The fire performance of timber facades

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The fire performance of timber facades

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## Contents

1. Introduction 4

2. Details of tests carried out 4
   2.1 Fire design 7
   2.1.1 Parametric fire exposure 9
   2.1.2 Equivalent time of fire exposure 10
   2.2 Instrumentation 12

3. Test results 14
   3.1 Fire development and atmosphere temperatures 14
   3.2 Separation between dwellings 18
   3.3 Cavities 23
   3.4 Spread to neighbouring buildings 24

4. Discussion 27
   4.1 Regulatory Issues 27
   4.1.1 Standard 2.2 Separation 28
   4.1.2 Standard 2.4 Cavities 28

5. Concluding Remarks 28

6. Acknowledgements 29

7. References 30
1 Introduction

This document describes the test parameters, results and observations from a large-scale research project to investigate the performance in fire of timber frame dwellings having a timber façade. The work has been undertaken following discussions between BRE, The Scottish Building Standards, the Forestry Commission Scotland with input from the Centre for Timber Engineering (CTE) at Napier University.

The objective of the large scale fire test was to evaluate the performance of the separation between dwellings (Scottish Technical Standard 2.2), and the performance of the window detail and horizontal cavity barriers (Scottish Technical Standard 2.4), subject to a natural fire representative of a fully developed fire within the living area of a domestic dwelling. The fire was designed to be equivalent to a medium duration fire resistance (60 minutes). The test scenario is effectively a combination of a standard furnace test and a large-scale cladding test. The fire scenario is chosen to be representative of a fully-developed post-flashover fire in a dwelling with flames emerging from the room involved and impinging directly on the façade.

As part of the project BRE were also commissioned to investigate Scottish Technical Standard 2.6 dealing with fire spread to neighbouring buildings. This is the subject of a separate report.

This report and the test on which it is based are concerned with the impact of the use of home-grown timber as cladding material for the domestic market and its application for two storey houses in single occupancy. Fire spread to the roof through the eaves is specifically excluded from the study.

2 Details of tests carried out

The test consisted of a front elevation representing the external façade of a timber framed dwelling. The main section consisted of two panels approximately 3.7m wide by 2.3m high. The lower panel represents the ground to first floor elevation and included a central (unglazed) window opening 1m wide by 0.9m high with the bottom of the window located 0.9m from ground floor level. The main test panels were connected to adjacent panels through a party wall detail consistent with the requirements for Napier University’s Standard Robust Details for sound insulation at separating walls and floors, providing a medium fire duration (60 minutes fire resistance). On one side the panels were in line with the main test panel. On the other side an additional panel was located at 90° to the main test panel representing an occupancy offset from the front elevation.

The situation is illustrated schematically in Figure 1 while Figures 2 and 3 show the façade and fire compartment prior to the test.
Figure 1 Plan of test rig showing fire compartment and test frames
Figure 2 Façade prior to testing
2.1 Fire design

The fire load, ventilation conditions and thermal properties of the compartment linings were chosen to provide the conditions for a fully developed fire equivalent to at least a 60 minute duration within a standard fire test. Two calculation methods were used to estimate the severity of the fire and to provide a prediction of the anticipated time-temperature response; the parametric approach and the time equivalent method as set out in the fire part of the Eurocode for Actions\(^1\).

The key parameters for the fire design calculations are as follows:

- Fire load density: 450MJ/m\(^2\)
- Thermal properties of compartment linings: 520 J/m\(^2\)s\(^{1/2}\)K
- Opening factor: 0.02556 m\(^{1/2}\)

The compartment design is based on previous experience of undertaking large scale testing. In particular, the parameters of the Timber Frame 2000 (TF2000) compartment fire test have been used to define the geometry and ventilation conditions. This approach has the advantage of providing realistic boundary conditions and allowing for a comparison between the two cases.
The plan dimensions of the fire compartment are 3.6m x 4m with a floor to ceiling height of 2.4m. The compartment was open on one face to allow the external wall of the main façade to be connected to it. All internal linings (including the floor) were covered with fire resistant plasterboard to provide at least 60 minutes fire resistance to the frame.

The ventilation opening in the front of the compartment was 0.9m high by 1m wide. An additional opening was provided in the rear wall of the fire compartment with dimensions of 0.9m by 0.9m.

The fire load was provided by 360kg of softwood formed from seven hundred and twenty 50mm x 50mm x 500mm rough sawn crib sticks with a moisture content less than 13%. The fire load was uniformly distributed within the fire compartment in 12 individual cribs consisting of 60 sticks per crib (Figure 4). Each crib was connected to the next via fibre strips soaked in paraffin prior to ignition, to accelerate flashover and ensure uniform thermal conditions within the compartment. The fire load represents 25kg of wood per square metre of floor area or 450MJ/m² in terms of energy.

Figure 4 Plan view of the fire compartment showing the location of the fire load

COMPARTMENT PLAN
2.1.1 Parametric fire exposure

The parametric approach from BS EN1991-1-2: 2003 is a simplified fire model based on the physical characteristics of the specific fire compartment. The input parameters are the fire load density, ventilation conditions and the thermal properties of the compartment linings. The basic formulation is given by:

\[ \Theta_g = 1325(1-0.324e^{-0.2t^*} - 0.204e^{-1.7t^*} - 0.472e^{-19t^*}) \]

where:

- \( \Theta_g \) = temperature in the fire compartment (°C)
- \( t^* \) = \( t \Gamma \) (h)
- \( t \) = time (h)
- \( \Gamma = \frac{[O/b]^2}{(0.04/1160)^2} \)
- \( b = \sqrt{(\rho c \lambda)} \) and should lie between 100 and 2200 (J/m²s²/°K)
- \( O \) = opening factor \( (A_v/\sqrt{h/At}) \) (m⁻¹)
- \( A_v \) = area of vertical openings (m²)
- \( h \) = height of vertical openings (m)
- \( A_t \) = total area of enclosure (m²)
- \( \rho \) = density of boundary enclosure (kg/m³)
- \( c \) = specific heat of boundary of enclosure (J/kgK)
- \( \lambda \) = thermal conductivity of boundary (W/mK)

The relevant parameters for calculation in this case are:

- Fire load \( q_{f,d} \) = 450 MJ/m²
- Thermal properties of compartment lining \( b \) = 520 J/m²s²/°K
- Compartment length = 4m
- Compartment width = 3.6m
- Compartment height = 2.4m
- Window 1 = 0.9 x 1.0m
- Window 2 = 0.9 x 0.9m
- Opening factor = 0.02556m⁻¹
- Ventilation area \( A_v \) = 1.71m²
- Floor area \( A_t \) = 14.4m²

The anticipated time-temperature response is illustrated below and compared with the standard fire curve.
2.1.2 Equivalent time of fire exposure

The concept of time equivalence relates the thermal exposure in a real fire to an equivalent period in a standard furnace subject to the standard time-temperature response. The concept is illustrated in Figure 6 with reference to data from a protected steel element in a real fire which has been subject to a standard fire test.
The formula for equivalent time of fire exposure from BS EN 1991-1-2 is:

\[ t_{ed} = (q_{f,d} \times k_b \times w_f) \]

with \( q_{f,d} \) defined as above = 450 MJ/m²

\( k_b \) is dependent on the thermal properties of the compartment linings and for \( b < 720 = 0.09 \) (UK National Annex to BS EN 1991-1-2)

\[ w_f = (6.0 / H)^{0.3} [0.62 + 90 (0.4 - \alpha_v)^4] \]

(in the absence of horizontal openings in the roof)

with \( \alpha_v = A_v / A_t \) giving \( w_f = 1.5385 \)

So for the test compartment the value of time equivalence is given by:

450 MJ/m² \times 0.09 \times 1.5385 = 62.3 minutes

During the test the time equivalent value was confirmed from direct measurement of an indicative test sample with a known performance in a standard fire resistance test.
2.2 Instrumentation

For the duration of the tests and for some time afterwards measurements were made of the temperature within the fire compartment, the temperature at key locations within the structural frame, the temperature of the unexposed faces and the heat flux at key points on the facade.

The location of the atmosphere thermocouples is shown in Figure 7, the location of the thermocouples on the frames is shown in Figure 8.

![Diagram of location of atmosphere thermocouples](image)

*Figure 7 Location of atmosphere thermocouples (300mm from underside of ceiling)*
At each measurement location on gridline A, a single atmosphere thermocouple is used to measure the temperature of the façade (100mm from surface). On gridline B two thermocouples are used at each location measuring the surface temperature and the temperature below the cavity barrier. At gridline B’ three thermocouples are used at each location to measure the surface temperature, the temperature above the cavity barrier and the temperature of the unexposed (inner) surface of the plasterboard. Similarly at level C three thermocouples are used at each measurement location. In addition heat flux measurements were made at locations A2, C2, C6 and C10. Additional heat flux measurements were made directly opposite the window opening at a distance of 2m from the front elevation and opposite the ventilation opening in the rear of the fire compartment at 1m from the opening. Two thermocouples were used to measure the temperature of the cavity and the unexposed face at the party wall junction at locations X and Y.
3 Test results

3.1 Fire development and atmosphere temperatures

The test lasted approximately 53 minutes from ignition of the fire load to termination by the Fire and Rescue Service. The decision to abort the test was taken once some of the boards on the ceiling within the fire compartment had collapsed leading to flames emerging from the roof of the fire compartment. This constituted a danger to test personnel, to the structure of the building and to the functionality of the test instrumentation. The atmosphere temperature measured within the compartment is shown in Figure 9 and compared to the standard fire curve and the predicted parametric response. Due to an electrical fault during the test no measurements were recorded for a 10 minute interval between 23 and 33 minutes from ignition. This has had no impact on the analysis or interpretation of the results. From the start of the test flaming was initially concentrated to the rear of the compartment. This meant that the façade was not subject to external flaming from the window opening. For this reason the rear ventilation was shut off some 20 minutes from ignition by placing a sheet of fire resistant plasterboard over the emerging flames. Whilst this led to some external flaming it was clear that the available oxygen was insufficient to enable the required fire severity to be achieved. The plasterboard sheet was therefore slid away from the rear opening so that approximately 50% of the rear open area was available for ventilation. This took place approximately 23 minutes from ignition and led to a sharp increase in measured temperature and flame impingement on the façade (Figure 10). This continued for the duration of the test.

Figure 9 Measured atmosphere temperatures inside the compartment
The main observations from the test indicating the time of significant events are given in Appendix A. The time-temperature response is in reasonably close correlation to both a standard 60 minute fire exposure and to the predicted value using the Eurocode parametric approach (with input values modified to take into account changes in the ventilation condition). The results from an indicative steel test specimen protected with a 90 minute intumescent coating provide further evidence of the equivalent fire severity inside the compartment. Figure 11 shows a comparison between the measured values from the test and the results from a similar section subject to a standard fire test for a period in excess of 90 minutes. The results indicate an equivalent severity of 65.5 minutes which corresponds to the time taken for the average measured value in the standard test to attain the same value as the peak measured average temperature (412°C) during the natural fire test. This correlates very well with the calculated value of 62.3 minutes using the time equivalent approach from the Eurocode.

Figure 10 Flame impingement on façade (photo courtesy of CTE)
External flaming was initially concentrated at the rear of the compartment. However, in a real situation it is unlikely that a fire compartment would contain only a single ventilation opening. External flaming would be a function of the relative location and geometry of the external openings. The exposure of the external façade to direct flame impingement during the test is considered to be representative of a fire in the compartment equivalent to a medium duration fire resistance. A medium duration fire resistance as defined in the Technical Handbooks published by Scottish Building Standards equates to a 60 minute fire resistance period. Despite the direct flame impingement from the flames emerging from the front opening there was no significant lateral flame spread during the test. External flaming and combustion of the paint and cladding system was concentrated above the window opening.

Towards the end of the test the timber frame could be seen burning behind the façade (Figure 12). The extent of the damage to the frame is illustrated in Figure 13. Based on observations during the test and analysis of the data the mechanism for fire spread is a combination of a breakdown in the fire protection to the (short duration) external wall and the impact of the flames emerging from the front opening and through the (short duration) window detail.
Figure 12 Latter stages of test – Note: extent of burning behind façade (photo courtesy of CTE)
3.2 Separation between dwellings

Although fire spread over the external façade was extensive with flaming extending the full height of the test structure there was no ignition of either the panel adjacent to the main test frame nor the return wall offset at 90 degrees from the main façade. This is in large part attributable to the performance of the vertical cavity barriers between the frames. There was no evidence of the fire breaking back through the frame at a level above the horizontal cavity barrier separating ground and first floor.

Figure 14 is a comparison between the measured temperatures above and below the cavity barrier in the area most directly exposed to external flaming i.e. above the window opening.
Comparison of temperatures above and below cavity barrier immediately above window

![Comparison of temperatures above and below cavity barrier immediately above window](image)

**Figure 14 Comparison of temperature above and below the cavity barrier at first floor level above the window opening**

The intumescent horizontal cavity barrier separating ground and first floor clearly provided a significant level of protection to the upper floor when subject to a fully developed fire internally and combustion of the cladding externally. The relative damage below and above the cavity barrier can clearly be seen in Figure 15. Above the cavity barrier the breather membrane and OSB sheathing can clearly be seen. The figure also shows the effect of the vertical fire barrier between the adjacent panels.
At the corner junction the vertical separation was achieved through two 47x50 decay resistant softwood battens. The batten on the main test frame had started to char at approximately floor to floor level (Figure 16). However, there was no sign of any fire spread on the return panel and the timber batten remained intact. It is unclear how much longer this detail would have prevented the spread of fire had the fire not been extinguished.
The vertical separation between the test panel and the adjacent panel was also achieved using softwood timber. Again this prevented any flame spread from the main test panel to the adjacent panel for the duration of the test as illustrated in Figure 17. It is therefore concluded that the vertical cavity barrier achieved a short duration fire resistance under the particular circumstances of the test. The test has demonstrated the capability of the junction detail as supplied by Centre for Timber Engineering between dwellings to achieve a medium duration fire resistance under the particular circumstances of the test.
Figure 18 shows the temperature of the structural frame either side of the vertical fire separation at location B. The figure indicates that the fire has entered into the structural frame at location B8 at approximately 43 minutes from ignition. The temperature rise at location B9 indicates a possible breach in the vertical fire separation at a local level. However, this is not supported by visual observations (see Figure 17). The spike may have been due to fire fighting operations or problems with the cables arising from the fire emerging.
from the compartment through the ceiling. The full plot is included here to show that both B3 and B9 have returned almost to their ambient temperature values.

Figure 18 Effect of vertical separation at location B on frame temperatures

3.3 Cavities

As mentioned above the cavity barrier at first floor level provided a barrier to the spread of flame between ground and first floor level and the vertical fire barriers. The effect of the cavity barrier around the window opening is not quite so simple to evaluate as the frame itself may be exposed to either break down of the plasterboard from inside the compartment, flames emerging out of the compartment and bypassing the cavity barrier around the window frame and attacking the structural frame through the façade or fire breaking out directly from ignition of the window frame and entering the structural frame directly. The cavity barrier around the window should prevent the last of these events occurring for a period corresponding to a short duration fire resistance. Figure 18 shows the measured temperatures in the structural frame at the level between the window and first floor level (level B on Figure 8). There is no significant temperature rise for at least the first 30 minutes of the fire exposure. According to observations the window frame ignited some 17 minutes from ignition. The temperature rise after the first 30 minutes is most likely due to the involvement of the façade above the window opening and direct flame impingement on the OSB. It is therefore concluded that the cavity barrier around the window opening is capable of providing short duration fire resistance when exposed to a post-flashover fire breaking out of a window on a domestic dwelling. A short duration fire resistance as defined in the Technical Handbooks published by Scottish Building Standards equates to a 30 minute fire resistance period.
3.4 Spread to neighbouring buildings

Although this issue has been addressed in a complementary report for the SBSA/Forestry Commission the test provided an opportunity to quantify the heat release rate generated from a post-flashover fire in a residential dwelling and assess the effect of external flaming on adjacent structures. To this end heat flux devices were placed in the positions shown in figure 20. In all cases the instruments were mounted flush to the surface of the timber. The heat flux readings are shown in Figure 21.
Figure 20 Location of heat flux measurement (based on drawing by James Jones and Son)
Figure 21 Heat flux measurements at various locations

The peak values are summarised in Table 1 below.

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
<th>Peak Heat Flux (kW/m²)</th>
<th>Time to peak (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF1</td>
<td>Return wall position A2</td>
<td>5.57</td>
<td>50</td>
</tr>
<tr>
<td>HF2</td>
<td>Above front window position C6</td>
<td>43.46</td>
<td>29.5</td>
</tr>
<tr>
<td>HF3</td>
<td>Opposite rear ventilation opening 1m from centre of opening</td>
<td>27.46</td>
<td>49</td>
</tr>
<tr>
<td>HF4</td>
<td>Adjacent wall position A10</td>
<td>0.39</td>
<td>50</td>
</tr>
<tr>
<td>HF5</td>
<td>Opposite front ventilation opening 2m from centre of opening</td>
<td>12.46</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 1 Peak values of heat release

According to the BRE report\(^2\) the methods for calculating the distance between a building and the boundary are based on a number of assumptions among which is a condition that assumes an exposed surface on an adjacent building should not receive an incident heat flux above 12.6 kW/m². On the basis of the tests this does not constitute a problem for the return wall or the adjacent panel. The readings at 2m from the window are just on the limit of what would be deemed to be acceptable in terms of heat flux. The value of
12.6 kW/m² is valid for pilot ignition of dry timber assuming a 10 minute exposure. What is clear is that the heat flux at the position where one would normally expect a first floor window would be sufficient to ignite a wooden frame, break the glazing and provide a possible route for fire spread from floor to floor that would bypass any fire separation at floor level. This is supported by the thermocouple readings at this location which show air temperatures of 800ºC towards the end of the test at a location 100mm from the surface of the cladding.

The peak heat flux above the window opening of 43.46 kW/m² with corresponding plume temperatures of approximately 800ºC compares with the peak measured values of 30 kW/m² and 500ºC measured in the TF2000 test. Given that the fire load density, compartment linings and ventilation condition were very similar this provides some indication of the additional heat flux provided by localised burning of the timber cladding.

4 Discussion

4.1 Regulatory Issues

This report and the test on which it is based were concerned with 2 storey domestic dwellings. The objectives were to consider the effectiveness of the standard details in meeting the functional requirements in respect of separation and cavities. The guidance in the domestic technical handbook for performance in fire of separating elements (including cavity barriers) is related to performance in a standard fire test. Fire resistance is predicated on fire from one side at a time with the fire restricted to the inside of the compartment.

Regulatory controls on external flame spread are assessed in relation to reaction to fire issues and evaluated using small-scale standard tests. A new British Standard has been developed for non-loadbearing external cladding systems. However, this is only appropriate for dwellings if the height of the building above ground level is greater than 18m. Standard 2.7 dealing with fire spread on external walls requires buildings to be designed and constructed in such a way that, in the event of an outbreak of fire within the building, or from an external source, the spread of fire on the external walls of the building is inhibited. The results from the test show that the spread of fire on the external façade was inhibited as external flaming was restricted to the area immediately above the window opening and there was no appreciable lateral flame spread and no ignition of the adjacent or perpendicular panels.

An external fire exposure curve is included in the European fire resistance classification standard BS EN 13501-2 with more information on the practical application of the curve given in BSEN1363-2. At first glance this would appear to be one route for demonstrating the suitability of the fire performance of the external façade. The example given in the standard relates to an external wall at the perimeter of a building which may be exposed to an external fire or flames coming out of the window. However, there is no performance criteria set out in the Building Regulations and associated guidance so it would be very difficult to know what constitutes a pass or fail under such conditions. While the standard test would provide some information on the likelihood of re-entry into the building through a loss of integrity of the wall construction it would not provide any information on lateral flame spread.
4.1.1 Standard 2.2 Separation
The standard requires every building to be separated in such a manner that fire and smoke are inhibited from spreading beyond the area of occupation where the fire originated in the event of a fire within the building. With respect to the party wall junction between the adjacent frame and the frame adjacent to the test frame the test has demonstrated that the detail is capable of achieving a medium duration fire resistance when subjected to a realistic fire scenario under the particular conditions of the test.

4.1.2 Standard 2.4 Cavities
The standard requires that every building must be designed and constructed such that in the event of a fire within the building, the unseen spread of fire and smoke is inhibited. With respect to the cavity barrier around the head, jambs and sill of the window opening the test has demonstrated that the standard detail is capable of achieving a short duration fire resistance when subjected to a realistic fire scenario. With respect to the cavity barrier between ground and first floor level the test has demonstrated that the intumescent barrier used is capable of achieving a short duration fire resistance when subjected to a realistic fire scenario. With respect to the vertical cavity barrier between the test frame and the adjacent frame and between the test frame and the frame perpendicular to the test frame the test has demonstrated that the standard detail provided is capable of achieving a short duration fire resistance when subjected to a realistic fire scenario.

Each of the details assessed has achieved the requirements of the regulations for low rise domestic dwellings. The requirements relate to a fire from within the building and do not make specific allowance for external flaming. The test has shown that the regulatory requirements can be achieved subject to a combination of a medium duration fire within the building in combination with external flaming and the use of a combustible cladding system.

There is currently no suitable means of test and assessment for low rise dwellings where the fire is either initiated outside the building or the integrity of the construction is threatened through a combination of external flaming through a window opening igniting the material of the external façade. Such a scenario is more appropriate to assess the performance of cavity barriers and fire stopping than a standard fire resistance test. The test described in this report provides a draft methodology for such a test and assessment method.

5 Concluding Remarks

BRE, on behalf of the Forestry Commission Scotland have carried out a large-scale simulation of a fully developed post-flashover fire scenario within a timber frame building with timber cladding. The purpose of the test has been to investigate the performance of the structure when subject to a medium duration fire resistance and to quantify the effects of the timber cladding on subsequent fire development and fire propagation. From the test results and observations during and following the test the following conclusions can be made:

- The test results have confirmed that the structure was subjected to a natural fire scenario equivalent to a medium duration fire resistance period. In addition to the compartment fire the test
The fire performance of timber facades

structure was subject to external flaming leading to ignition of the combustible cladding above the window opening.

- The timber frame as supplied by CTE is capable of meeting the requirements (REI60) for a medium duration fire resistance. Although the test had to be terminated before all the available fire load was consumed there was no evidence of any potential failure of the system from inside the compartment to outside. Although the test was terminated because of a breach of compartmentation, this involved only the ceiling of the fire compartment and was not a failure of the frame members. However, at this stage the fire had involved the OSB and the timber frame through a combination of external flaming and fire spread into the cavity from the window opening.

- The horizontal intumescent cavity barrier at first floor level prevented extensive fire spread within the structural frame. The barrier met the requirements in relation to a short duration fire resistance period.

- The vertical cavity barriers between the test frame and the return wall and the test frame and the adjacent panel prevented lateral fire spread for the duration of the test and achieved a short duration fire resistance.

- The cavity barriers around the window opening delayed the onset of burning within the structural frame for a period corresponding to a short duration fire resistance. It is unclear whether flame initiation at this point was a result of a break down in the cavity barrier or due to fire spread through the façade.

- The measured value of incident heat flux on the return wall and the adjacent panel in the vicinity of the window opening was insufficient to cause ignition of the cladding. The measured value directly above the window opening would have caused the ignition of a timber window frame above approximately 29 minutes from ignition leading to a potential for fire spread from floor to floor. The measured value of heat flux 1m away from the rear ventilation opening would have caused pilot ignition of dry timber 35 minutes from ignition.

6 Acknowledgements

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Larbert, Stirlingshire, FK5 4NQ  
Supply of timber frames and cladding

Chris Thompson  
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Trafford Park, Manchester, M17 1RU  
Supply of intumescent cavity barriers

Noel Cornforth  
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Hartlepool, TS25 5TB  
Fire fighting

Hugh Dale  
Lafarge Plasterboard Ltd., Marsh Lane  
Easton-in-Gordano, Bristol, BS20 0NF  
Provision of GTecFireboard

Simon Jones  
Nullifire Limited, Torrington Avenue  
Coventry, West Midlands, CV4 9TJ  
Provision of indicative test specimen and accompanying test results

7 References


### Appendix A Test Observations

<table>
<thead>
<tr>
<th>Time</th>
<th>Observation</th>
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<tbody>
<tr>
<td>0.00</td>
<td>Ignition</td>
</tr>
<tr>
<td>4.38</td>
<td>Flames at ceiling height</td>
</tr>
<tr>
<td>7.00</td>
<td>Light smoke emanating from front and rear openings</td>
</tr>
<tr>
<td>12:02</td>
<td>Smoke emanating from top of adjacent panel</td>
</tr>
<tr>
<td>13.00</td>
<td>Intermittent flame from rear opening</td>
</tr>
<tr>
<td>13.54</td>
<td>Flame from rear opening</td>
</tr>
<tr>
<td>15.40</td>
<td>Flashover in compartment</td>
</tr>
<tr>
<td>15.40</td>
<td>Dark smoke from front opening</td>
</tr>
<tr>
<td>17.16</td>
<td>Window frame ignition</td>
</tr>
<tr>
<td>19.50</td>
<td>Rear vent covered</td>
</tr>
<tr>
<td>23.20</td>
<td>Rear vent partially opened</td>
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<tr>
<td>23.45</td>
<td>Window frame alight</td>
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<tr>
<td>24.32</td>
<td>Flaming above front opening</td>
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<tr>
<td>25.18</td>
<td>Significant flaming above front opening</td>
</tr>
<tr>
<td>25.48</td>
<td>Flame from front opening 0.5m high</td>
</tr>
<tr>
<td>29.09</td>
<td>Flame on face of heat flux meter above window opening</td>
</tr>
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<td>32.36</td>
<td>Extensive flaming from front and rear opening</td>
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<td>35.10</td>
<td>Flaming half the height of panel</td>
</tr>
<tr>
<td>42.00</td>
<td>Flame extending full height of cladding</td>
</tr>
<tr>
<td>45.55</td>
<td>Smoke coming from adjacent panel</td>
</tr>
<tr>
<td>52.00</td>
<td>Heat Flux 3 falls over</td>
</tr>
<tr>
<td>53.00</td>
<td>Flame through roof of fire compartment – test terminated</td>
</tr>
</tbody>
</table>