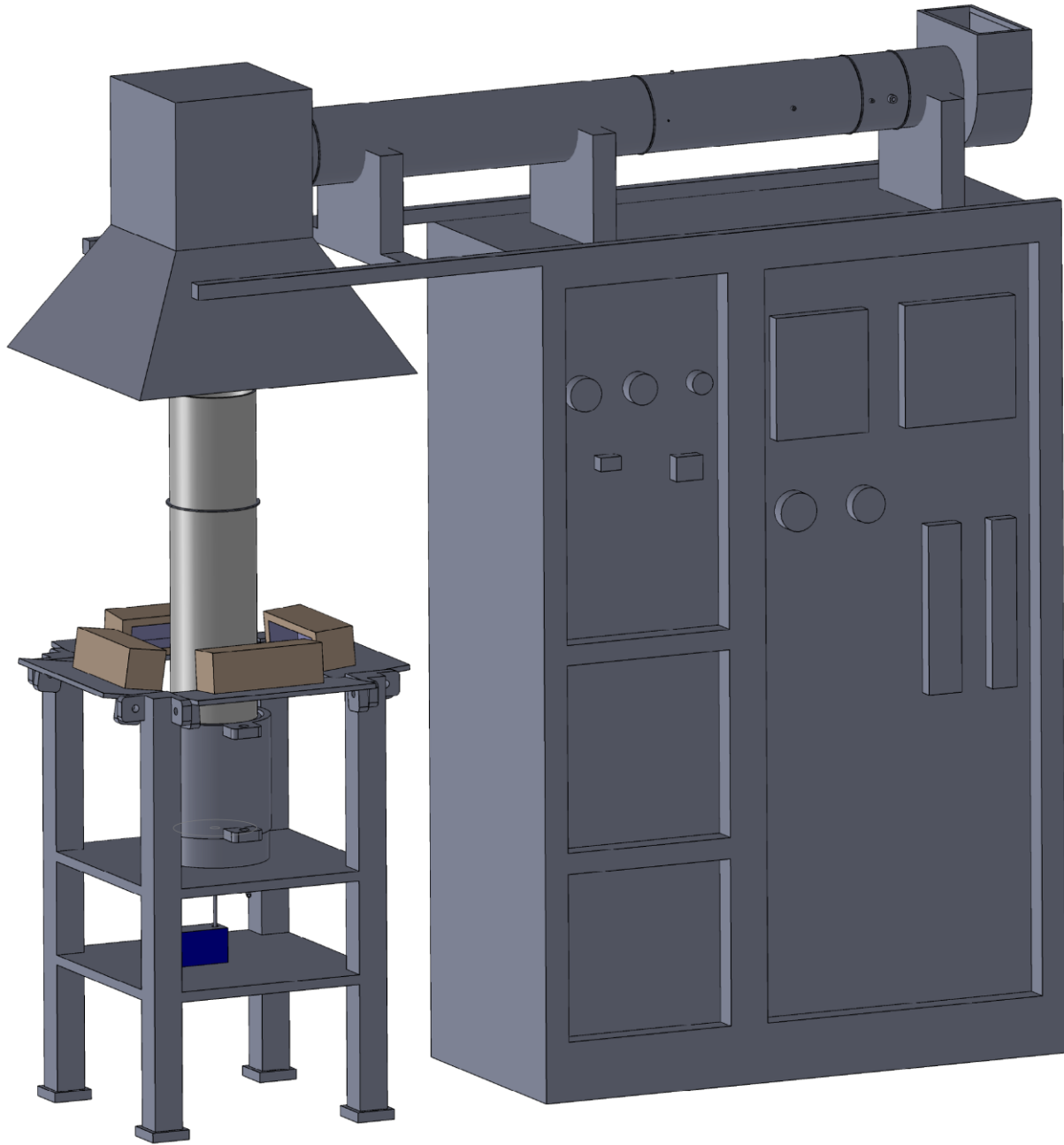


Fig. 1. Fire Propagation Apparatus

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1 Introduction and scope

The FPA (Fire Propagation Apparatus) is used to evaluate the flammability of materials and products. It is also designed to obtain the transient response of such materials and products to prescribed heat fluxes in specified inert or oxidizing environments and to obtain laboratory measurements of generation rates of fire products (CO₂, CO, and, if desired, gaseous hydrocarbons) for use in fire safety engineering.

The following test methods, capable of being performed separately and independently in FPA

- 1) **Ignition test**, to determine ignition time for a horizontal specimen.
- 2) **Combustion test**, to determine chemical heat release rate, convective heat release rate effective heat of combustion, and smoke yield from burning of a horizontal specimen.
- 3) **Pyrolysis test**, to determine mass loss rate of test specimen and heat of gasification.
- 4) **Fire propagation test**, to determine chemical heat release rate from burning of a vertical specimen.

International Standard (ISO 12136) determines and quantifies the flammability characteristics of materials, in relation to their propensity to support fire propagation, by means of a fire propagation apparatus (FPA). Material flammability characteristics that are quantified in the international Standard include time to ignition, chemical and convective heat release rates, mass loss rate, effective heat of combustion, heat of gasification and smoke yield. These properties can be used for fire safety engineering and for fire modelling.

2 Suggested Reference

ISO 12136.

ISO 12136 was prepared by Technical Committee ISO/TC 92, Fire safety, Subcommittee SC 1, Fire initiation and growth.

3 Schematic of fire propagation apparatus

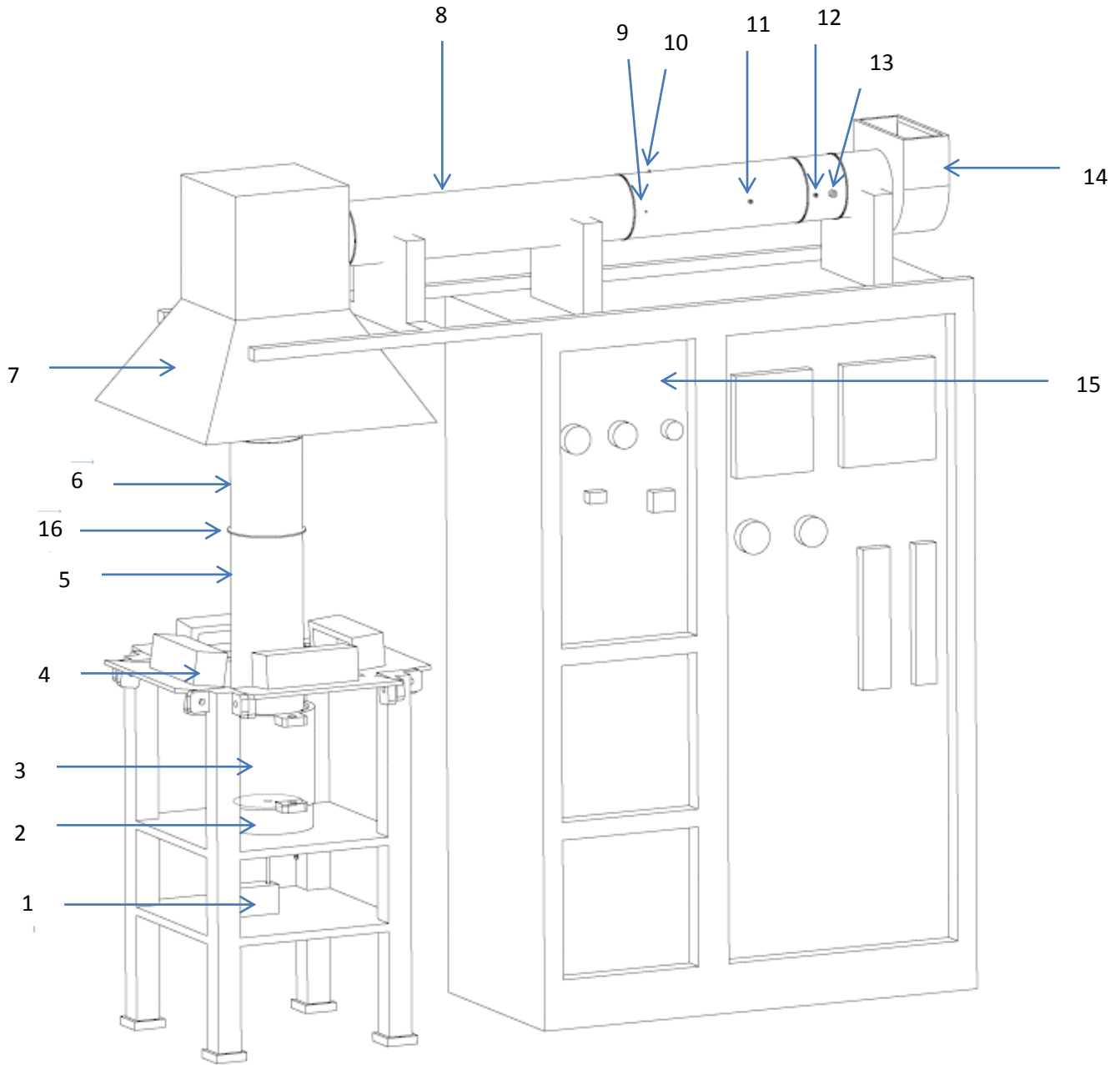


Fig. 2

1	Load cell
2	Air distribution chamber

Fire Propagation Apparatus

3	Water cooled shield with pneumatic piston
4	Four infrared heaters
5	Quartz pipe
6	Quartz pipe extension
7	Exhaust system
8	Stainless steel tubing 152 mm inner diameter, 1.57 mm thickness
9	Thermocouple port
10	Air velocity port, vertical across duct
11	Gas sample port, horizontal across duct
12	Laser smoke measuring system
13	Corrosion probe port
14	Blower
15	Steel cabinet (consist of power controls (of heater ,blower) ,gas analyzers ,mass flow controllers.)
16	Stainless steel connector

4 Main components

FPA			
4.1 Test section unit		4.2 Exhaust and analysis unit	
4.1.1	Heat flux gauge	4.2.1	Gas Analysis System
4.1.2	Load cell system	4.2.2	Thermo couple
4.1.3	IR heaters	4.2.3	Averaging pitot probe and pressure transducer
4.1.4	Ignition pilot flame	4.2.4	Exhaust blower
4.1.5	Water-cooled shield	4.2.5	Power controller
4.1.6	Air distribution chamber	4.2.6	Hood and duct
4.1.7	Air supply pipes	4.2.7	Digital data collection system
		4.2.8	Smoke measuring unit
		4.2.9	Mass flow controllers

4.1 Test section unit

4.1.1 Heat-Flux Gage:

- For calibration of the IR heating system, a Gardon type, or equivalent, total heat-flux gage having a nominal range of 0 to 100 kW/m² can be used.
- The sensing surface shall be 6 to 8 mm in diameter, flat and coated with a durable flatblack finish.
- The body of the gage shall be cooled by water above the dew point of the gage environment.
- The gage shall be rugged and maintain an accuracy of within 63 % and repeatability within 0.5 % between calibrations.

4.1.2 Load Cell System:

The load cell system shall consist of a load cell with a suitable load cell signal conditioning load cell controller. The load cell shall have,

- An accuracy of 0.1 g or better
- Measuring range from 0 g to 1000 g
- A 6.35-mm diameter stainless steel shaft, at least 330 mm long, resting on the load cell support point
- A 100-mm diameter, 1.5-mm thick aluminum load platform connected to the upper end of the stainless steel shaft by a collar
- Two low friction, ball-bushing bearings that guide the shaft as it passes through the top and bottom, respectively, of the air distribution chamber
- The stainless steel shaft shall incorporate, at the lower end, a threaded adjustment rod to compensate for horizontal test specimens of different thicknesses

4.1.3 IR heaters:

- The IR heating system shall consist of four 240 mm long, 81 mm high and 81 mm wide heaters
- Each of the four IR heaters shall contain six tungsten filament tubular quartz lamps (each 1000 watts) in a compact reflector body that produces up to 510 kW/m² of radiant flux in front of the quartz window that covers the lamps
- The reflector body is water cooled and the lamp chamber, between the quartz window and reflector, is air cooled for prolonged life.(compressed air cooling required)
- The emitter of each lamp is a 127 mm long tungsten filament in an argon atmosphere enclosed in a 9,5 mm outer diameter clear quartz tube.
- The emitter operates at approximately 2205°C (4000°F) at rated voltage, with a spectral energy peak at 1.15 μm
- The quartz bulb envelope and heater front window absorbs the wavelengths greater than about 4μm, which are air cooled.
- Note: All quartz used in the FPA (this includes the heaters as well as the quartz tubes in the test section) should be made from infrared grade quartz. This means that the silica used to manufacture the quartz needs to be electrically fused rather than flame fused. Doing this will avoid strong spectral radiation absorption at around 2.7 μm and finally, quartz becomes opaque beyond 4 μm

4.1.4 Ignition Pilot Flame:

- The ignition pilot shall consist of an ethylene/air (25/75 by volume) flame adjusted for a 10-mm length
- The pilot flame is anchored at the 50 mm long, horizontal end of a 6.35 mm O.D., 4.70 mm I.D. stainless steel tube
- In the horizontal tube section, use a four-hole ceramic insert to produce a stable flame and prevent flashback
- The pilot flame tube shall be able to be rotated and elevated to position the horizontal flame at specified locations near the specimen.

4.1.5 Water-Cooled Shield:

- To prevent the specimen from being exposed to the IR heaters during the one-minute heater stabilization period, there shall be a shield consisting of two aluminum cylinders welded together with an inlet and outlet for water circulation.
- An electrically actuated, pneumatic piston shall raise the shield to cover the specimen during test preparation and shall lower the shield within 1 s to expose the specimen at the start of a test.

4.1.6 Air Distribution Chamber:

- This aluminum chamber shall contain eight discharge tubes arranged in a circle of 165-mm inside diameter, with humidity control system.
- Each tube shall be aluminum and built to distribute inlet gases (air, O₂, N₂, etc.) to three sets of screens (stainless steel woven wire cloth of 10, 20, and 30 mesh from bottom to top, respectively), for producing a uniform air flow.
- Inlet air flows downward through the eight discharge tubes, disperses on the bottom plate, and then rises through the mesh screens toward the aluminum support cylinder.

4.1.7 Air Supply Pipes: (aluminium cylinder)

- These pipes shall consist of an aluminum cylinder extending from the air distribution chamber up to the load platform.
- This cylinder shall contain a step to support a quartz pipe.
- Above the load platform elevation, the quartz pipe shall supply oxidant to the specimen flame while allowing radiant energy from the IR heating system to reach the specimen surface.
- The aluminum support cylinder shall be rigidly attached to the distribution chamber, but the quartz pipe (electrically fused) shall be removable.
- Aluminium cylinder should be watercooled.

4.2 Exhaust and analysis unit

4.2.1 Gas Analysis System:

The gas analysis system shall consist of a gas sampling system and gas analysis instruments.

4.2.1.1 Gas Sampling system consists of,

- A sampling probe in the test section duct,
- A plastic filter (5-micron pore size) to prevent entry of soot,
- A condenser operating at temperatures in the range -5°C to 0°C to remove liquids,
- A tube containing an indicating desiccant (10–20 mesh) to remove most of the remaining moisture,
- A filter to prevent soot from entering the analyzers, if not already removed, a sampling pump that transports the flow through the sampling line,
- A system flow meter and manifolds to direct the flow to individual analyzers (CO, CO₂, O₂, and hydrocarbon gas).
- The sampling probe, made of 6.35-mm (0.25-in.) O.D. stainless steel tubing inserted through a test section port, shall be positioned such that the open end of the tube is at the center of the test section (Tube is perforated along its span and consist of 14 holes 1.6mm in diameter spaced every 10mm). The sampling probe is connected to a tee fitting that allows either sample or calibration gas to flow to the analyzer, and the excess to waste.
- Sampling unit should be capable of extracting gas samples from a height of 10m without condensation (i.e. conditioning unit must include electrically heated gas extraction tube to prevent condensation along the walls).
- Vendor should mention other details of conditioning unit going to adopt (like condenser operating temperature, sampling pump) in the quote.
- The gas sample lines should be constructed of stainless steel and plumbing should be using Swagelok fittings
- Proper valve arrangement must be provided to (as shown in Fig. 3) switch the extraction point(A and B).

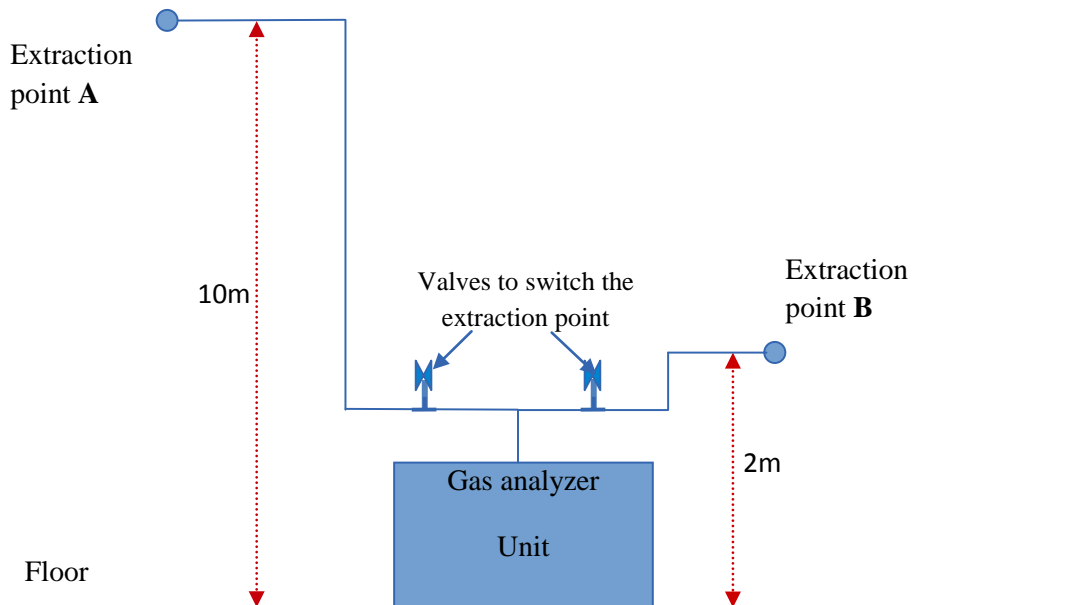


Fig. 3

4.2.1.2 Gas analysis instruments(GAS ANALYZERS)

(Gas analyzers 1 to 5 should be contained in single movable steel cabinet unit, refer fig-2,

page-8)

Sl no:	Gas analyzer	Specification
1.	Carbon dioxide	Method : NDIR Range resolution : 25% 0.01% Accuracy : ± 0.1% abs. or 5% rel. Response Time : 10 Sec(max), typically 5s (10%-90% full scale) Drift and noise : <±1% of full scale over 24 h period **Delay Time : 25 Sec(max)
2.	Carbon monoxide	Method : NDIR Range resolution : 25% 0.01% Accuracy : ± 0.1% abs. or 5% rel. Response Time : 10 Sec(max), typically 5s (10%-90% full scale) **Delay Time : 25 Sec(max)
3.	Oxygen	Method : Paramagnetic sensor Range resolution : 100% 0.1% Accuracy : ± 0.05% of full scale Response Time : 10 Sec(max) (10%-90% full scale) Drift and noise : <±0.005 vol% of full scale over 30min period **Delay Time : 25 Sec(max)
4.	Hydrocarbon (CH ₄)	Method : Flame ionization Range resolution : 5% 0.001% Accuracy : ± 0.1% abs. or 5% rel. Response Time : 1 Sec (max) (10%-90% full scale) **Delay Time : 25 Sec(max)
5.	Oxygen	Method : Paramagnetic sensor Range resolution : 100.00% 0.1% Accuracy : ± 0.05% of fullscale Response Time : 10 Sec (max) (10%-90% full scale) Drift and noise : <±0.005 vol% of full scale over 30min period **Delay Time : 25 Sec(max)

**Delay time = measured from sampling probe to analyser.

4.2.2 Test Section Thermocouple Probe:

Fire Propagation Apparatus

- A thermocouple probe, inserted through a test section port, shall be positioned such that the exposed, type K measurement bead is at the center of the test section, at the axial position of the gas sampling port.
- Fabricate the thermocouple probe of wire no larger than 0.254-mm diameter for measurement of gas temperature with a time response (in the specified exhaust flow) of no more than 1 s and an accuracy of 1.0°C.

4.2.3 Averaging Pitot Probe and Pressure Transducer:

- An averaging Pitot probe, inserted through a test section port 220 to 230 mm downstream of the thermocouple port, shall measure the mass flow rate of the gas stream using at least four sets of flow sensing openings, one set facing upstream and the second downstream and shall be designed for compatibility with the test section diameter.
- Measure the differential pressure generated by the probe with an electronic pressure transducer (electronic manometer). The measured differential pressure is proportional to the square of the flow rate.
- Experience has shown that the averaging Pitot probe in this application is reliable, while minimizing pressure losses in the exhaust system.

4.2.4 Exhaust blower

- Duct size=152mm
- High temperature blower to draw gases through the intake funnel, mixing duct and test section at flow rates from 0.1 to 0.3 m³/s.

4.2.5 Power Controller

- The controller shall maintain the output voltage required by the heater array despite variations in load impedance through the use of phase angle power control to match the hot/cold resistance characteristics of the tungsten/quartz lamps.
- The controller also shall incorporate average voltage feedback to linearize the relationship between the voltage set by the operator and the output voltage to the lamps.

4.2.6 Hood and duct

- Material: stainless steel
- Thickness=1.57mm (for other dimensions refer figure)

4.2.7 Digital data collection system

- Digitally record the output from the CO, CO₂, hydrocarbon gas, O₂ combustion and O₂ inlet-air analyzers, the load cell, the test section duct thermocouple, photodiode, and the electronic pressure transducer at 1 s intervals.
- Time shift the data for the gas concentrations to account for delays within the gas sampling lines and respective instrument response times.
- The data collection system shall be accurate to within 61°C for temperature measurement and 60.01 % of full-scale instrument output for all other channels.
- The system shall be capable of recording data for at least 1 h at 1-s intervals, although test duration typically is between 8 and 15 minutes.

Specification and position of sensors are as follows.

Fire Propagation Apparatus

Sensor	Specification	Position of sensor from ground	Number of sensors	Comment
Gas analyzers	Refer sec:4.2.1.2	10m or 2m (based on switching of extraction point)	5	Vendor must provide analyzers, DAQ and connection up to extraction point (for both 2m and 8m).
Thermocouple (T1)	Refer sec:4.2.2	2m	1	Vendor must provide DAQ, thermocouple and connection up to thermocouple.
Pressure transducer (P1)	Refer sec:4.2.3	2m	1	Vendor must provide DAQ, transducer and connection up to transducer.
Photodiodes (Pd1 and Pd2)	Refer sec:4.2.8	2m	2	Vendor must provide DAQ, photodiode and connection up to photodiode.
Load cell (L1)	Refer sec:4.1.2	1m	1	Vendor must provide DAQ, load cell and connection up to load cell.

- The manufacturer must provide following additional channel in DAQ
 - 2 additional channels for gas analyzers(Gas-X and Gas_Y)
 - 12 additional channels for thermocouple (T2 to T13)
 - 4 additional channels for pressure transducer (P2 to P5)
 - 4 additional channels for photodiode (Pd2 to Pd5)
 - 3 additional channels for load cell (L2 to L4)
- The data from all gas analyzers (CO, CO₂, CH₄ and two O₂ analyzers), thermocouples, pressure transducers and photodiodes must be digitally recorded at 1s intervals.
- Time shift the data for gas concentrations to account for delays within the gas sampling lines and respective instrument response times.
- Data collection system shall be accurate to within +/-1 degree Celsius for temperature measurement and +/- 0.01% of full-scale instrument output for all other channels.
- The system must be capable of recording data for at least 1 hour at 1s intervals.
- The DAQ must be configured in such a way that it should display and record the reading from 7 gas analyzers (5 + 2 additional channel), 13 thermocouples (1 + 12 additional channel), 5 pressure transducer (1 + 4 additional channel), 6 photodiode (2 + 4 additional channel) simultaneously (at 1s interval) in below mentioned format and unit. (as shown in Table 1, 2, 3, 4)

*vendor need not provide computer

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Gas analyzer data (ppm)							
Time (s)	CO	CO ₂	O ₂	CH ₄	O ₂	Gas-X	Gas-Y

Table 1 (output from gas analyzers)

Temperature (K)													
Time (s)	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13

Table 2 (output from thermocouple)

Pressure (N/m ²)					
Time (s)	P1	P2	P3	P4	P5

Table 5 (output from pressure transducer)

Intensity (W/m ²)	

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Time (s)	Pd1	Pd2	Pd3	Pd4	Pd5	Pd6

Table 4 (output from photodiode)

Mass (g)				
Time(s)	L1	L2	L3	L4

Table 5 (output from load cell)

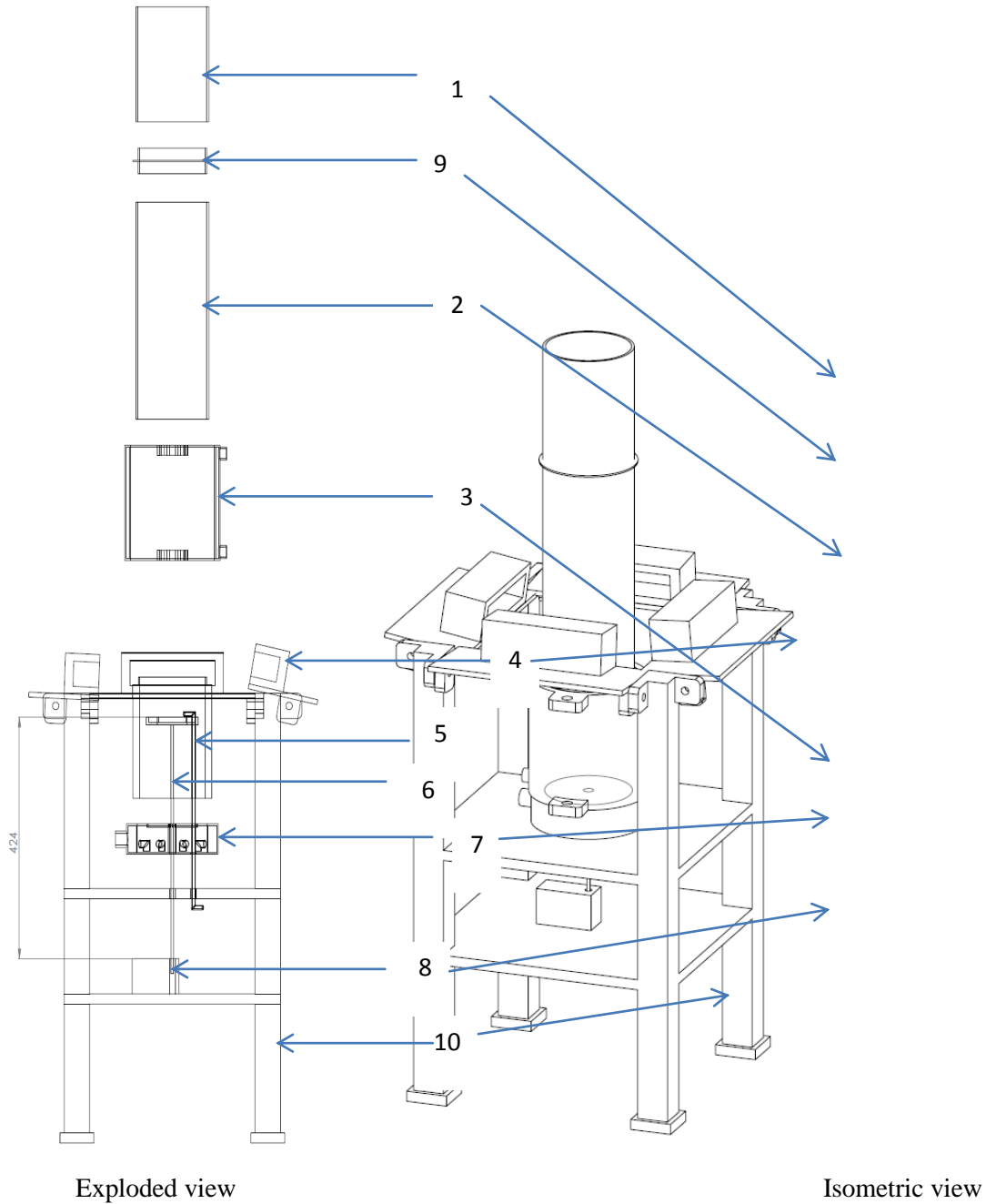
4.2.8 Smoke measuring unit

- The laser smoke measuring system is installed in the test section duct (230 mm downstream of the gas sampling port) of the apparatus and is designed to measure smoke extinction coefficient.
- It has an optical path length of 0.152 m. The smoke measuring system consists of a stabilized laser (0.5 mW nominal power helium-neon), which emits light energy at the red wavelength of 0.6328 μm , two photodiodes as main and compensating detectors, and associated electronics including amplifier and power supply.
- The laser smoke measuring system is fitted to a rigid cradle, which serves as an optical bench. The laser system is aligned so that light falls on the photo detector system, which has two signal outputs, typically in the range 0V to 2V.
- The vendor must provide at least 2 nos. of non-dispersive (ND) optical filters (of suitable wave length) for calibration of smoke measuring unit.

4.2.9 Mass flow controllers

- All metering and control of air should be done by MFC's instead of rotameters.
- MFC for Nitrogen----(0-250)SLPM
- MFC for Oxygen----- (0-100)SLPM

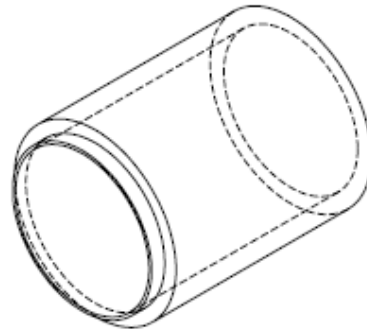
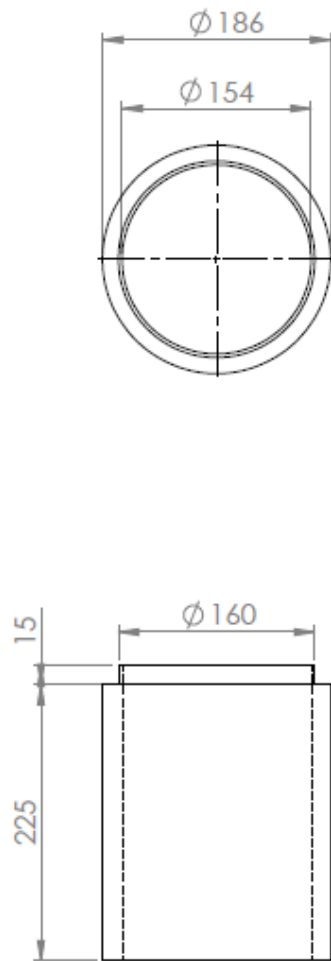
5 IR heating system and specimen area



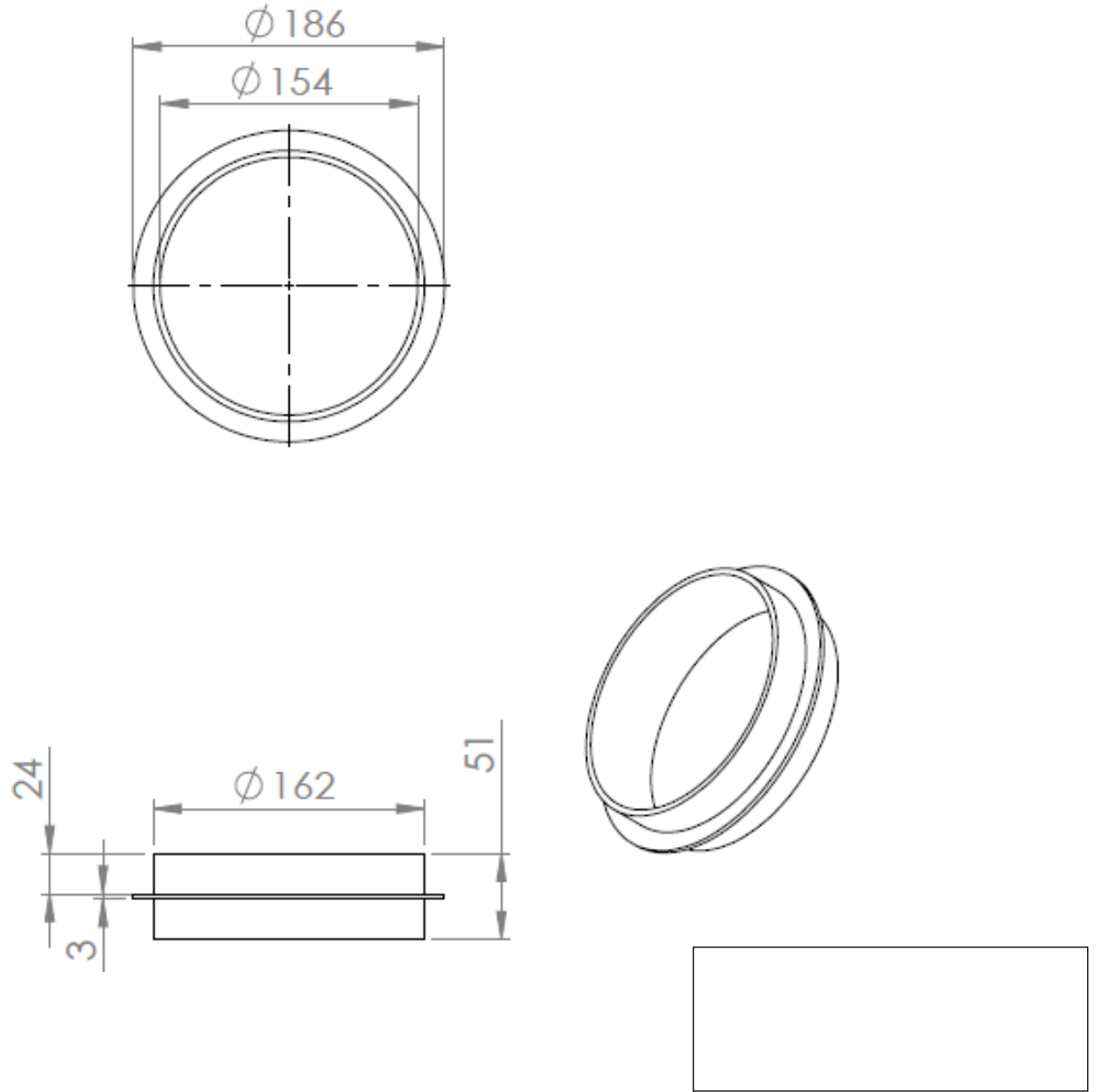
1	Quartz pipe extension	6	Stainless steel shaft, 6 mm diameter
2	Quartz pipe	7	Aluminium air distribution box
3	Water cooled shield	8	Load cell
4	IR heater	9	Stainless steel connector
5	Stainless steel pilot flame tube, 6 mm diameter	10	Steel frame members

6 Dimension details

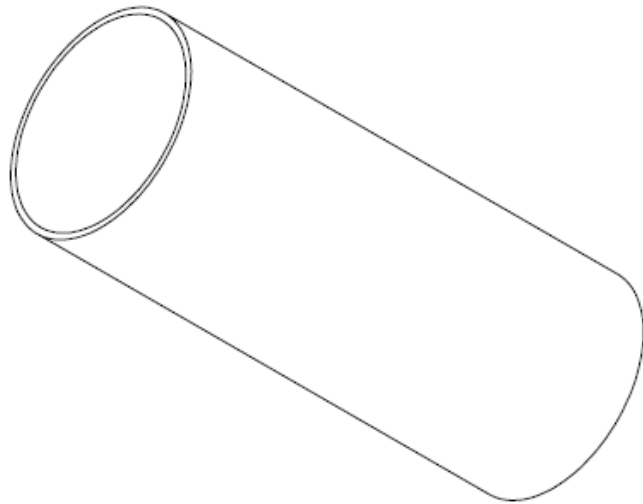
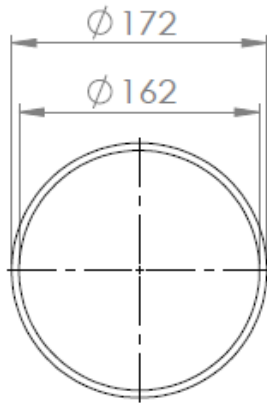
6.1 Aluminium cylinder



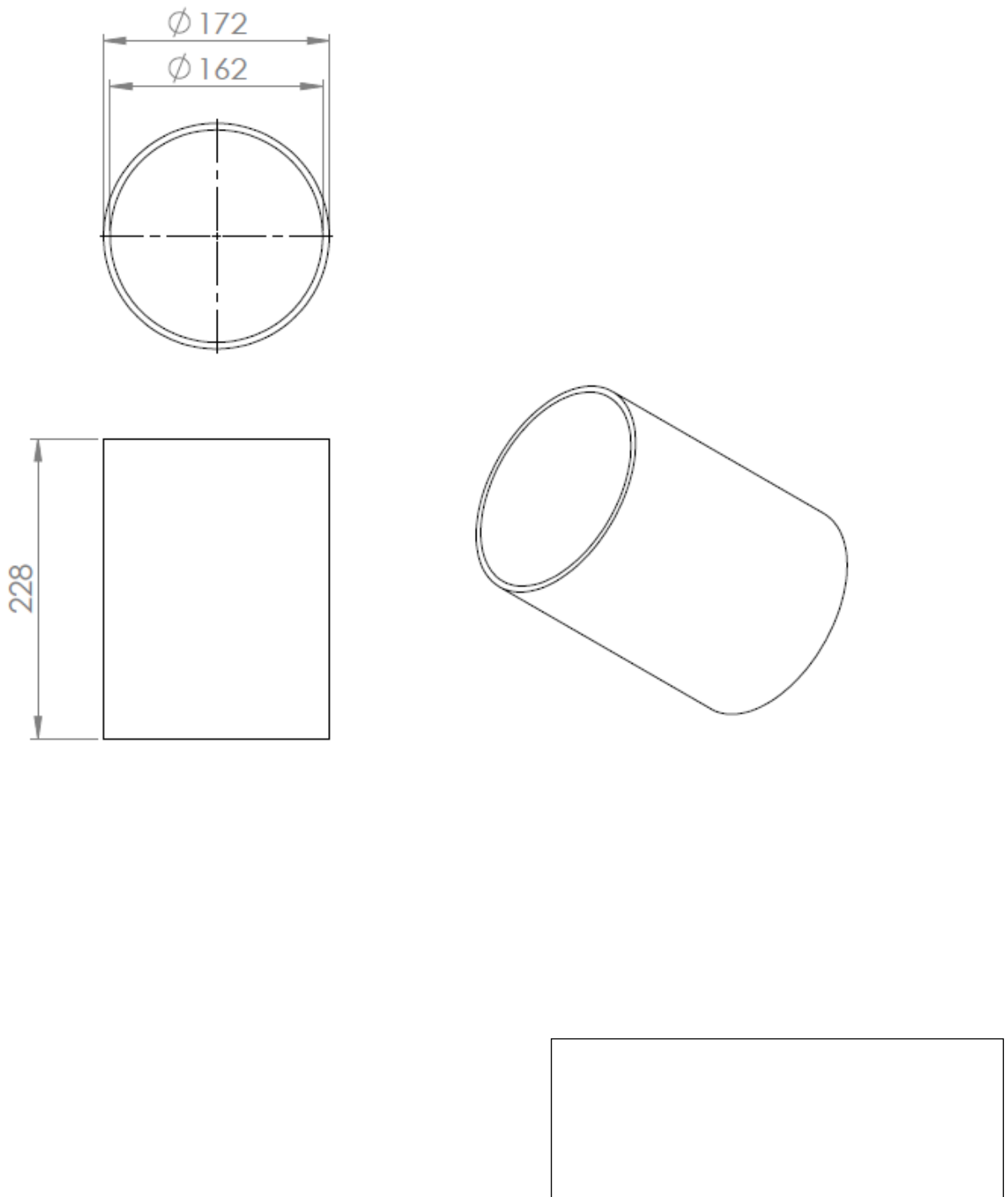
6.2 Stainless steel connector



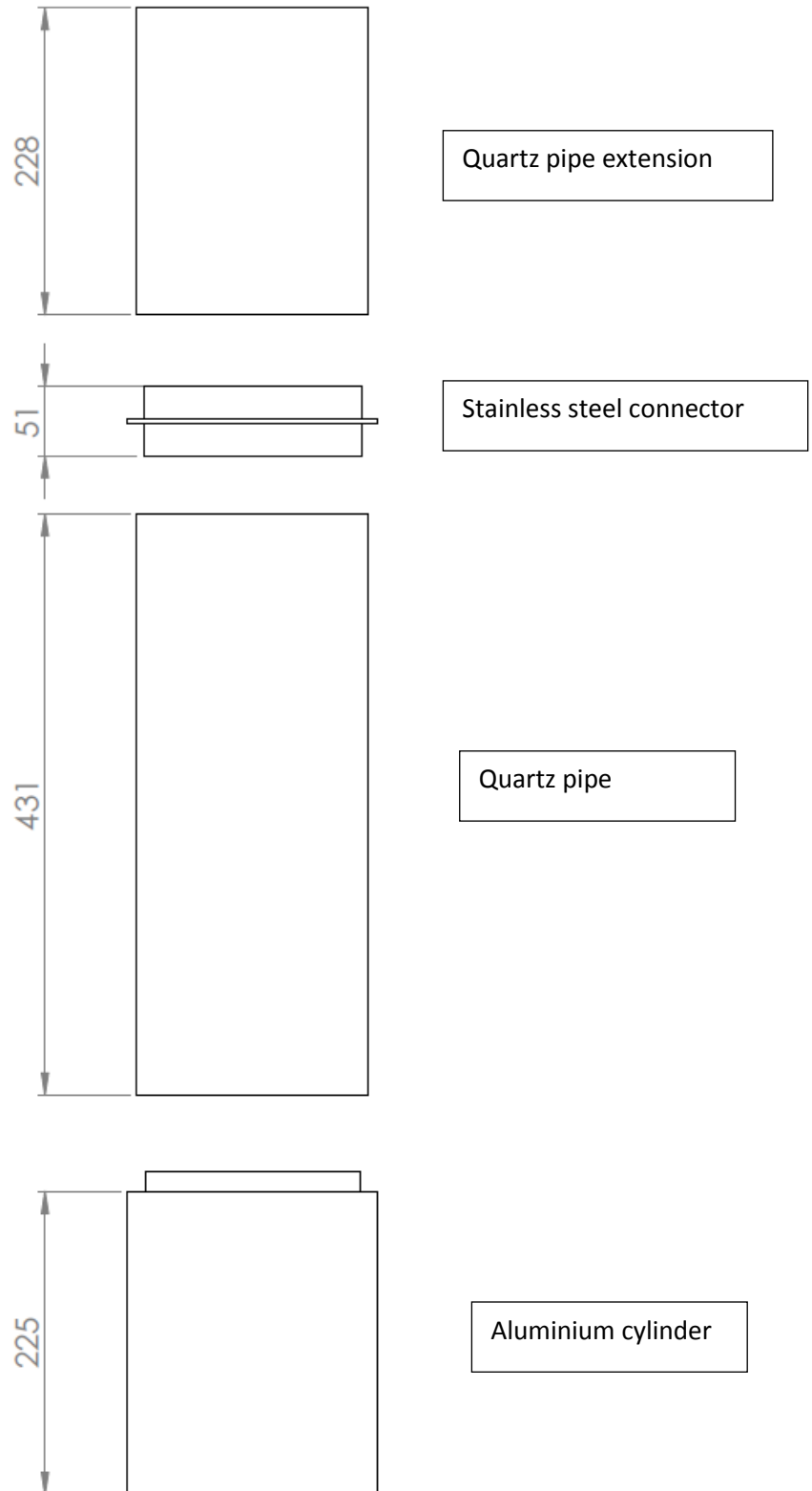
6.3 Quartz pipe



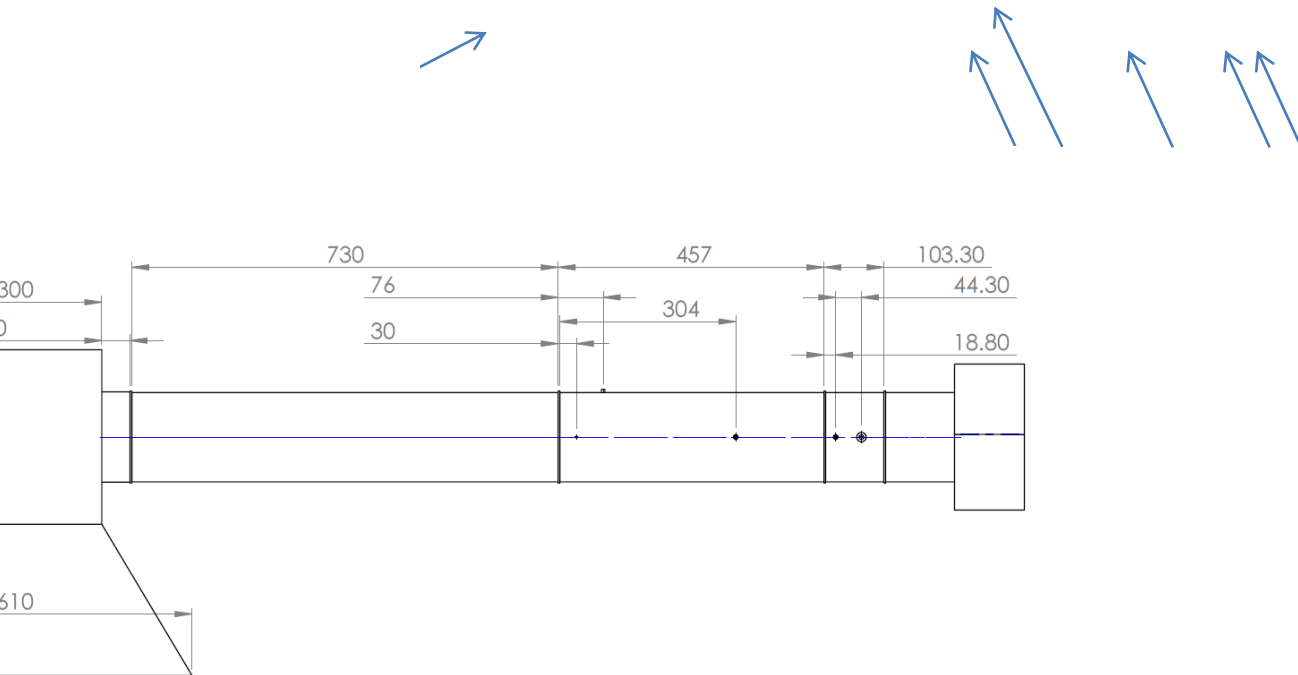
6.4 Quartz pipe extension



6.5 Relative position of combustion enclosure



6.6 Hood and Duct



- 1) Orifice plate welded into position, sharp edge away from plenum
- 2) Thermocouple port
- 3) Air velocity port, vertical across duct

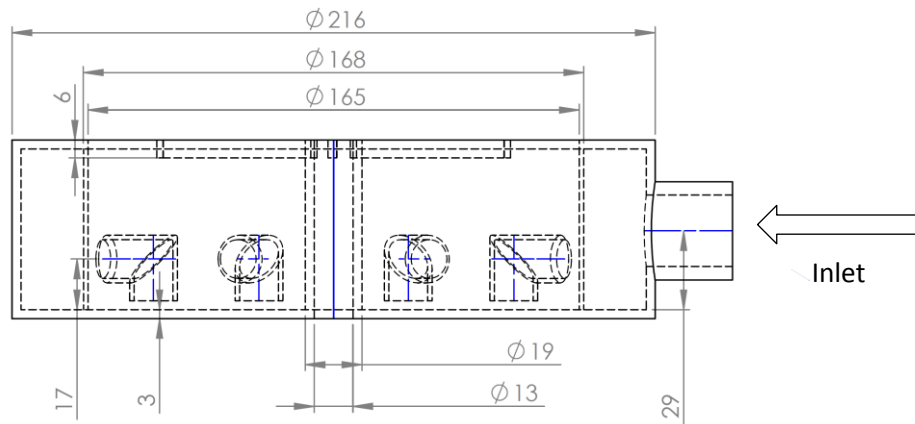
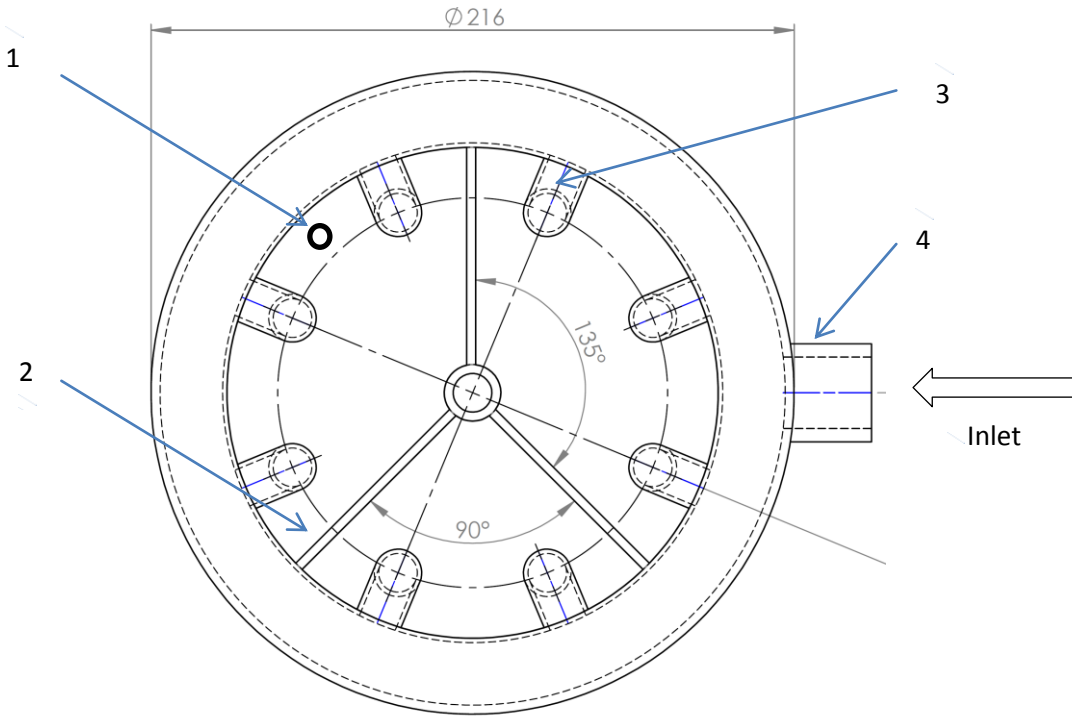
Fire Propagation Apparatus

- 4) Gas sample port, horizontal across duct
- 5) Laser port, horizontal across duct
- 6) Corrosion probe port



6.7 Air distribution chamber

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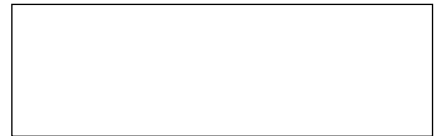
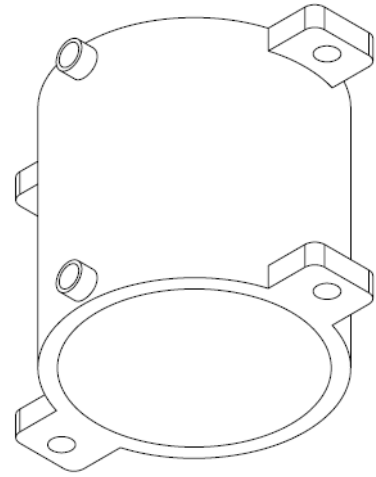
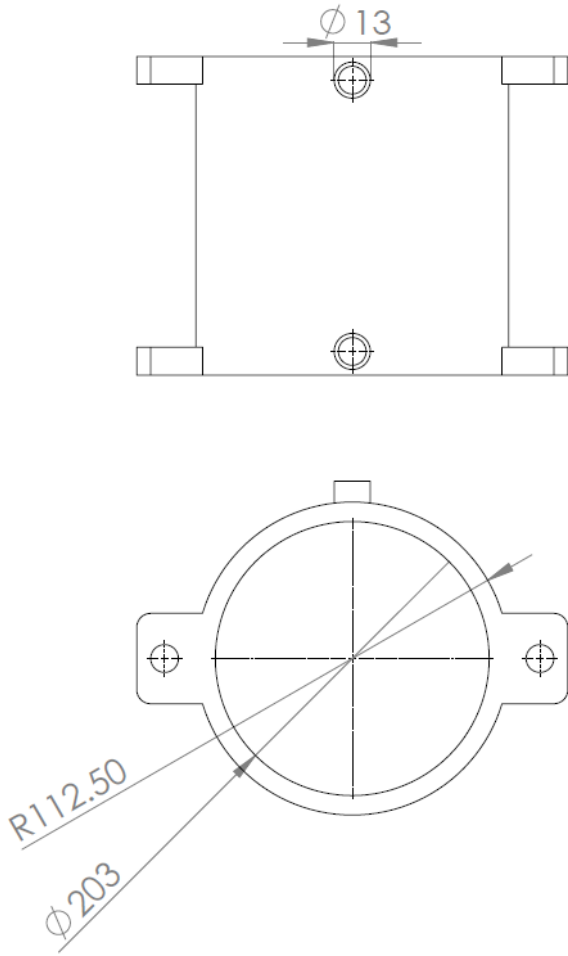


1. Stainless steel tube, 6mm
2. Flat bar, 19mm length x3mm width
3. Discharge tube
4. Threaded socket aluminium, 33mm



6.8 Water cooled shield

Fire Propagation Apparatus



6.9 Steel frame members

Fire Propagation Apparatus

