1. Introduction
PVC exhibits excellent fire behaviour and it does not burn once the source of heat or flame has been removed from it. This limited response to fire, coupled with a range of other attractive benefits (e.g. durability, toughness, rot-proof, dimensional stability, minimum maintenance) makes PVC-U an attractive material for window-frames.

The fire properties of PVC have been described fully in the BPF publication "PVC in Fires", ref.1. This document considers the fire performance of PVC-U window-frames in relation to the fire hazards which may occur in this application.

2. Reaction-To-Fire-Hazards
PVC-U is very difficult to ignite using commonly available ignition sources (e.g. match, blow-lamp, chip-pan). Tests with a wide range of sources varying in heat intensity and impingement area on PVC-U window-frames show that the product only burns whilst the source is applied. When the source is removed, there is no residual flame on the product.

Figure 1 shows that for a range of sources the PVC-U window-frame only burnt within the impingement zone of the flame source.

The limited burning of PVC-U is confirmed in a variety of other standard fire tests, which measure specific parameters such as rate of heat release and flame spread under different conditions.

The conclusions are clear:
1. The rate of heat release and the total heat released by PVC-U are significantly lower than most organic building materials.
2. When flames impinge on PVC-U, it forms a protective char which restricts the burning zone.

3. Smoke and Fumes
The rate of generation and quantity of smoke and fumes produced by a PVC-U window-frame will depend on the severity of the external source of heat applied. The smoke and fumes emitted will be confined to the area of the product affected by this source and their transport away from the impingement zone will depend upon local factors such as ventilation and survival of the glazing.

4. Fire Resistance
The fire resistance of a glazed window is mainly influenced of the fracture behaviour of the glazing at high temperature. The fire resistance of glazed PVC-U window-frames is generally found to be similar to that of glazed wood window-frames.

5. Large-Scale Fire Tests
In a programme carried out at the Cardington Laboratory of the Fire Research Station (ref.2), the performance of PVC-U window frames in fires has been compared
with that of traditional wood frames in a room, 3m x 3.3m x 2.4m high. All windows were double glazed. Two fire loads were used in the form of cribs built from wooden sticks, one weighing 30kg, the other 100kg, with low and higher ventilation conditions respectively. The report of this programme drew the following conclusions:

1. Little damage was evident to both PVC-U and wood windows until the glass panes were displaced. Glass panes failed by cracking and then falling out in a random manner.

2. After failure of one glass pane the increased ventilation accelerated fire growth and in most tests the other panes fell out shortly afterwards.

3. Wood frames burned after the displacement of glass while the PVC-U window frames softened and the casement sometimes fell out. There was some evidence of combustion of PVC-U. PVC-U windows did not show any aspects of performance which could create new hazards in fire involving buildings.

4. Carbon monoxide, produced mainly from the wooden crib under low ventilation conditions, was the major toxic hazard in each test and was produced in concentrations which would prove lethal in regions where ambient temperatures would allow survival.

5. The concentrations of carbon monoxide were noticeably lower in the fire involving only PVC-U frames; this was possibly caused by a low rate of burning in this test.

Overall Conclusion
PVC-U windows present a satisfactory performance in fires

References:
* A video of these fire tests is also available. 'Fire Performance of uPVC window frames'.

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