



## 1. Scope of Test

This report is a record of a smoke control test conducted by Forte Testing and Consultants Co., Ltd. in conformity with requirements in *BS EN 1634-3: 2004 "Fire resistance and smoke control tests for door, shutter and openable window assemblies and elements of building hardware Part 3: Smoke control test for door and shutter assemblies"*. References were also made to the standards and documents given in the normative reference list in *BS EN 1634-3: 2004*.

The test subject was a single acting double leaf composite timber door with single glazed element. The specimen was installed with intumescent fire seals, door rebate smoke seal and conceal bottom smoke seal. The specimen was supplied for test by Leung's Wooden Company Limited, the Sponsor, for single side exposure (outward movement). The Sponsors designated the specimen to be tested to procedures for ambient together with medium temperature.

## 2. Test Information

|   |  |
|---|--|
| <b>Test Laboratory:</b>                   | FORTE Testing and Consultants Company Limited  |
| <b>Testing Location:</b>                  | West Side of Huan Xiang Shan, Xin Yu Road, Shajin, Baoan District, Shenzhen, Guangdong Province, China.                              |
| <b>Test Sponsors:</b>                     | Leung's Wooden Company Limited<br>Garish Crown Fire Engineering & Consultancy  |
| <b>ID no. of the Specimen:</b>            | QT 13-090A   |
| <b>Date Received:</b>                     | 2013-06-15   |
| <b>Test Number:</b>                       | Ambient: QT 13-090A; Medium: QT 13-090B<br>*A total of two sets of report (Report no. IT13-068 and IT13-153) are issued on this test |
| <b>Date Tested:</b>                       | 2013-06-19   |
| <b>Approved Test Operator from FORTE:</b> | Ms. Sammi Cheng  |
| <b>Witness of the Test:</b>               | Mr. C.K. Leung – Official Delegate of the Sponsor  |

### 3. Construction Details of Specimen

#### 3.1 Specimen Description

##### 3.1.1 Door Frame

The timber door frame was single rebated type with an overall size 1266 (width) x 2337 mm (height) of a sectional dimension 50 mm (w) x 100 mm (thick) with 20 mm door stop rebate.

The film-plywood sub-frame was fixed onto the back of the door frame by wood screws.

The door frame together with the sub-frame was fixed into the opening on the drywall partition system by 10 x 112 mm self-tapping screws. There were 4 numbers of fixings on each jamb and 2 numbers on the head of door frame.

1 number of 10 mm (w) x 4 mm (t) intumescent strip and 1 number of 20 mm (w) x 4 mm (t) intumescent strip were fitted aside into grooves on the head and jambs. The 10 mm (w) intumescent strip was not interrupted whereas the 20 mm (w) seal was interrupted at hinge positions and the strike plate position.

1 number of rebate corner smoke seal was installed along the door stop rebate corner on the head and jambs. The rebate corner smoke seal was not interrupted.

The space between door frame, sub-frame and structural opening was fully filled with fire sealant and silicone sealant.

##### 3.1.2 Door Leaf

The specimen comprised of a door leaf sized 1200 mm (w) x 2300 mm (h) x 50 mm (t).

The stiles and rails were made of 45 mm (w) x 38 mm (t) wooden slabs. The stiles and rails were fixed together by steel brackets and glue. The core between stiles and rails were filled with 38 mm (t) perlite board. The core was fixed to the stiles and rails by glue.

Both sides of the door core was covered with a layer of 3 mm (t) fire resistance board sub-facing and then finished with a layer of 3 mm (t) medium density fibreboard (MDF) facing. The sub-facing was fixed to the door core by M5 x 25 mm screws at approximate 250 mm centre to centre; whereas the fixing was fixed to the sub-facing by glue.

The door lipping was made of wooden strip.

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**Door Leaf Sub-facing**

|            |                               |
|------------|-------------------------------|
| Supplier:  | Leung's Wooden Co., Ltd.      |
| Brand:     | Gemtree                       |
| Material:  | Magnesium Oxide *             |
| Density:   | 950 ± 100 kg/m <sup>3</sup> * |
| Thickness: | 3 mm ± 0.5 mm                 |

**Door Leaf**

|                         |                             |                               |
|-------------------------|-----------------------------|-------------------------------|
| Supplier:               | Leung's Wooden Co., Ltd.    |                               |
| Overall Sizes:          | 1200 mm by 2300 mm by 50 mm |                               |
| <b>Stiles and Rails</b> | Material:                   | Wooden Slabs                  |
|                         | Width:                      | 45 mm                         |
|                         | Thickness:                  | 38 mm                         |
|                         | Density:                    | 350 - 450 kg/m <sup>3</sup> * |
|                         | Moisture Content:           | 12 - 17%*                     |
| <b>Core</b>             | Supplier:                   | Leung's Wooden Co., Ltd.      |
|                         | Material:                   | Perlite *                     |
|                         | Thickness:                  | 38 mm                         |
|                         | Density:                    | 380 kg/m <sup>3</sup> *       |
|                         | Moisture Content:           | 12 - 17%*                     |

**Glass Pane – Glazed Element**

|                               |   |
|-------------------------------|---|
| Supplier:                     | Leung's Wooden Co., Ltd.  |
| Brand:                        | Hangbao   |
| Nominal Thickness:            | 25 mm *   |
| Composition:                  | Not Provided  |
| Full Sizes:                   | 325 mm by 1227 mm   |
| Visual Sizes:                 | 275 mm by 1177 mm   |
| Depth of Cover of Glass Edge: | 10 - 15 mm  |
| Fixing Method:                | Lined by Mineral Wool, Clamped by Stainless Steel Angles and Wooden Glazing Beads on Both Sides |

**Ceramic Fibre – Glazed Element**

|           |   |
|-----------|---|
| Supplier: | Garish Crown Fire Engineering and Consultants |
| Material: | Fire Resistant Wool (Ceramic Fiber Tape)      |
| Density:  | 200 kg/m <sup>3</sup> *                       |
| Sizes:    | 3 mm  |

**Glazing Beads – Glazed Element**

|                   |                               |
|-------------------|-------------------------------|
| Supplier:         | Leung's Wooden Co., Ltd.      |
| Material:         | Hardwood *                    |
| Density:          | 550 - 700 kg/m <sup>3</sup> * |
| Moisture Content: | 12 - 17% *                    |
| Sizes:            | 25 mm by 14.5 mm              |
| Fixing Method:    | Wood Nails                    |

**Hinges**

|           |                          |
|-----------|--------------------------|
| Supplier: | Leung's Wooden Co., Ltd. |
| Brand:    | Valance                  |
| Model:    | 3044-2RB-ST              |
| Material: | Stainless Steel *        |
| Sizes:    | 102 mm by 102 mm by 3 mm |

**Lever Handle**

|           |                         |
|-----------|-------------------------|
| Supplier: | Leung's Wooden Co. Ltd. |
| Model:    | Not Provided            |
| Material: | Stainless Steel *       |
| Sizes:    | ø20 mm by 150 mm        |

**Door Closer**

|           |                          |
|-----------|--------------------------|
| Supplier: | Leung's Wooden Co., Ltd. |
| Brand:    | ECO                      |
| Model:    | TS-20                    |



**Frame Fixing – Self-tapping Screws**

|           |  |
|-----------|--|
| Supplier: | Leung's Wooden Co., Ltd.               |
| Brand:    | Howin – HMF                            |
| Sizes:    | 10 mm by 112 mm Screws with Metal Plug |

**Fire Sealant**

|           |   |
|-----------|---|
| Supplier: | Garish Crown Fire Engineering and Consultants |
| Brand:    | FIREMATE                                      |
| Model:    | Not Provided                                  |

**Glue**

|           |                          |
|-----------|--------------------------|
| Supplier: | Leung's Wooden Co., Ltd. |
| Model:    | Not Provided             |
| Type:     | 木膠粉 *                    |

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#### 4. Specimen Condition

##### 4.1 Selection of the Specimen

The specimen was selected by the Sponsor and submitted to the Test Location. FORTE did not involve in the selection of the specimen.

All the components of the test specimen were supplied by the Sponsor.

##### 4.2 Verification of the Specimen

In *section 3.2* of this report, items which had been verified by FORTE was clearly identified and distinguished from those relying on Sponsor's declaration.

##### 4.3 Supporting Construction

The specimen was fixed into a structural opening sized 1270 mm (w) x 2355 mm (h) made of steel hollow sections. The space between specimen and the test frame was sealed by a drywall partition.

The drywall partition was constructed by steel studs and channels with single layer gypsum board fixed on both sides.

##### 4.4 Installation of the Specimen

The specimen was assembled and installed by workers delegated by the Sponsor on 2013-06-15.

| Specimen No. | Orientation   | Test No. |            |
|--------------|---|----------|------------|
| QT 13-090A   | Door leaf could only be swung outwards the test chamber | Ambient  | QT 13-090A |
|              |   | Medium   | QT 13-090B |

##### 4.5 Specimen Conditioning

The specimen was stored in the Test Location from 2013-06-15, the date which specimen was received, to 2013-06-19, the date which smoke leakage test was performed.

The average environment parameters in the Test Location within this period were:

| Ambient Temperature (°C) | Relative Humidity (%) |
|--------------------------|-----------------------|
| 28 ± 8                   | 75 ± 10               |

## 5. Test Method

### 5.1 Pre-test Conditioning

The pre-test conditionings of the specimen were carried out on 2013-06-18 prior to the smoke leakage test with reference to *BS EN 1634-3: 2004* and *clause 5.1, BS EN 14600: 2005*.

### 5.2 Smoke Leakage Test

#### 5.2.1 Symbols and Designation

| Symbol                 | Unit                | Designation                                     |
|------------------------|---------------------|---|
| Q                      | m <sup>3</sup> /h   | Leakage rate                                    |
| Q <sub>app</sub>       | m <sup>3</sup> /h   | Apparatus leakage rate                          |
| Q <sub>sup/assoc</sub> | m <sup>3</sup> /h   | Supporting/associated construction leakage rate |
| Q <sub>spec</sub>      | m <sup>3</sup> /h   | Test specimen leakage rate                      |
| Q <sub>t</sub>         | m <sup>3</sup> /h   | Total leakage rate                              |
| Q <sub>l</sub>         | m <sup>3</sup> /h/m | Linear leakage rate                             |

#### 5.2.2 Sequence of Testing

For each specimen, the test was carried out in the following sequence:

- Determine the leakage rate through the test chamber and any supporting or associated construction at ambient temperature i.e.  $Q_{app}^{(20)} + Q_{sup/assoc}^{(20)}$
- Determine the total leakage rate at ambient temperature i.e.  $Q_t^{(20)}$
- Determine the total leakage rate at medium temperature i.e.  $Q_t^{(200)}$
- Determine the leakage rate through the apparatus and any supporting and associated construction at medium temperature 200°C i.e.  $Q_{app}^{(200)} + Q_{sup/assoc}^{(200)}$

#### 5.2.3 Ambient Temperature

The leakage rate through the specimen was measured at pressure difference 10 Pa, 25 Pa and 50 Pa, or for at the pressure difference specified by the Sponsor. During the measurement of the leakage rate the pressure difference was maintained for 2 minutes and the value of  $Q_{spec}^{(20)}$  was established at the end of this period using:

$$Q_{spec}^{(20)} = Q_t^{(20)} - (Q_{app}^{(20)} + Q_{sup/assoc}^{(20)})$$

$$Q_l^{(20)} = Q_{spec}^{(20)} / \text{"length of gap"}$$

\*where the "length of gap" is defined in *Clause 10.2.2.1; BS EN 1634-3: 2004*.

### 5.2.4 Medium Temperature

The average air temperature close to the face of the specimen was raised from ambient temperature to the  $200 \pm 20$  °C in  $30 \pm 5$  minutes. The temperature distribution over the face of the specimen was monitored by 9 numbers of type K (*Figure 1*) thermocouples positioned  $100 \pm 50$  mm from the exposed face of the test specimen. During the heating up period, neutral pressure was maintained in the test chamber.

The leakage rate through the test specimen was measured at pressure differences of 10 Pa, 25 Pa and 50 Pa, or at pressure difference specified by the Sponsor. These measurements were taken within 10 minutes of achieving the test temperature. During measurement of the leakage rate the pressure difference was maintained for 2 minutes and the value of  $Q_{spec}^{(200)}$  established at the end of this period using:

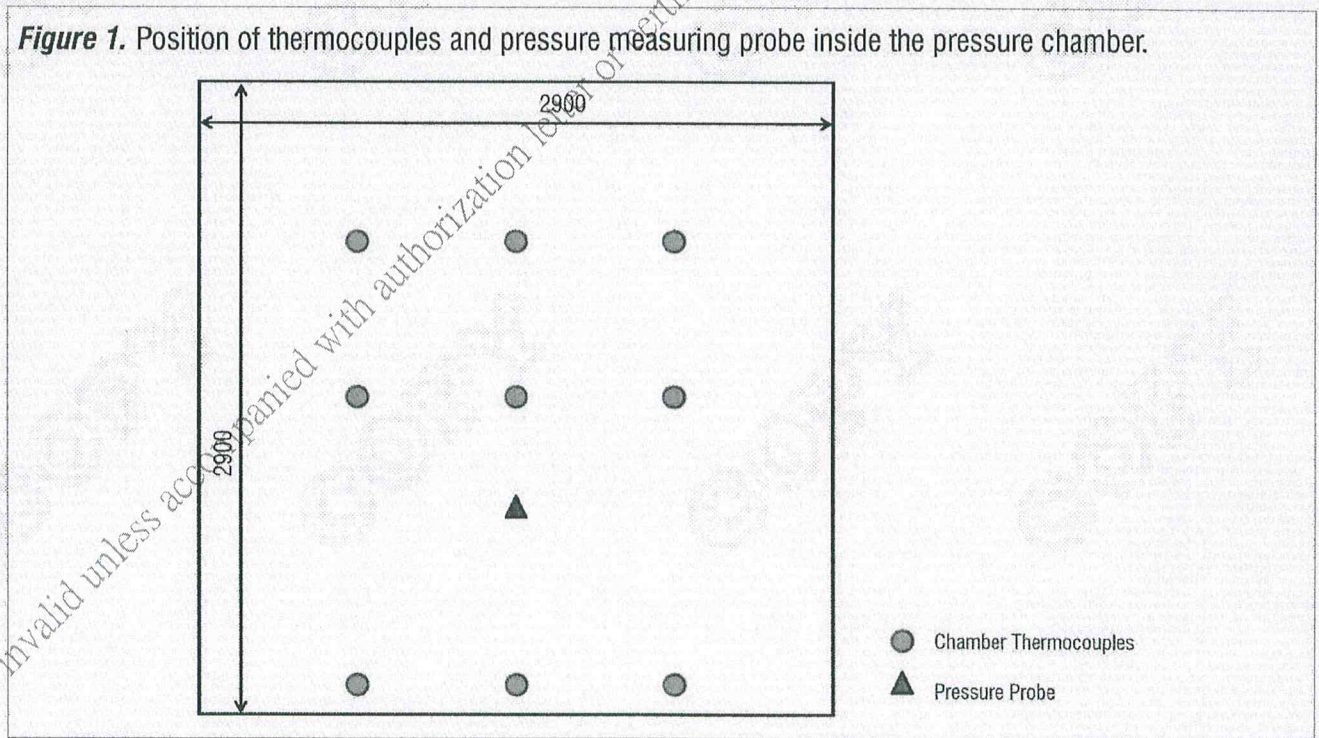
$$Q_{spec}^{(200)} = Q_t^{(200)} - (Q_{app}^{(200)} + Q_{sup/assoc}^{(200)})$$

### 5.3 Deflection Measurements

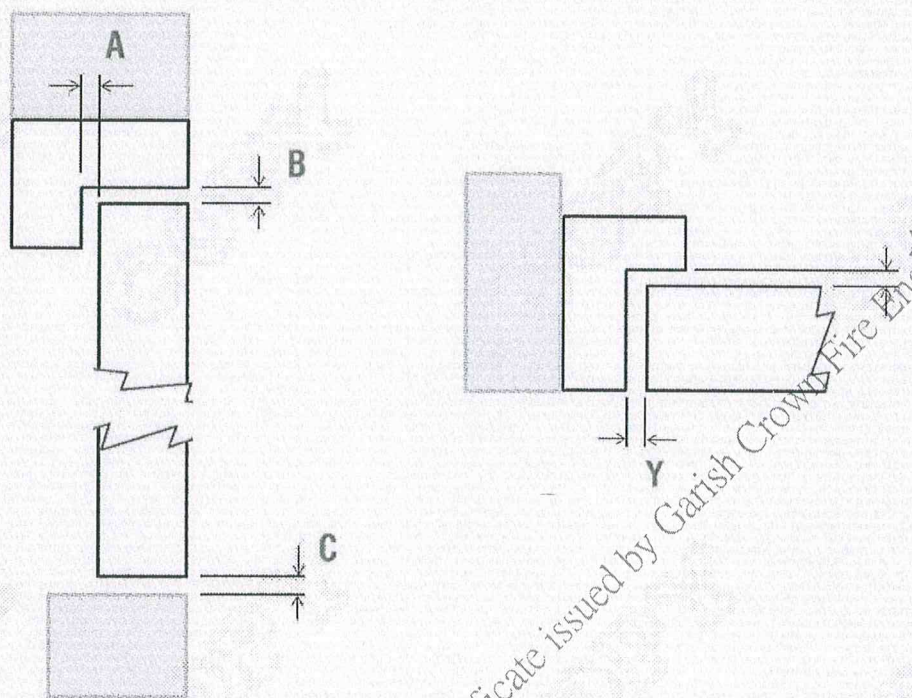
Measurements of the deflection of the test specimen were taken with a steel rule from cross line lasers across the top, mid-height and bottom of the specimen during the medium temperature smoke leakage test.

The positions of deflection measurement points are shown in *Figure 3*.

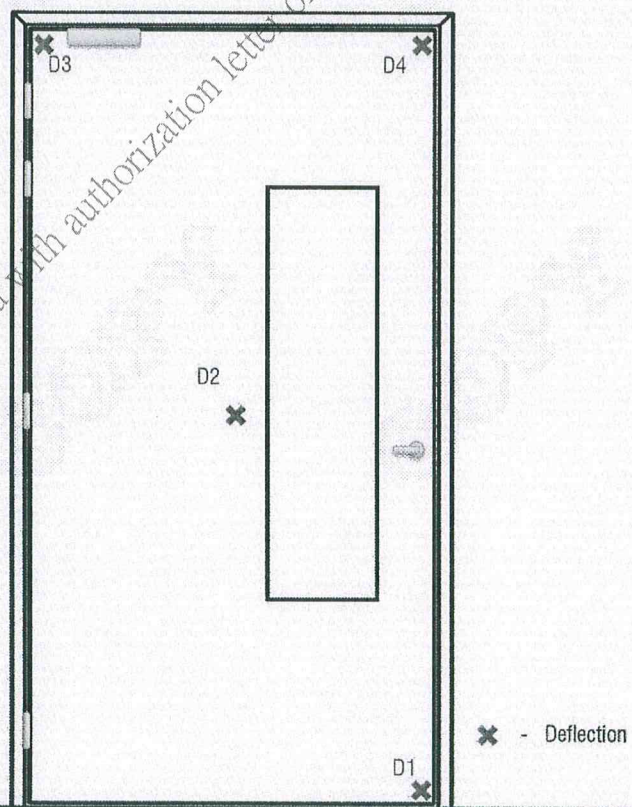
**Figure 1.** Position of thermocouples and pressure measuring probe inside the pressure chamber.



**Figure 2.** Primary gaps measurement positions.



**Figure 3.** Position of deflection measurement on specimen QT13-090A (outward movement)

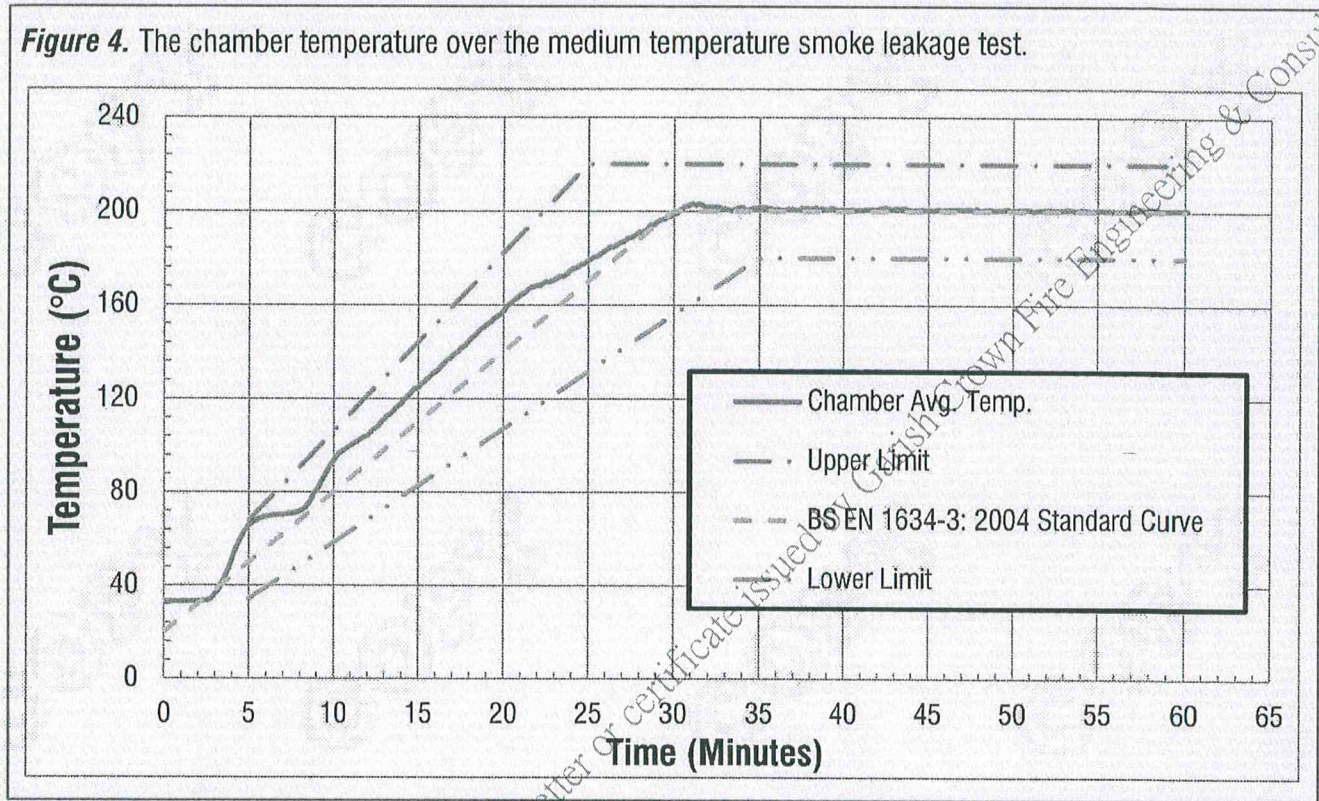




#### 6.1.4 Chamber Temperature

The chamber temperature over the medium temperature smoke leakage test period is shown in *Figure 4*.

**Figure 4.** The chamber temperature over the medium temperature smoke leakage test.



#### 6.1.5 Lateral Deflections

Measured lateral deflections over the medium temperature smoke leakage test period are summarized in the following table.

A positive measurement indicates a movement towards into the pressure chamber and vice versa.

Measurements were taken in mm.

Maximum deflection measured was -5 mm at D2 at 36.5 minute of test.

| Position \ Time (min) | 0  | 5  | 10 | 15 | 20 | 25 | 30 | 31.5 | 34 | 36.5 |
|-----------------------|----|----|----|----|----|----|----|------|----|------|
| <b>D1</b>             | +0 | +0 | +0 | +0 | +0 | +0 | +1 | +1   | +1 | +1   |
| <b>D2</b>             | +0 | +0 | +1 | +1 | +1 | +1 | +1 | -1   | -2 | -5   |
| <b>D3</b>             | +0 | +0 | +1 | +1 | +1 | +2 | +2 | +2   | +2 | +2   |
| <b>D4</b>             | +0 | +0 | +1 | +1 | +0 | +2 | +2 | +2   | +2 | -1   |



### 6.1.6 Observations

Significant behaviours of the specimen during the test period are summarized in the following table.

Photos taken during the test period are also attached.

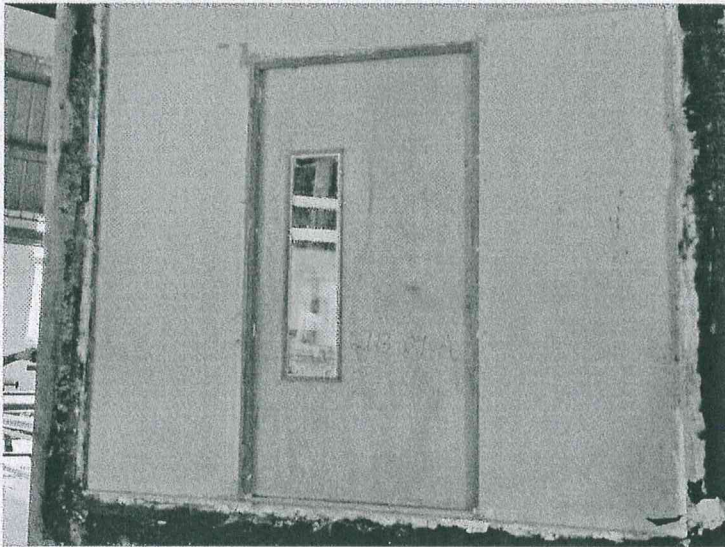
#### 6.1.6.1 Ambient Temperature Smoke Leakage Test

No significant changes of the specimen were observed.

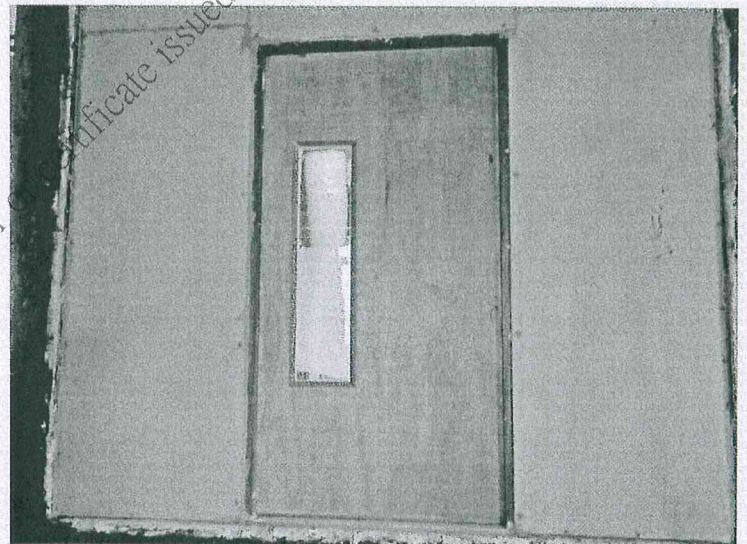
#### 6.1.6.2 Medium Temperature Smoke Leakage Test

| Time (min.sec)                                     | Observation (from unexposed side)  |
|--|--|
| 00.00  | Test started.  |
| 38.13  | Smoke released from the bottom edge of the door leaf.<br>The exposed side glass pane cracked.  |
| 39.52  | The door leaf deformed.  |
| 60.17  | Heating and Pressurization was terminated.   |
| <b>After the end of heating and pressurization</b> | <p><b>Damages on the specimen:</b></p> <p>The interlayer of the glass pane reacted and turned white in color. Intumescent sealant around the glass pane expanded.</p> <p>The cases of the intumescent strips were softened. Some reacted intumescent was observed at the end of intumescent strips.</p> <p>Some cracks appeared on the door frame and the door lippings.</p> <p><b>Door operability after test:</b></p> <p>The door leaf could be fully-opened manually.</p> |

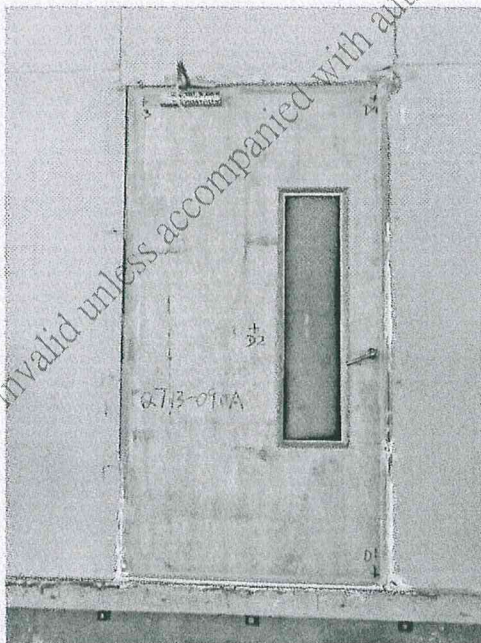
6.1.7 Photos



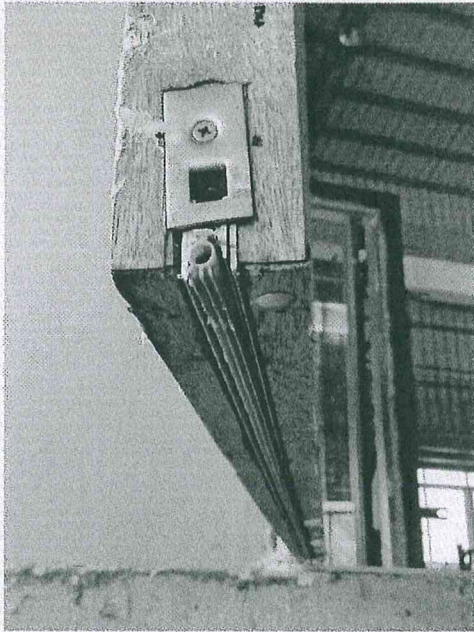
**Photo 1.** Exposed surface of the specimen after medium temperature test.



**Photo 2.** Exposed side of the specimen after medium temperature test.

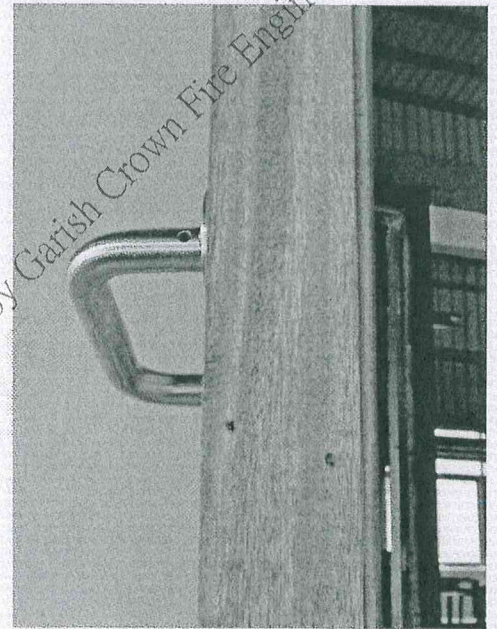


**Photo 3.** Unexposed side of the specimen after medium temperature test.



**Photo 4.** Conceal bottom smoke seal in the specimen after medium temperature test.

**Photo 5.** Lever handle position of the specimen after medium temperature test.



**Photo 6.** Hinge on the specimen after medium temperature test.



**Photo 7.** Strike plate position on the specimen before test.



## 7. Test Results

From the test data obtained from the smoke leakage tests, leakage rates for each test specimen were calculated and are summarized in the following table.

| No. of Test | Test no. (Face exposed to pressure) | Temperature & Conditions   | Leakage rate $Q_{spec}$ (m <sup>3</sup> /h) at pressure difference of |       |                    | Linear Leakage Rate $Q_l$ (m <sup>3</sup> /h/m) at pressure difference of |       |
|-------------|-------------------------------------|----------------------------|---|-------|--------------------|---|-------|
|             |                                     |                            | 10 Pa   | 25 Pa | 50 Pa              | 25 Pa   | 50 Pa |
| 1           | QT13-090A (Swing Outwards)          | Ambient (threshold sealed) | 1.24  | 5.81  | 10.96              | 1.01 <sup>+</sup>   | 1.90  |
|             |                                     | Ambient                    | 1.35  | 6.90  | 13.15 <sup>*</sup> | 1.20  | 2.28  |
| 2           | QT13-090B (Swing Outwards)          | Medium (200°C)             | 2.32  | 0.51  | <0.1 <sup>*</sup>  | -   | -     |

[+ & \*] Description on smoke leakage performance criteria for classification of smoke control door and shutter assemblies are quoted in *Appendix A*.

## 8. Limitations

This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in *BS EN 1363-1*, and where appropriate *BS EN 1363-2*. Any significant deviation with respect to size, construction details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report.

Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible to provide a stated degree of accuracy of the result.

This report may only be reproduced in full by the Sponsor, without comment, abridgement, alteration or addition, unless otherwise agreed with written approval by FORTE.

## 9. Field of Direct Application

The field of direct application of test results is restricted to the allowable changes which a sponsor may make to the tested specimen following a successful smoke leakage test. These variations may be introduced automatically without the need for the sponsor to seek additional evaluation, calculation or approval.

The series of rules and guidelines are defined in *Clause 13 "Field of direct application of test results", BS EN 1634-3: 2004* and relevant clauses and annexes. Permitted variations away from the test specimen include 1) construction of assembly, 2) size and aspect ratio, 3) glazing, 4) supporting constructions and 5) Seals.

## Appendix A

### Definitions on Smoke leakage $S_a$ and $S_m$ in BS EN 1634-3: 2004

Statements concerning definitions on smoke leakage  $S_a$  and  $S_m$  stated in BS EN 1634-3 are quoted:

*British Standards Institution, London, 2007 - BS EN 1634-3: 2004 Incorporating corrigendum no. 1 "Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware - Part 3: Smoke control test for door and shutter assemblies", 3.1.4 & 3.1.5*

#### **3.1.4 Smoke leakage $S_a$**

Ambient temperature smoke leakage classification as defined in 7.5.6.3.1 of EN 13501-2: 2003.

#### **3.1.5 Smoke leakage $S_m$**

Ambient plus medium temperature (200°C) smoke leakage classification as defined in 7.5.6.3.1 of EN 13501-2: 2003.

### Performance Criteria of Smoke Leakage in BS EN 13501-2: 2003

Statements concerning performance criteria of smoke leakage in BS EN 13501-2: 2003 are quoted:

*British Standards Institution, London, 2003 - BS EN 13501-2: 2003 "Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance tests, excluding ventilation services", 5.2.7 & 7.5.6.3.1*

## **5.2 Resistance to fire performance characteristics**

### **5.2.7 S – Smoke leakage**

Smoke leakage S is the ability of the element to reduce or eliminate the passage of gases or smoke from one side of the element to the other.

+  $S_a$  considers smoke leakage at ambient temperature only.

\*  $S_m$  considers smoke leakage at both ambient temperature and at 200°C.

### **7.5.6.3 Performance criteria**

#### **7.5.6.3.1 Smoke leakage**

This is the ability of the element to reduce or eliminate the passage of smoke from one side of the door to the other. The following performance levels are defined:

- a) \* smoke leakage  $S_m$  – when the maximum leakage rate measured at both ambient temperature and 200°C and up to a pressure of 50 Pa does not exceed 20 m<sup>3</sup>/h for a single leaf doorset, or 30 m<sup>3</sup>/h for a double leaf doorset;
- b) + smoke leakage  $S_a$  – when the maximum leakage rate measured at ambient temperature, and at a pressure of up to 25 Pa only, does not exceed 3 m<sup>3</sup>/h per meter length of gap between the fixed and movable components of the doorset (e.g. between the door leaf and door frame), excluding leakage at the threshold.

**END OF REPORT**