

# **SMOKE CONTROL TEST REPORT**

## **SINGLE-LEAF COMPOSITE TIMBER DOOR with A GLAZED ELEMENT**

in accordance with **BS EN 1634-3: 2004**

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**Report Number:** IT21-247

**Date of Issue:** 2022-01-05

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**HOKLAS Approved Signatory:**



**Ir Prof CHAN Yuk Kit, James, MH, JP, RPE (Fire)**

## 1. Scope of Test

This report was a record of a smoke control test conducted by Forte Testing and Consultants Company Limited 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-leaf composite timber door with a glazed element. The specimen was installed with smoke seals and intumescent seals with fins. The specimen was supplied for test by Yuk Tong Wooden Industries Limited & Shanghai Gallford Fire Sealing Material Company Limited, the Sponsors. The Sponsors designated the specimen to be tested to procedures for ambient with medium temperature on push side of the specimen under pressure.

## 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 Sponsor:</b>	Yuk Tong Wooden Industries Limited Shanghai Gallford Fire Sealing Material Company Limited
<b>ID no. of the Specimens:</b>	QT21-158A
<b>Date Received:</b>	2021-09-25
<b>Test Number:</b>	Ambient: QT21-158A Medium: QT21-158B *A total of two sets of report (Report no. IT21-150 and IT21-247) with identical content had issued at request of the sponsors.
<b>Date Tested:</b>	2021-11-27
<b>Test Operator from FORTE:</b>	Mr. Liang Kun Ru
<b>Witness of the Test:</b>	No witness from Sponsor
<b>Report Issue Record:</b>	Version 1 – 2022-01-05

### 3. Construction Details of Specimen

#### 3.1 Specimen Description

##### 3.1.1 Door Frame

The rebated door frame overall sized 1176 mm (width) x 2294 mm (height). The sectional dimension of the door frame at hinged sized and the others were 55 mm (w) x 75 mm (thick) with 20 mm door stop.

The door frame was made of timber post. The frame was fixed onto the test rig by 8 mm x 60 mm (long) door frame anchor bolts at approximate 370 mm – 550 mm centre to centre. There were 4 numbers of fixings on each jamb. 30 mm (w) x 4 mm (t) intumescent seal was centrally fitted into the groove along the head and jambs of door frame. Smoke seal was fitted at rebate corner of the door frame. The space between door frame, sub-frame and test rig was lined up with fire sealant.

##### 3.1.2 Door Leaf

The specimen comprised of leaf with overall size 1110 mm (w) x 2250 mm (h) x 49 mm (t).

The perimeter stiles and rails were made of a 60 mm (w) x 33 mm (t) wooden slab. The space between stiles and rails were filled with 33 mm (t) perlite core. Both sides of the door core were covered by 5 mm (t) fire board and a layer of 3 mm (t) plywood board. The fire board was fixed onto the door core by glue and screws, whereas the plywood board was fixed by glue. 15 mm (w) x 4 mm (t) intumescent seal was centrally fitted into the grooves along the edges of the door leaf except the bottom edge. Conceal drop seal was applied on the bottom of door leaf.

##### 3.1.3 Glazed Element

The specimen comprised of a glazed element.

The glazed element was visually sized of 140 mm (w) x 1560 mm (h) and it was installed 250 mm away from the top edge and 150 mm away from the leading edge of the door leaf.

Each glazed element consisted of a piece of nominal 27 mm (t) interlayered glass pane. The glass panes were set on 2 mm (t) intumescent seal glazed system. The glazing beads on both sides with chamfer type were size 20 mm (width, parallel to the glass) x 12 mm (thick, perpendicular to the glass). The glazing beads were fixed onto the door leaf by wood nails at approximate 150 mm – 250 mm centre to centre.

##### 3.1.4 Ironmongery

The door leaf was supported by butt hinges. The top and bottom hinge was 300 mm away from the top and the bottom rim of the door leaf respectively. The maximum distance between hinges was 700 mm.

A mortise lock and door guard were installed 1050 mm and 1250 mm above the bottom edge of the door leaf respectively. Door closer was installed at the top edge of door leaf. Intumescent material was applied to mortised area for ironmongeries.

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### 3.2 Material Schedule

Parts specifications were summarized in the following tables.

*Italics:* Information checked by FORTE.

#### Door Frame

Supplier:	Yuk Tong Wooden Industries Limited
Material:	<i>Timber (Hardwood)</i>
Overall Sizes:	<i>1176 mm x 2294 mm</i>
Density:	<i>550 - 650 kg/m<sup>3</sup></i>
Sectional Dimensions:	<i>55 mm x 75 mm</i>
Connection Method of Head to Jamb:	250 mm x 250 mm Steel Angle Plate Fixed By Wood Screw
Fixing Method to Sub-frame:	By 8 mm x 60 mm Door Frame Anchor
Gap Filling between Door Frame and Supporting Frame:	Lined Up with Fire Sealant

#### Intumescent Seal - Door Frame

Manufacturer:	Wuhu Gallford Fire Material Company Limited
Brand:	Gallford
Model:	YZ3004
Sizes:	<i>30 mm x 4 mm</i>
Location Applied:	Along the Head and Jamb of Door Frame

#### Smoke Seal - Door Frame

Manufacturer:	Wuhu Gallford Fire Material Company Limited
Brand:	Gallford
Model:	AD005T
Sizes:	<i>10 mm x 10 mm</i>
Location Applied:	Door Stop

#### Door Leaf

Supplier:	Yuk Tong Wooden Industries Limited	
Overall Sizes:	<i>1110 mm x 2250 mm</i>	
Nominal Thickness:	<i>49 mm</i>	
Measured Thickness:	<i>49.13 mm</i>	
Stiles and Rails	Material:	<i>Timber (Softwood)</i>
	Width:	Stile & Rail - 60 mm
	Thickness:	33 mm
	Density:	400 - 500 kg/m <sup>3</sup>
	Moisture Content:	12% - 15%
Core	Supplier:	Combine Fireproof Material Company Limited
	Material:	Perlite
	Thickness:	34 mm
	Density:	420 - 450 kg/m <sup>3</sup>



**Mortise Lock with Handle**

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	ECG
Model:	ECG 8200-A05.6072/SS
Material:	Stainless Steel – Casing/Lever Handle; Steel Alloy – Cylinder

**Butt Hinge**

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	KW
Model:	KW 834.404030/SS
Material:	Stainless Steel
Sizes:	102 mm x 102 mm x 3 mm

**Door Closer**

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	RYOBI
Model:	9903
Material:	Stainless Steel

**Door Guard**

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	ECG
Model:	ECG 8500-B01/SC
Material:	Zinc Alloy

**Intumescent Pad – Ironmongery**

Manufacturer	Wuhu Gallford Fire Material Company Limited
Brand:	Gallford
Thickness:	1 mm
Location Applied:	Concealed Face of Mortise Ironmongery

**Hinge Protection Pad**

Manufacturer	Wuhu Gallford Fire Material Company Limited
Brand:	Gallford
Thickness:	1 mm
Location Applied:	Concealed Face of Hinge

**Fire Sealant**

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	Fsi
Model:	Pyrocoustic Sealant
Location Applied:	Gap Between Door Frame and Supporting Structure

**Glue**

Supplier:	Foshan Nanhi Pingzhi Sealing Material Company Limited
Model:	PY-1 Green Type

## 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 1192 mm (w) x 2330 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 2021-11-18 to 2021-11-02.

Specimen No.	Orientation	Test No.	
QT21-158A	Door leaf could only be swung Outwards the test chamber (Pressure side – push side)	Ambient	QT21-158A
		Medium	QT21-158B

The door was UNLOCKED and UNLATCHED during the test.

### 4.5 Specimen Conditioning

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

Specimen No.	Store Period	Ambient Temperature	Relative Humidity (%)
QT21-158A	2021-09-25 to 2021-11-27	25 ± 5	42 ± 5

## 5. Test Method

### 5.1 Pre-test Conditioning

The pre-test conditionings of the specimen QT21-158A was carried out on 2021-11-27 prior to the smoke test with reference to *BS EN 1634-3: 2004* and *Annex A, A3 of BS EN 16034:2014*

#### *Operability test of the specimen:*

The specimen to be smoke tested shall be checked for operability in the test frame prior to being mounted on the test chamber by operating from fully closed to the maximum possible opening and at least 90° (in the case of hinged or pivoted doorsets and / or openable windows) and back to fully closed for 25 cycles.

#### *Self-closing for doorset without coordinating devices:*

For single leaf hinged or pivoted doorsets and/or openable windows the sample is opened to 10° ± 2° (for controlled closing devices) or 30° ± 2° (for uncontrolled closing devices) and held for 20 s ± 2 s, released without shock and allowed to close at a maximum mean average speed of 300 mm/s to ensure that their closed position is achieved. Other products are opened to 300 mm, held for 20 s ± 2 s, released without shock and allowed to close. For these products the maximum mean average speed shall be 300 mm/s except those with a vertical opening/closing movement where the maximum mean average speed shall be 150 mm/s.

### Smoke Leakage Test

#### 5.1.1 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

#### 5.1.2 Sequence of Testing

For the 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.  $Q_{app}^{(200)} + Q_{sup/assoc}^{(200)}$

### 5.1.3 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" was defined in *Clause 10.2.2.1; BS EN 1634-3: 2004.*

### 5.1.4 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:

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

## 5.2 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 point were shown in *Figure 3*.

## 6. Test Data

### 6.1 Specimen QT21-158A [Test no. QT21-158A & QT21-158B]

#### 6.1.1 Ambient Temperature

The ambient temperature at the commencement of tests was 25.1°C.

#### 6.1.2 Retention Forces and Pre-Conditioning of the Specimen

The retention forces on the door leaf of the specimen were determined. The respective highest gauge measurements were summarized in the following table.

Push	Pull
38.2 N	40.1 N

Operability test of the specimen:

The specimen had been tested for operability in the test frame by operating from fully closed to fully open at 90 degrees for 25 cycles. Closing speed of the specimen without coordinating devices:

Leading Edge Speed (mm/s)
210.58

#### 6.1.3 Gap Measurements

##### 6.1.3.1 Primary gap width

Primary gap widths of the specimen were measured and summarized in the following table. The measurement positions were shown in *Figure 2*.

Measurements were taken in mm.

Gap	Measured		
	Minimum	Maximum	Average
A	3.5	3.8	3.6
B	2.0	4.9	3.4
C	3.8	5.0	4.5
X	2.8	5.5	3.5
Y	2.3	4.0	3.4

##### 6.1.3.2 Length of Gap

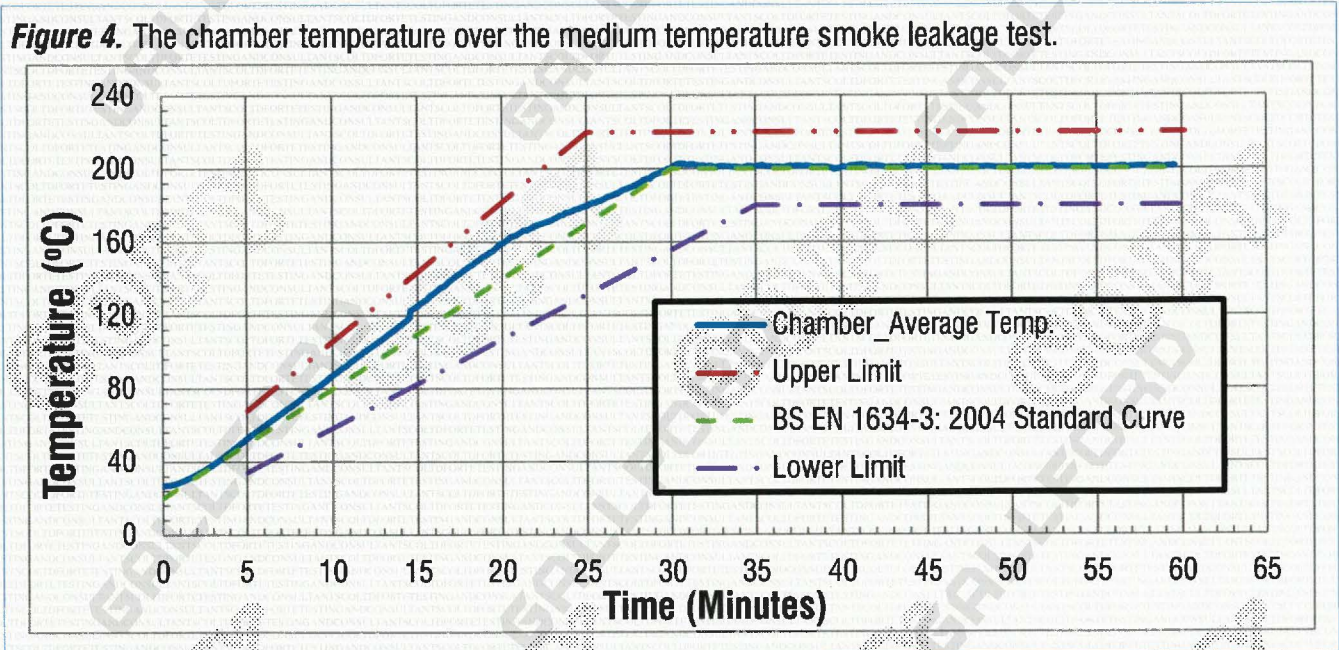
“Length of Gap” of the specimen:

$$1105 \text{ mm} + (2261 \text{ mm} \times 2) = 5.627 \text{ m}$$

6.1.4 Chamber Temperature – Test no. QT21-158B

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

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



6.1.5 Lateral Deflection

Measured lateral deflections over the medium temperature smoke leakage test period were 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 value of the specimen was **BOLDED** at the following table.

Positions \ Time (min)	Time (min)										
	0	5	10	15	20	25	30	31.5	34	36.5	
<b>D1</b>	+0	+0	+0	+0	-1	-1	-1	-1	-1	-1	
<b>D2</b>	+0	+1	+1	+1	+1	+4	+5	+5	+5	+5	
<b>D3</b>	+0	+0	+0	+0	-2	-2	-3	-4	-2	-2	
<b>D4</b>	+0	+0	+0	+0	+0	-1	-1	-1	-1	-1	

6.1.6 Observations

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

Photos taken during the test period were also attached.

6.1.6.1 Ambient Temperature Smoke Leakage Test – Test no. QT21-158A

No significant changes of the specimen were observed.

6.1.6.2 Medium Temperature Smoke Leakage Test – Test no. QT21-158B

Time (min.sec)	Observation (from unexposed side)
00.00	Test started.
31.00	No significant changes were observed from the specimen.
43.00	The glass pane's interlayer of the door leaf and fixed panel start reacted.
60.04	Termination of heating and pressurization.
<b>After the end of heating and pressurization</b>	<p><b>Damages on the specimen:</b></p> <p>The glass pane's interlayer of the door leaf and fixed panel reacted and turned slightly milky. Smoke seals were shrink and soften. Slightly expansion was observed at the intumescent seals.</p> <p><b>Door operability after test:</b></p> <p>The door leaf could be fully-opened manually.</p>



### 7. Test Results

From the test data obtained from the smoke leakage tests, leakage rates for test specimen were calculated and were 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	QT20-158A (Push Side)	Ambient (Threshold Sealed)	2.19	4.17	6.40	0.74*	1.14
		Ambient	2.79	5.46	8.48*	0.97	1.51
2	QT20-158B (Push Side)	Medium	<0.01	2.01	4.56*		

[+ & \*] Description on smoke leakage performance criteria for classification of smoke control door and shutter assemblies were 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, and edge or end conditions other than those allowed under the field of direct application in the relevant test method was 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 was not possible to provide a stated degree of accuracy of the result.

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## 9. Field of Direct Application

The field of direct application of test results was 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 were 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.

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## 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 were 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 were 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 was 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 was 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 were defined:

- \* 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;
- + 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**