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ISO 9705 Fire Test on XFlam Polystyrene Insulated Panel

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ISO 9705 Fire Test on XFlam Polystyrene Insulated Panel

1. CLIENT

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2. TEST METHOD

The test was carried out in accordance with ISO 9705 – 1993 (the standard) except as follows:

- Smoke measurement was carried out using a helium-neon laser instead of a white light system. This was not expected to adversely affect the results.
- Heat flux at the floor was not measured.
- The heat output of the burner fell outside the ± 5% level (as required by Clause 6.1.3 of the standard) in the 300 kW step after 1056 seconds and remained below till the end of the test. The maximum deviation did not exceed 7% (279 kW).

3. DESCRIPTION OF TEST SPECIMEN

3.1 General

This test comprised three walls and the ceiling lined with XFlam polystyrene insulated panel (PIP).

3.2 Description of Specimen and Mounting Technique

The lining material was nominally 100 mm thick comprising white fire retardant treated expanded polystyrene beads bound with an orange coloured phenolic resin binder and sandwiched between steel skins of 0.6 mm thickness. The density of the core was approximately 57 kg/m^3. Panels were secured at 250 mm centres with 4.8 mm by 13.5 mm stainless steel blind rivets on the bottom edges between 50 x 50 x 0.6 mm colorsteel angles screwed to the floor. The mitred corners were joined with 50 x 50 x 0.6 mm colorsteel angle on the internal corners and external corners and in each case the angles were attached to the steel skins with 4.8 mm diameter by 13.5 mm long stainless steel blind rivets at 250 mm centres for the internal and external corner angles respectively.

The layout of the panels in the assembly provided three 1200 mm wide panels on each 3600 mm long side wall with two slip (interlocking) joints. The 2400 mm long end wall comprised a 1200 mm wide panel in the centre interlocked with two 600 mm wide half-panels to the mitred corners. The ceiling comprised two panels of nominal dimensions 3600 x 1200 mm with the interlocking joint running along the centre of the 3600 mm dimension of the ISO room.
The slip joints on the walls were riveted at 250 mm centres. The slip joint on the ceiling was riveted at approximately 500 mm centres, and at each end. The rivets in the slip joints secured at least three layers of skin. The ceiling was secured to the walls with 50 x 50 x 0.6 mm colorsteel angles riveted at 250 mm centres. All rivets were stainless steel, size as above. All slip joints were sealed with a nominal 5 mm bead of Fosroc Flamex PU. The same fire rated sealant was

applied to all joints and junctions, and a nominal 5 mm bead of sealant was applied along each flange of the colorsteel angle flashings.

The ceiling of the XFlam PIP lining was secured to the underside of the lightweight concrete room using four 10 mm diameter bolts finished internally with mushroom caps. Two bolts were located approximately 500 mm off the back wall and 760 mm off each side wall, with the remaining two located approximately 700 mm off the front wall (that containing the door) and the same 760 mm off each side wall. The same fire rated sealant was applied to seal around the bolt thread where it passed through the inner room lining.

The material was provided and installed by Bondor New Zealand.

3.3 Specimen Conditioning

The specimen was not subjected to any special conditioning as the product is considered to be non-hygroscopic.

4. EXPERIMENTAL PROCEDURE

4.1 Test Standard

The test was carried out according to the test specifications and procedure described in ISO 9705:1993 'Fire tests – Full-scale room test for surface products' (the test standard), with variations as noted in Section 2 above.

4.2 Test Date and Initial Conditions

The test was conducted on the 13 June 2005, supervised by Mr P Whiting.

The initial conditions in the laboratory were 11°C, 80% relative humidity and 102.3 kPa atmospheric pressure.

The horizontal wind speed at a horizontal distance of 1 m from the centre of the doorway did not exceed 0.5 m/s.

4.3 Fire Test Room

The fire test room consisted of four walls at right angles, a floor and ceiling with the following nominal dimensions – 3.6 m long x 2.4 m wide x 2.4 m high. A doorway was located in the centre of one of the 2.4 m x 2.4 m walls and this had nominal dimensions 2.0 m high x 0.8 m wide. The opening discharged into a steel hood for the collection of all combustion products connected to an exhaust system that allowed gas sampling and light obscuration measurements to be done.

The test room was constructed of nominally 150 mm thick, lightweight concrete panels with a density of 560 kg/m³.

4.4 Ignition Source

The ignition source was a propane gas sand diffusion burner with a square (0.17 x 0.17 m) top surface at a height of 0.35 m above floor level. The burner was placed on the floor in a corner

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opposite to the doorway opening, and positioned as close as possible to the specimen in the corner wall. The gas flow to the burner was controlled to generate a heat output of 100 kW for 10 minutes followed by 300 kW for a further 10 minutes after which the test was stopped.

4.5 Gas Analysis

The products of combustion from the test room were collected in the hood and exhausted through a duct 0.4 m in diameter. Instrumentation in the duct included a sampling probe to take off gas samples for analysis.

Gas samples taken from the duct were analysed and the oxygen consumption was measured using an enhanced SERVOMEX 4100 paramagnetic oxygen analyser. The oxygen mole fraction was corrected for any changes in barometric pressure during the period of the test using output from an absolute pressure transducer. Carbon monoxide and carbon dioxide concentrations were also measured with an infrared CO/CO_2 sensor fitted within the same chassis as the oxygen analyser.

4.6 Flow Volume Monitoring

The duct instrumentation section contained a bi-directional probe connected to a differential pressure transducer. A 1.5 mm type K thermocouple was located with its tip close to the open end of the bi-directional probe. This was used for volume flow monitoring.

4.7 Optical Density

Smoke obscuration measurements of exhaust gases in the duct were taken using a 0.5 mW Helium-neon laser system with photometric detector fitted to a rigid cradle. The laser was aligned to fall on a photodetector system, on the opposite side of the duct. A compensating detector was situated on the laser side of the duct to act as a reference. A 1.5 mm type K thermocouple was located with its tip close to the laser beam. These were used for smoke obscuration and production measurements.

4.8 Heat Flux Instrumentation

Heat flux measurements were not recorded.

4.9 Gas Temperatures

Gas temperatures were measured within the compartment using thermocouples.

4.10 Data Recording

Data recording logging at 3-second intervals was commenced at least 2 minutes before ignition of the burner and continued (till after extinguishment).

5. SYSTEM PERFORMANCE

5.1 Calibration

Prior to the product test, a calibration was performed with the burner positioned directly beneath the hood and output adjusted to 0 kW for 2 minutes, then 100 kW for 5 minutes, then 300 kW for 5 minutes, then 100 kW for 5 minutes and then 0 kW for 2 minutes. Data was collected at 3 second intervals. The ratio of the average mass flow per unit area to mass flow per unit area in the centre of the exhaust duct that resulted in the least difference in the heat release rate calculated from the measured oxygen consumption, and that calculated from the metered gas input was determined. This value (k_t=0.81) was then used in subsequent calculations of heat release rate for the actual product test.

At steady state conditions, the difference between the mean rate of heat release over 1 minute calculated from the measured oxygen consumption and that calculated from the metered gas input did not exceed 5% for the first 100 kW and the 300 kW level of heat output. On returning to 100 kW the difference recorded a maximum of 7.2 %. As described in section 4.4, the actual test is limited to 10 minutes at 100 kW followed by 10 minutes at 300 kW. On this basis the calibration was not considered to adversely affect the test results. The calibration results are shown in Figure 1.

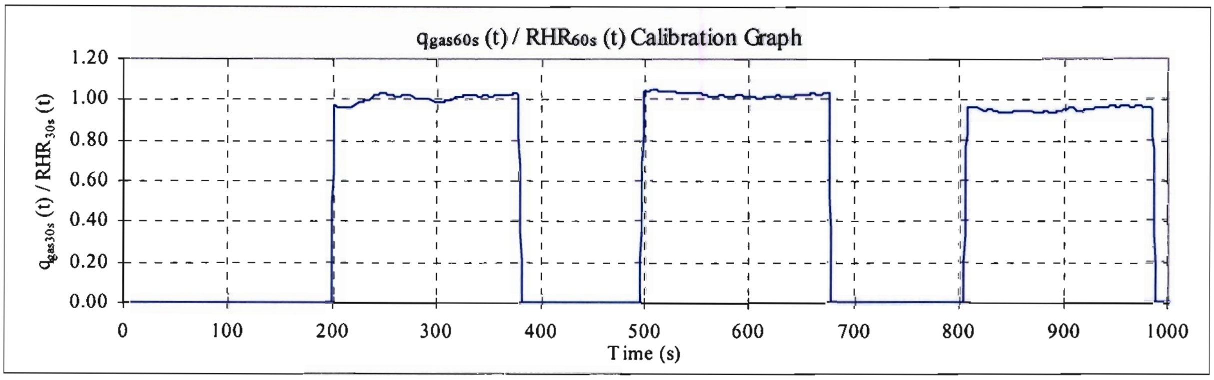

Figure 1: Calibration results for 100/300/100 kW burner output

5.2 System Response

The time delay of the oxygen analyser, as determined by the time difference between a 2.5 K change in the duct temperature and a 0.05% change in the oxygen concentration, determined during the calibration procedure, was 15.8 seconds. The oxygen mole fractions were corrected on the basis of this delay time before calculating the heat release rate.

The response time of the oxygen analyser, found as the time between a 10% and 90% change in the measured oxygen concentration, determined during the calibration procedure, was 9.8 seconds.

The time delay of the CO/CO_2 analyser, as determined by the time difference between a 2.5 K change in the duct temperature and a 0.02% change in the carbon dioxide concentration, determined during the calibration procedure, was 12 seconds. The carbon dioxide and carbon monoxide mole fractions were corrected on the basis of this delay time before calculating the heat release rate.

The response time of the CO/CO$_2$ analyser, found as the time between a 10% and 90% change in the measured carbon dioxide concentration, determined during the calibration procedure, was 9.8 seconds.

6. RESULTS

6.1 Observations

Observations from video and dictaphone confirmed by photos.

Minutes: Seconds	Observation
0:00	Test started
1:20	Flames were licking up the wall to the ceiling joint and small amounts of sealant were burning. A slight buckle in the ceiling above the burner had established diagonally out from the corner. A small amount of smoke was exiting from one of the rivets on a vertical joint 1200 mm from the burner.
2:00	Some flaming sealant was dripping from the ceiling above the burner and reaching floor level.
2:45	Flaming on the wall to ceiling joint had established.
3:20	The ceiling in the burner corner had sagged a little further.
3:30	A small amount of smoke was escaping from the doorway but there was no evidence of the formation of smoke layer in the room and visibility remained clear.
6:45	Smoke was flowing from the back of the panels across the doorway and back into the room.
7:00	Panels remained intact
9:00	No change
13:00	Smoke was increasing inside room and flames were reaching the entire length of the wall to ceiling joint on the 3.6 m wall on the burner side.
14:20	The plastic mushroom bolt heads near the doorway were melting and dripping to the floor.
14:40	The deflection of the ceiling in the burner corner had increased
15:45	Visibility in room remained clear and the plastic mushroom bolt heads continued to melt and drip to the floor
20:00	Test stopped. All joints remained intact as did the attachment of the ceiling through the mushroom bolts, a red glow continued in the burner corner. A small region behind the wall to ceiling joint was glowing brighter indicating the presence of flame although this diminished over a period of about 30 seconds.

6.2 Test Results and Reduced Data

6.2.1 Duct flow

Time-volume flow in the exhaust duct is shown in Figure 2.

6.2.2 Total heat release

The total rate of heat release measured during the test and the contribution from the burner is shown in Figure 3. A peak rate of heat release (including the burner) was 401 kW recorded at 957 seconds.

6.2.3 CO concentration

The concentration of carbon monoxide measured during the test is shown in Figure 4. The highest CO concentration was recorded at 918 seconds at 221 ppm.

6.2.4 CO_2 concentration

The concentration of carbon dioxide measured during the test is shown in Figure 5. the highest CO_2 concentration was recorded at 681 seconds at 0.475 %.

6.2.5 Optical density

The rate of production of light-obscuring smoke measured during the test is shown in Figure 6. The smoke production peaked at rate of 2.0 m^2/s and was measured at 795 seconds. The maximum value of the 60 second running average smoke production rate was determined to be 1.7 m^2/s at 780 seconds.

6.2.6 Heat flux

The heat flux was not measured.

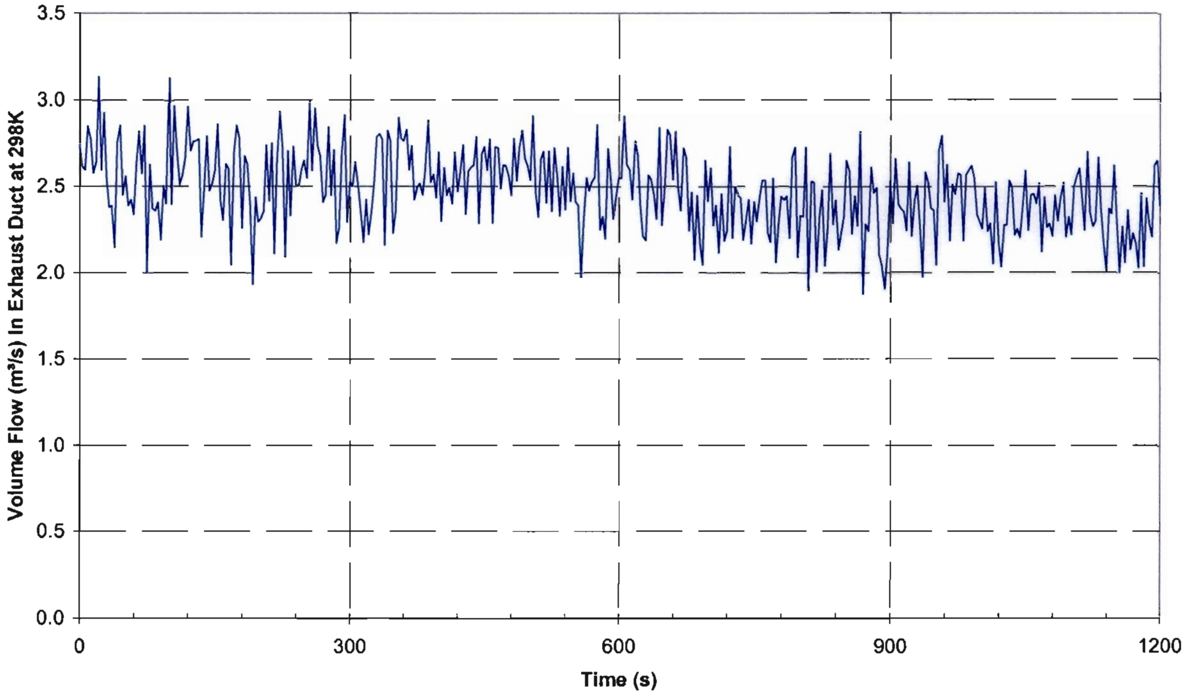

Figure 2: Volume flow at 298 K in exhaust duct

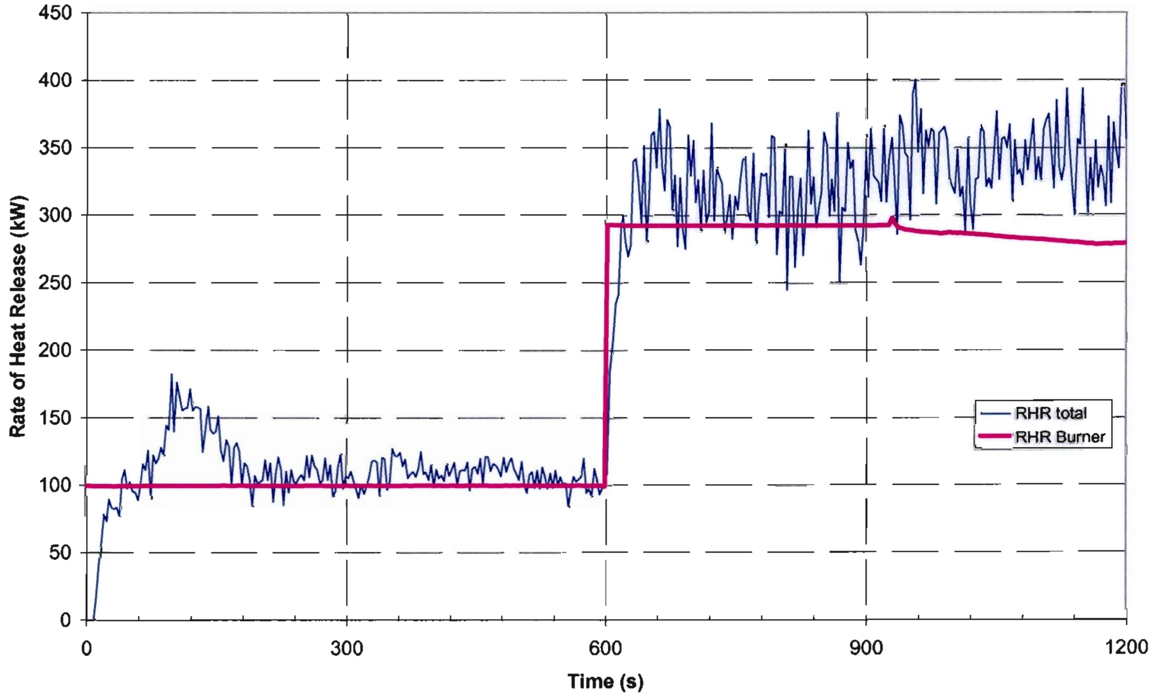

Figure 3: Rate of heat release

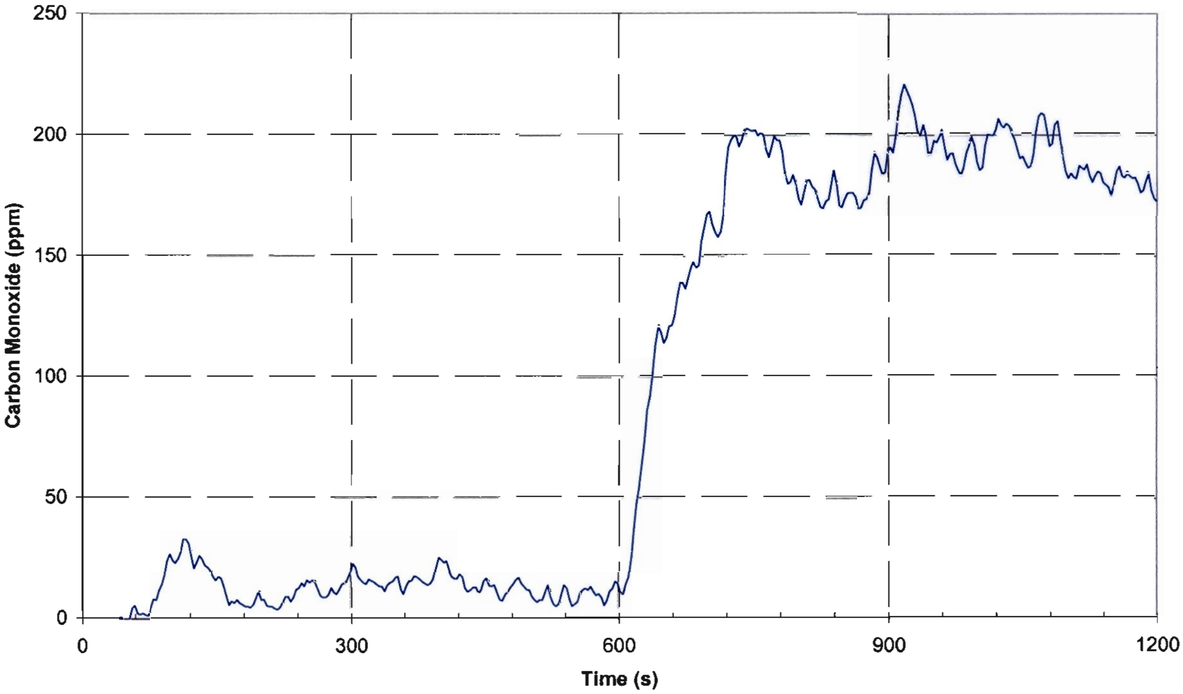

Figure 4: Carbon monoxide concentration

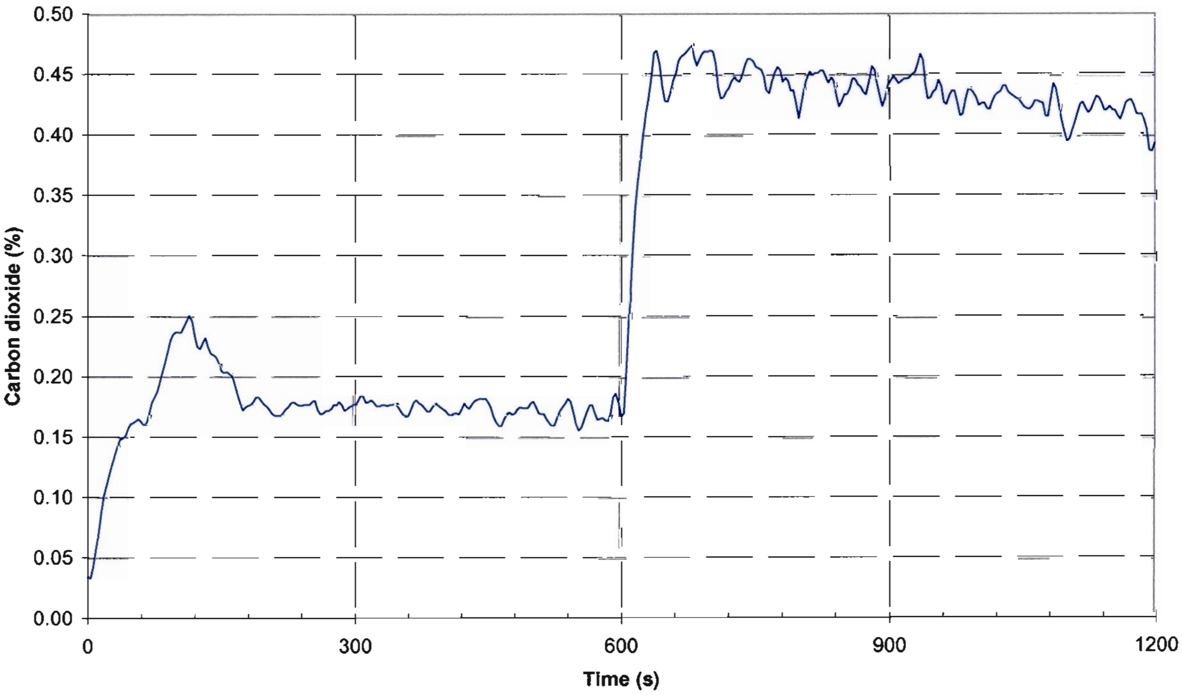

Figure 5: Carbon dioxide concentration

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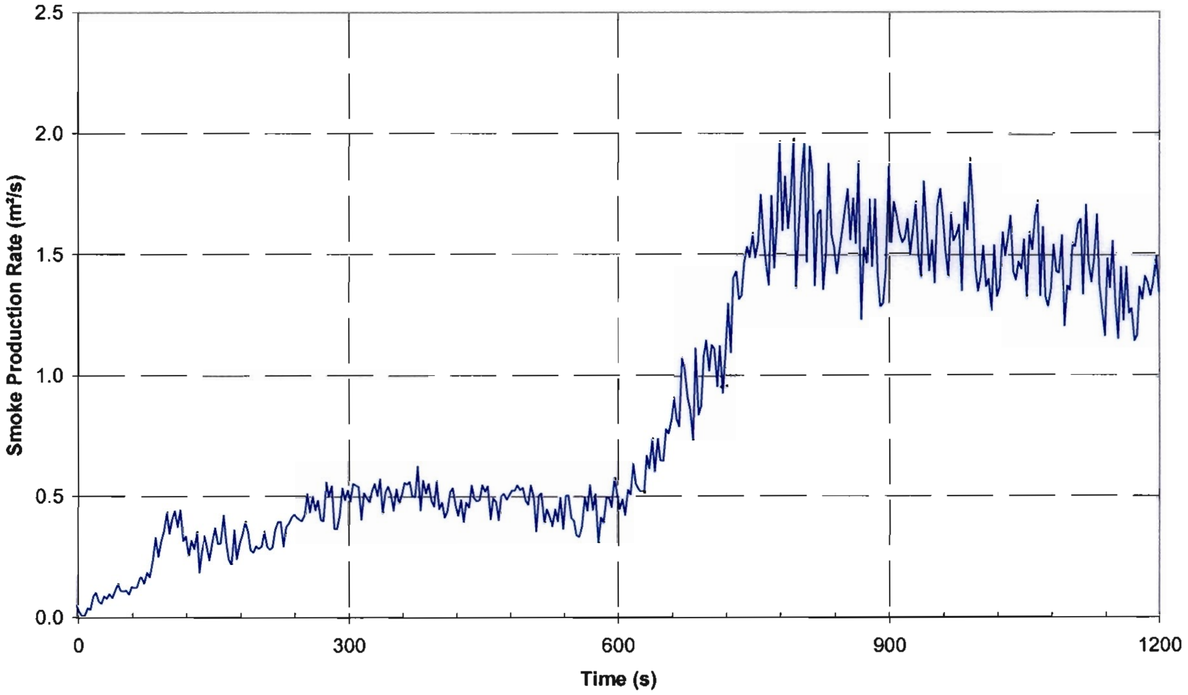

Figure 6: Smoke production rate

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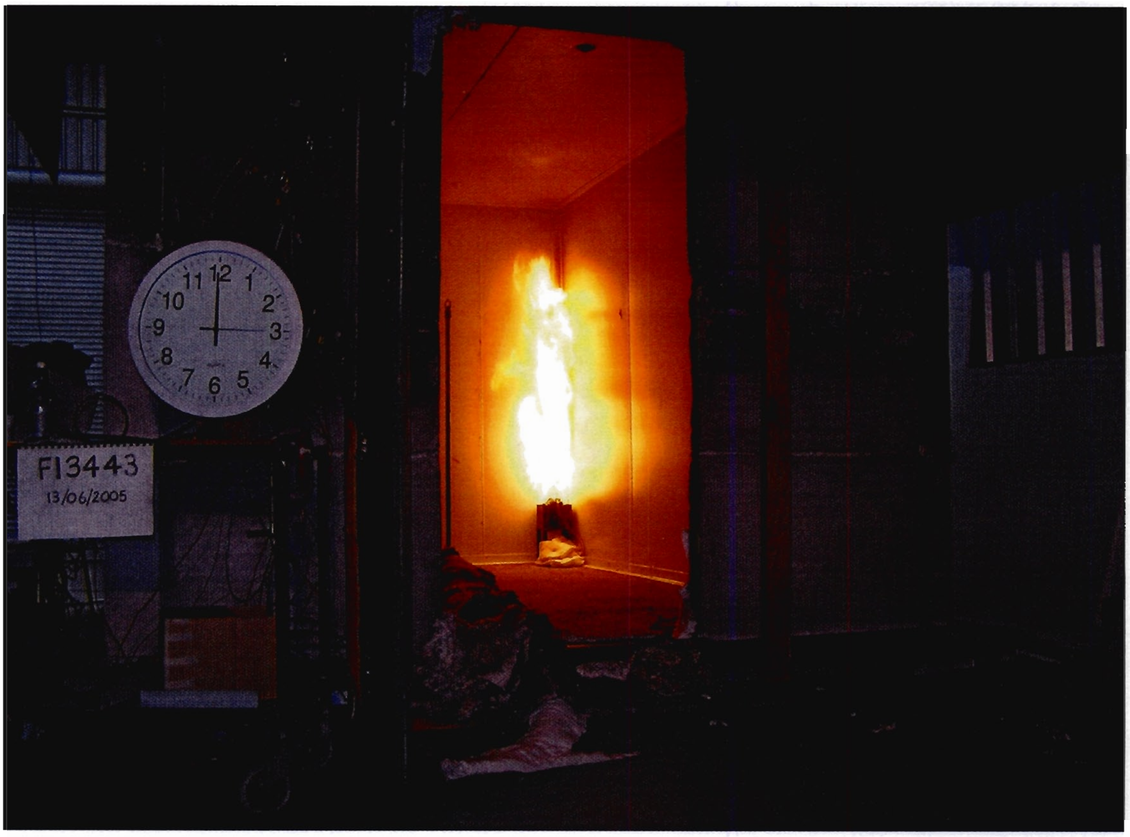

Figure 7: Specimen at 15 seconds after start of test

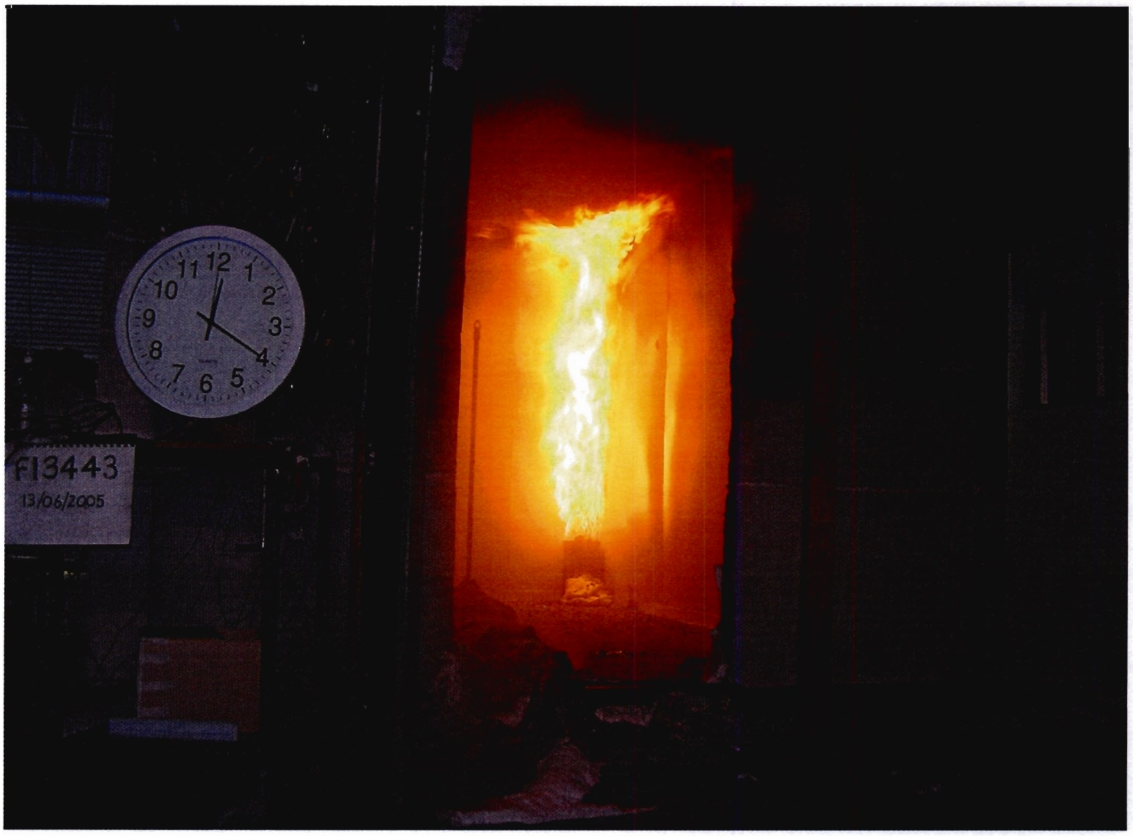

Figure 8: Specimen at 1200 seconds

Figure 9: Specimen after fire exposure