

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 subjects were two identical single acting double-leaf composite timber door with two glazed elements. Each specimen was installed with intumescent seals, intumescent seal with plastic fins and concealed bottom drop seal. The specimens were supplied for test by Yuk Tong Wooden Industries Limited & Shanghai Gallford Fire Sealing Material Company Limited, the Sponsors. The sponsors designated the each specimen to be tested to procedures for ambient with medium temperature on one side.

2. Test Information

Test Laboratory:	FORTE Testing and Consultants Company Limited	
Testing Location:	West Side of Huan Xiang Shan, Xin Yu Road, Shajin, Baoan District, Shenzhen, Guangdong Province, China.	
Test Sponsor:	Yuk Tong Wooden Industries Limited Shanghai Gallford Fire Sealing Material Company Limited	
ID no. of the specimen:	QT21-156A	QT21-157A
Date Received:	2021-09-25	2021-09-25
Test Number:	Ambient: QT21-156A Medium: QT21-156B	Ambient: QT21-157A Medium: QT21-157B
	*A total of two sets of report (Report no. IT21-149 and IT21-246) with identical content had issued at request of the sponsors.	
Date Tested:	2021-11-03	2021-11-26
Test Operator from FORTE:	Mr. Liang Kun Ru	
Witness of the Test:	No witness from Sponsor	
Report Issue Record:	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 1529 mm (w) x 2294 mm (h). The sectional dimension of the door frame was 55 mm (w) x 75 mm (t) with 20 mm rebate.

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 and 2 numbers of fixing on the head.

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 centrally into the groove at the door stop.

The space between door frame, sub-frame and test rig was lined up with fire sealant.

3.1.2 Door Leaves

The specimen comprised of two unequal width door leaves with rebated-type edges: the active door leaf sized 1000 mm (w) x 2250 mm (h) x 49 mm (t), whereas the inactive door leaf sized 450 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, except the meeting edge stile of the active door leaf was made of 2 numbers of 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 fitted centrally into the groove along the top and hinged edge of each door leaf.

30 mm (w) x 4 mm (t) intumescent seal was centrally fitted into the grooves along the meeting edge of the active door leaf. 15 mm (w) x 4 mm (t) intumescent seal was centrally fitted into the grooves along the meeting edge of the inactive door leaf. Smoke seal was fitted at rebate corner of the inactive door leaf. Concealed drop seal was applied on the bottom of each door leaf.



3.1.3 Glazed Elements

The specimen comprised of two glazed elements.

On active door leaf, the upper glazed element was visually sized of 360 mm (w) x 360 mm (h) and it was installed 250 mm away from the top edge and 150 mm away from the meeting edge of the door leaf. The lower glazed element was visually sized of 160 mm (w) x 610 mm (h) and it was installed 150 mm below the upper glazed element 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 – 250 mm centre to centre.

3.1.4 Ironmongery

The active and inactive door leaf was supported by 4 numbers of butt hinges and spring hinges respectively. The top and bottom hinge was 300 mm away from the top and the bottom rim of the door leaf. The maximum distance between hinges was 700 mm.

A door closer was installed at the top edge of active door leaf on the fire exposed side.

A flush bolt was fixed at the top and bottom of the inactive door leaf next to the meeting edge.

A rim lock was installed 1050 mm above the bottom edge of the active door leaf.

Door selector was installed at the horizontal door frame near the top of meeting edges.

A door viewer was installed 1500 mm above the bottom edge of the inactive door leaf.

Intumescent material was applied to mortised area for ironmongeries.



**Fire Board**

Supplier:	Dongguan City Gain Leader New Type Decorative Material Company Limited
Brand:	Jiameide
Description:	Magnesium Oxide Board
Thickness:	5 mm
Nominal Density:	1000 - 1100 kg/m ³

Door Leaf Facing

Supplier:	Yuk Tong Wooden Industries Limited
Material:	Plywood
Thickness:	3 mm
Density:	650 - 670 kg/m ³
Fixing Method:	By Glue

Intumescent Seal - Door Leaf

Supplier:	Wuhu Gallford Fire Material Company Limited
Brand:	Gallford
Model:	YZ1504
Sizes:	15 mm x 4 mm
Location Applied:	Along the Top and Vertical Edges of Door Leaf

Concealed Drop Seal

Supplier:	Wuhu Gallford Fire Material Company Limited
Brand:	Gallford
Model:	GF-B092FR
Location Applied:	Along the Bottom Edge on Door Leaf

Glass Pane

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	Boan
Nominal Thickness:	27 mm
Measured Thickness:	27.38 mm; 27.15 mm
Combination of the glass pane:	5 ± 0.5 mm Clear Glass + 16 ± 0.5 mm Gel + 5 ± 0.5 mm Clear Glass
Overall Sizes:	380 mm x 380 mm 180 mm x 630 mm
Visual Sizes:	360 mm x 360 mm 160 mm x 610 mm
Depth of Cover of Glass Edge:	15 mm
Fixing Method:	Set on 2 mm Intumescent Seal Glazed System Clamped by Timber Glazing Bead

Intumescent Seal - Glazing Element

Manufacturer:	Wuhu Gallford Fire Material Company Limited
Brand:	Gallford
Model:	60 Minutes Fire Glazing Seal System

**Rim Lock**

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	ECG
Model:	ECG 2000
Material:	Metal Alloy with Sliver Colour Finishing

Door Selector

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	KW
Model:	KW8602/SS
Material:	Stainless Steel

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

Spring Hinge

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	KW
Model:	KW 841.404030/SS
Material:	Stainless Steel
Sizes:	102 mm x 102 mm x 3 mm

Flush Bolt

Supplier:	Yuk Tong Wooden Industries Limited
Brand:	KW
Model:	KW8500-D02.22/SS
Material:	Stainless Steel

Door Viewer

Supplier:	Wuhu Gallford Fire Material Company Limited
Brand:	Gallford
Model:	FV25
Material:	Metal Alloy with Chrome Finish and Back Cover
Sizes:	25 mm

Door Closer

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

4. Specimens Condition

4.1 Selection of the Specimens

The specimens were 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 specimens were supplied by the Sponsor.

4.2 Verification of the Specimens

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 specimens were fixed into a structural opening sized 1529 mm (w) x 2294 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 specimens were assembled and installed by workers delegated by the Sponsor from 2021-10-27 to 2021-10-28 for QT21-156A, and from 2021-10-28 to 2021-11-02 for QT21-157A.

Specimen No.	Orientation	Test No.	
QT21-156A	Door leaves could only be swung outwards the test chamber	Ambient	QT21-156A
		Medium	QT21-156B
QT21-157A	Door leaves could only be swung inwards the test chamber	Ambient	QT21-157A
		Medium	QT21-157B

Each door was UNLOCKED and UNLATCHED; the flush bolts were UNBOLTED during the test.

4.5 Specimens Conditioning

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

Specimen No.	Store Period	Ambient Temperature (°C)	Relative Humidity (%)
QT21-156A	2021-09-25 to 2021-11-03	29 ± 5	82 ± 5
QT21-157A	2021-09-25 to 2021-11-26	19 ± 5	45 ± 5

5. Test Method

5.1 Pre-test Conditioning

The pre-test conditioning of the specimen QT21-156A was carried out on 2021-10-29 and on 2021-11-17 for QT21-157A prior to the smoke test with reference to *BS EN 1634-3: 2004* and *clause 5.1.1.1 and 5.1.1.3, BS EN 14600: 2005*.

Operability test of the specimen:

Each specimen should be tested for operability in the test frame by operating from fully closed to fully open at 90 degrees for 25 cycles.

Self-closing for doorsets without coordinating devices:

Each specimen had each leaf opened to $10^{\circ} \pm 2^{\circ}$ and held for $20s \pm 2s$ and then without shock and allowed to closed at the speed between one-tenth of the leaf width per second up to a maximum leading edge speed of 300 mm/s.

5.2 Smoke Leakage Test

5.2.1 Symbols and Designation

Symbol	Unit	Designation
Q	m ³ /h	Leakage rate
Q _{app}	m ³ /h	Apparatus leakage rate
Q _{sup/assoc}	m ³ /h	Supporting/associated construction leakage rate
Q _{spec}	m ³ /h	Test specimen leakage rate
Q _t	m ³ /h	Total leakage rate
Q _l	m ³ /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. $Q_{app}^{(200)} + Q_{sup/assoc}^{(200)}$

6.1.3.2 Length of Gap

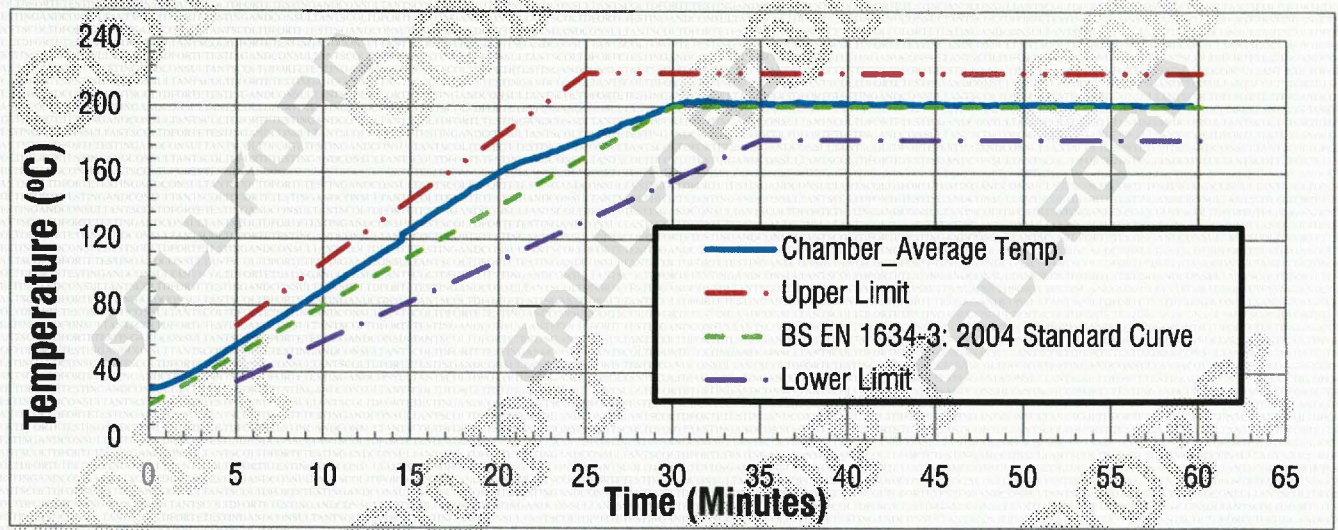
“Length of Gap” of the specimen:

$$1456 \text{ mm} + (2253 \times 3) \text{ mm} = 8.215 \text{ m for test no. QT21-156A}$$

6.1.4 Chamber Temperature – Test no. QT21-156B

The chamber temperature over the medium temperature smoke leakage test period was shown in *Figure 5*.

Figure 5. 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.

Position \ Time (min)	0	5	10	15	20	25	30	31.5	34	36.5
D1	+0	-1	-1	+9	+0	+0	+1	+1	+1	+1
D2	+0	-1	-1	-1	+0	+0	+1	+1	+1	+1
D3	+0	+0	+1	+3	+6	+6	+7	+7	+7	+7
D4	+0	+0	+0	+2	+3	+4	+4	+4	+5	+5
D5	+0	+0	+0	+0	+0	+0	+1	+1	+1	+1
D6	+0	-1	-1	+0	+0	+1	+2	+2	+2	+1
D7	+0	-1	-1	+0	+0	+1	+1	+1	+1	-1
D8	+0	-1	-1	+0	-1	-1	-1	-1	-1	-1

6.2 Specimen QT21-157A [Test no. QT21-157A and QT21-157B]

6.2.1 Ambient Temperature

The ambient temperature at the commencement of test was 18.8°C.

6.2.2 Retention Forces

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

Door Leaf	Push	Pull
Active Leaf	69.7 N	75.9 N
Inactive Leaf	17.7 N	22.2 N

Operability test of the specimen:

The specimen had been tested for operability in the fire test frame by operating from fully closed to fully open at 90 degrees for 25 cycles.

Closing speed of the specimen without coordinating devices:

Door Leaf	Leading Edge Speed (mm/s)
Active Leaf	141.51
Inactive Leaf	57.33

6.2.3 Gap Measurements

6.2.3.1 Primary gap width

Primary gap widths of the specimen was 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	3.1	4.5	3.9
B	2.5	3.0	2.8
C	3.0	5.0	4.0
X	2.0	5.0	2.9
Y	2.5	4.2	3.4
P	2.5	3.0	2.6
R	2.5	3.0	2.6

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 ³ /h) at pressure difference of			Linear Leakage Rate Q_l (m ³ /h/m) at pressure difference of	
			10 Pa	25 Pa	50 Pa	25 Pa	50 Pa
1	QT21-156A (Push Side)	Ambient (Threshold Sealed)	2.54	5.90	9.68	0.72*	1.18
		Ambient	2.85	6.53	10.67*	0.79	1.30
2	QT21-156B (Push Side)	Medium	1.41	0.70	<0.01*		
3	QT21-157A (Pull Side)	Ambient (Threshold Sealed)	1.91	3.42	5.12	0.42+	0.63
		Ambient	3.51	6.61	10.11*	0.81	1.24
4	QT21-157B (Pull Side)	Medium	<0.01	<0.01	1.38*		

[+ & *] 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.

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 m³/h for a single leaf doorset, or 30 m³/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 m³/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