



# **The Building Test Centre**

**Fire Acoustics Structures**

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Assessment Number **BTC 16426FA**

A FIRE TEST ASSESSMENT TO BS EN 1364-1: 1999 ON  
A 5.0m BRITISH GYPSUM CLASSIC PARTITION CLAD  
WITH A DOUBLE LAYER OF 15mm GYPROC FIRELINE  
EACH SIDE OF GYPFRAME 92S50 STUDS  
INCORPORATING ISOVER APR 1200 IN THE CAVITY,  
CONDUCTED IN ACCORDANCE WITH F.T.S.G.  
RESOLUTION No. 82 /PFPF GUIDE.

Assessment Date: 11<sup>th</sup> June 2009

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Applicant: **British Gypsum**  
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**Applicant:** British Gypsum

A FIRE TEST ASSESSMENT TO BS EN 1364-1: 1999 ON A 5.0m BRITISH GYPSUM CLASSIC PARTITION CLAD WITH A DOUBLE LAYER OF 15mm GYPROC FIRELINE EACH SIDE OF GYPFRAME 92S50 STUDS INCORPORATING ISOVER APR 1200 IN THE CAVITY, CONDUCTED IN ACCORDANCE WITH F.T.S.G. RESOLUTION No. 82 /PFPF GUIDE.

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## **DETAILS OF THE REQUEST**

It is required to assess the following constructions for fire resistance performance if tested in accordance with BS EN 1364-1: 1999.

Lightweight non-loadbearing metal stud partitions:

Gypframe 94 C 50channels were fixed to the head and base of the test aperture at 600mm centres with 60mm Hilti Hus fixings. Gypframe 92S50 studs were positioned at 600mm centres between the channels. The right hand stud viewed from unexposed face was not fixed to the perimeter test frame, but the gap between the stud and the lining was filled with a 50mm Rockwool Firebatt gasket. The left hand edge of the specimen was fixed to the test frame using a Gypframe 92S50 stud fixed with 60mm Hilti Hus fixings at 600mm centres.

The framework was lined on both sides with a double layer of 15mm Gyproc FireLine. The inner layer was fixed around the perimeter with 25mm Gyproc Drywall screws at 300mm centres. The outer layer was fixed around the perimeter and within the field of the board with 42mm Gyproc Drywall screws. All boards were staggered between layers.

Horizontal joints were positioned 2700mm from the base for the outer layers on both the exposed and unexposed faces of the construction. Horizontal joints were positioned 600mm and 3200mm from the base for the inner layers on both the exposed and unexposed faces of the construction. A Gypframe GFS1 fixing strap was used behind the horizontal board joints in the outer layers.

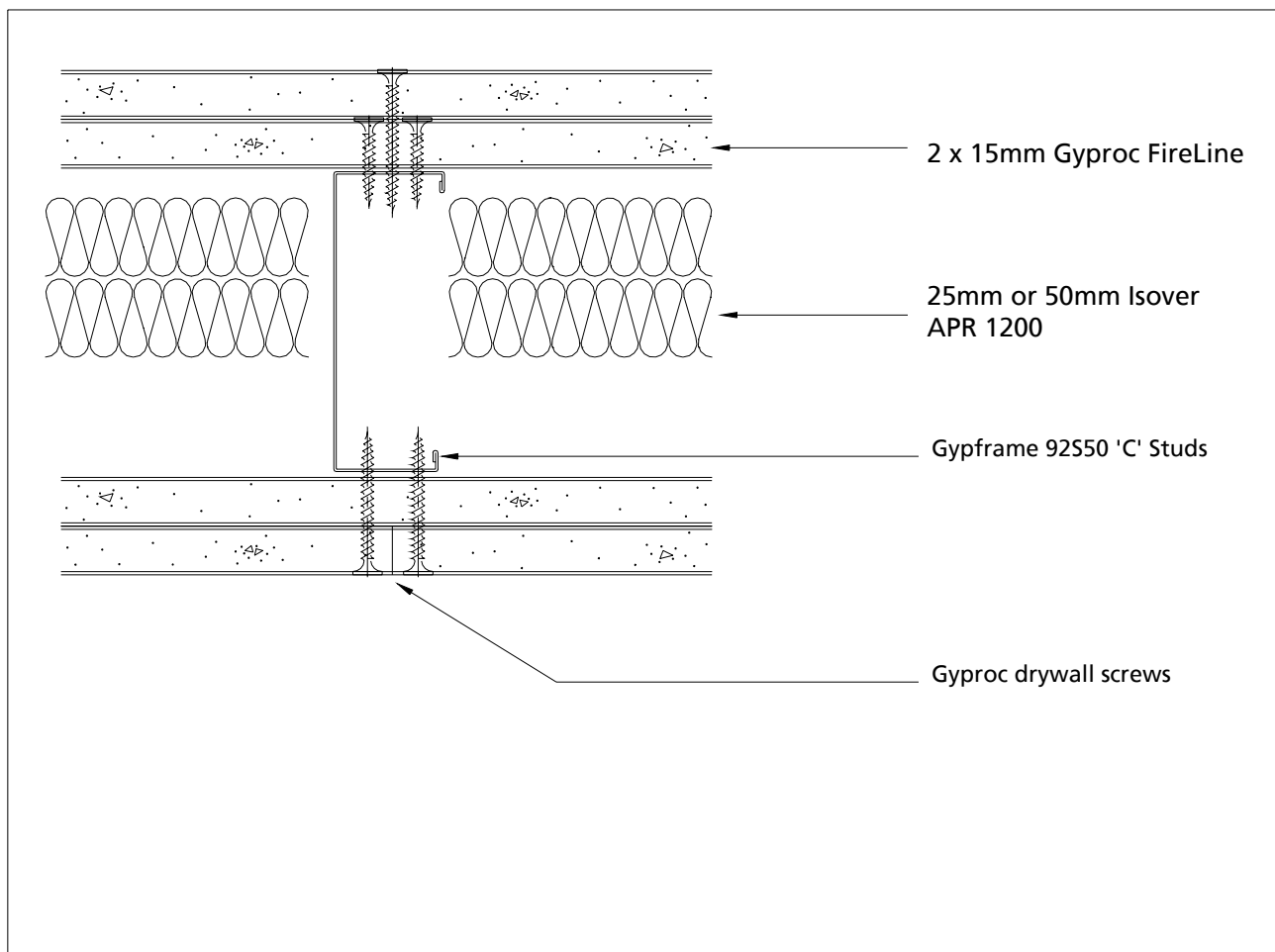
25mm or 50mm Isover APR 1200 was installed in the cavity

All joints were taped and filled using Gyproc Paper Joint Tape and Gyproc Joint Filler. All screw heads were spotted using Gyproc Joint Filler.

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**DRAWING: DETAILS OF THE REQUEST**



**Figure 1 - Horizontal Cross Section**



## THE ASSESSORS

The Building Test Centre operates as an independent accredited test house for the construction industry. The Building Test Centre has unrivalled experience in the development of drywall systems. The Building Test Centre is UKAS accredited under No. 0296 and 0296SI for fire resistance, reaction to fire, acoustic and structural testing. The Building Test Centre is wholly owned by British Gypsum a major manufacturer of building products.

The Building Test Centre is a founder member of the Fire Test Study Group an organisation comprising the UKAS accredited fire test laboratories conducting fire testing in the UK primarily for building control approval. The aim of the group is to ensure a common interpretation of test standards by all laboratories.



## ASSESSMENT AUTHORISATION

Assessment Author

**Paul Miller**  
BSc(Hons.),  
*Fire Resistance Laboratory Supervisor*

Reviewing Assessor

**Philip Barnes**  
BTC Manager

Assessment Date                      11<sup>th</sup> June 2009.

This assessment is not valid unless it incorporates the Declaration by Applicant form duly signed by the applicant.

## **TEST EVIDENCE**

The test evidence used in this assessment has been used under the authorisation of the test report owner and has been used with their permission (see Pages 13 and 14). Furthermore, the test evidence has been reviewed in accordance with Annex D of the PFPF guide to ensure that the test reports are still valid.

**BTC 12785F** – reviewed on 10<sup>th</sup> June 2009 BTC 16494FA

**A FIRE RESISTANCE TEST ON A BRITISH GYPSUM GYPWALL PARTITION CLAD WITH A DOUBLE LAYER OF 15mm GYPROC FIRELINE BOARD EACH SIDE OF GYPFRAME 70S50 STUDS, CONDUCTED IN ACCORDANCE WITH BS EN 1364-1: 1999.**

The specimen was constructed in a refractory concrete lined steel restraint frame having an opening of 3000mm high x 3000mm wide.

Gypframe 72C50 Standard Floor & Ceiling Channels were fixed to the head and base of the test aperture at 600mm centres with 60mm fire resistant fixings. Gypframe 70S50 'C' Studs were positioned at 600mm centres between the channels. The left hand stud viewed from unexposed face was not fixed to the perimeter test frame, and the gap between the stud and the frame lining was filled with a 25mm rock mineral fibre gasket. At the right-hand end a Gypframe 70S50 'C' Stud was used to fix the partition to the test frame with 60mm fire resistant fixings at 600mm centres.

The framework was lined both sides with a double layer of 15mm Gyproc FireLine board. The inner layer was fixed around the perimeter with 25mm Gyproc drywall screws at 300mm centres. The outer layer was fixed around the perimeter and within the field of the board with 42mm Gyproc drywall screws at 300mm centres. All joints were staggered between layers.

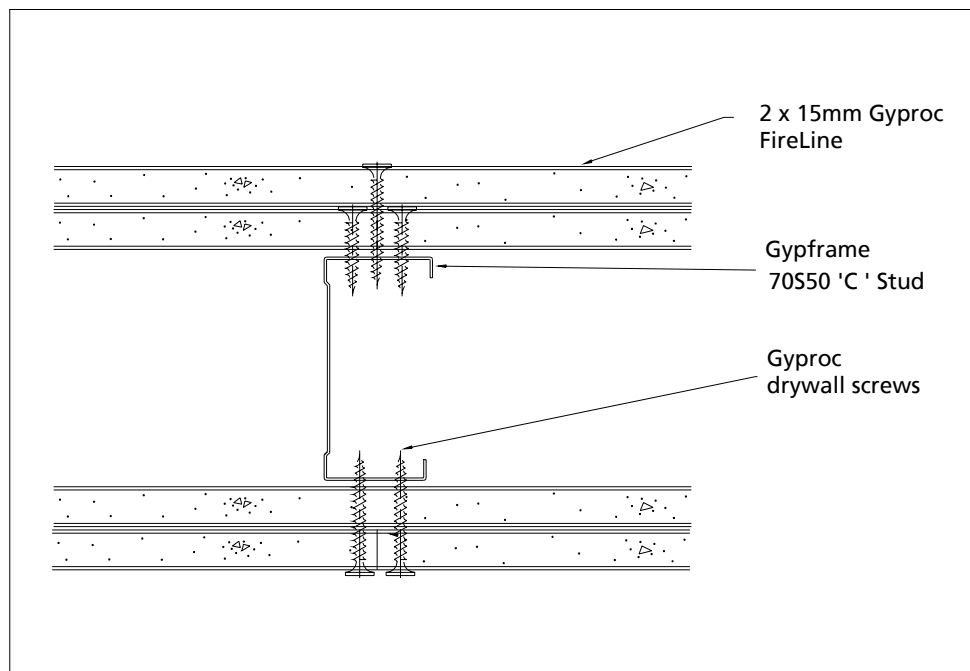
Horizontal joints were positioned 2700mm from the base for the outer layers on both the exposed and unexposed faces of the construction. Horizontal joints were positioned 300mm from the base for the inner layers on both the exposed and unexposed faces of the construction. A Gypframe GFS1 Fixing Strap was used behind the horizontal board joints in the outer layers.

All joints were taped and filled using Gyproc Paper Joint Tape and Gyproc Joint Filler. All screw heads were spotted using Gyproc Joint Filler.

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**DRAWING: DETAILS OF TEST EVIDENCE BTC 12785F**



**Figure 2 - Horizontal Cross Section**

The tested construction achieved the following results:

Integrity	164 minutes
Insulation	154 minutes

The test was carried out in accordance with BS EN 1364 - 1:1999, taking into account Fire Test Study Group standard interpretations where appropriate. The test was carried out on the 15<sup>th</sup> May 2003 at the Building Test Centre, UKAS accreditation No. 0296. The test was carried out on behalf of British Gypsum.

**Applicant:** British Gypsum



**BTC 12804F** – reviewed on 11<sup>th</sup> June 2009 BTC 16496FA

**A FIRE RESISTANCE TEST ON A BRITISH GYPSUM GYPWALL PARTITION CLAD WITH A DOUBLE LAYER OF 15mm GYPROC FIRELINE BOARD EACH SIDE OF GYPFRAME 70S50 STUDS WITH 50mm ISOWOOL IN THE CAVITY, CONDUCTED IN ACCORDANCE WITH BS EN 1364-1: 1999.**

The specimen was constructed in a refractory concrete lined steel restraint frame having an opening of 3000mm high x 3000mm wide.

Gypframe 72C50 Standard Floor & Ceiling Channels were fixed to the head and base of the test aperture at 600mm centres with 60mm fire resistant fixings. Gypframe 70S50 'C' Studs were positioned at 600mm centres between the channels. The right hand stud viewed from unexposed face was not fixed to the perimeter test frame, and the gap between the stud and the frame lining was filled with a 25mm rock mineral fibre gasket. At the left-hand end a Gypframe 70S50 'C' Stud was used to fix the partition to the test frame with 60mm fire resistant fixings at 600mm centres.

50mm Isowool Acoustic Partition Roll (1200) was located in the cavity.

The framework was lined both sides with a double layer of 15mm Gyproc FireLine board. The inner layer was fixed around the perimeter with 25mm Gyproc drywall screws at 300mm centres. The outer layer was fixed around the perimeter and within the field of the board with 42mm Gyproc drywall screws at 300mm centres. All joints were staggered between layers.

Horizontal joints were positioned 2700mm from the base for the outer layers on both the exposed and unexposed faces of the construction. Horizontal joints were positioned 300mm from the base for the inner layers on both the exposed and unexposed faces of the construction. A Gypframe GFS1 Fixing Strap was used behind the horizontal board joints in the outer layers.

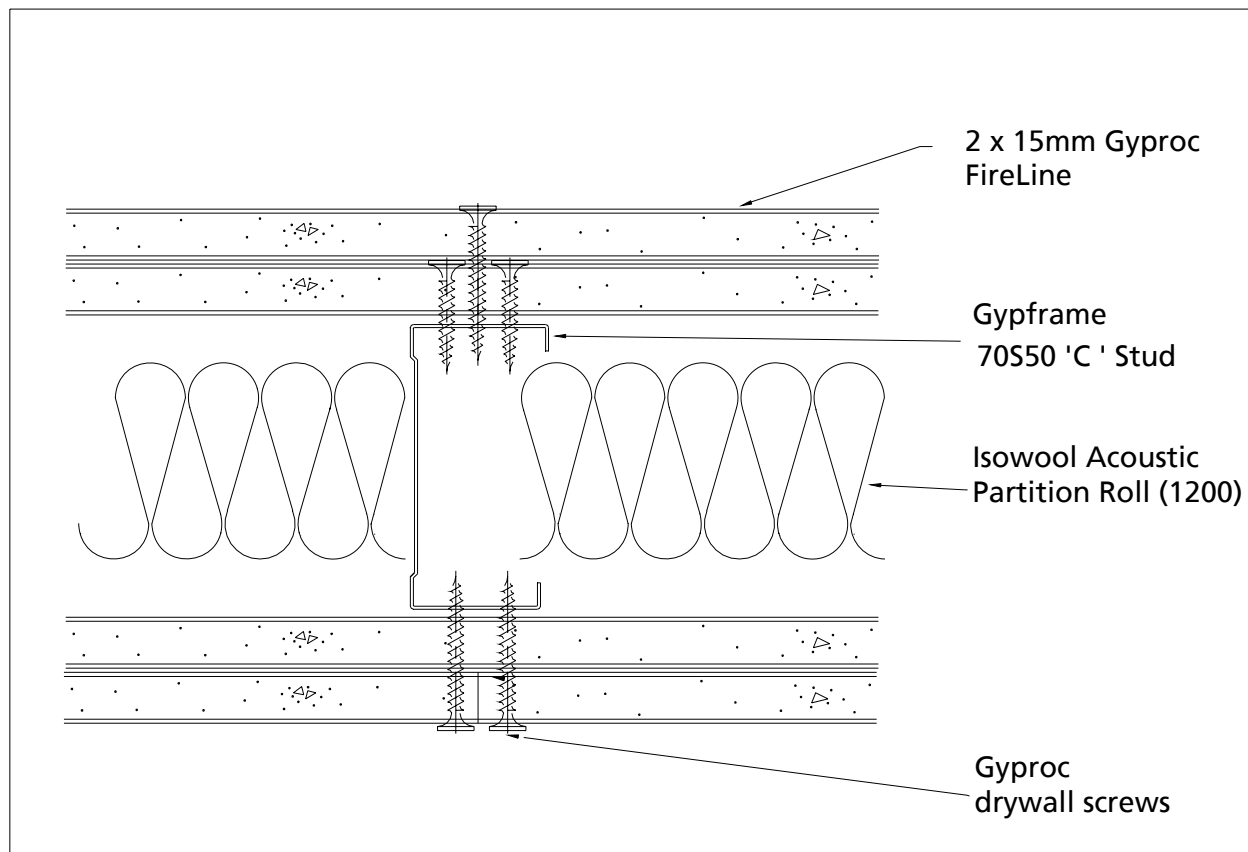
All joints were taped and filled using Gyproc Paper Joint Tape and Gyproc Joint Filler. All screw heads were spotted using Gyproc Joint Filler.

**Applicant:** British Gypsum





**DRAWING: DETAILS OF TEST EVIDENCE BTC 12804F**



**Figure 3 - Horizontal Cross Section**

The tested construction achieved the following results:

Integrity	167 minutes
Insulation	154 minutes

The test was carried out in accordance with BS EN 1364 - 1:1999, taking into account Fire Test Study Group standard interpretations where appropriate. The test was carried out on the 10<sup>th</sup> June 2003 at the Building Test Centre, UKAS accreditation No. 0296. The test was carried out on behalf of British Gypsum.

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## **DISCUSSION**

With non-loadbearing lightweight steel stud constructions, the duration of fire performance is governed by the level of protection offered by the exposed face and unexposed face linings and the support provided to these linings by the steel framework and fixings.

The construction described under DETAILS OF THE REQUEST varies from the tested construction detailed in test reports BTC 12785F and BTC 12804F. The variations are:

	<b>Requested construction</b>	<b>Tested construction (BTC 12785F)</b>	<b>Tested construction (BTC 12804F)</b>
<b>1. Stud dimension and channel</b>	92S50	70S50	70S50
<b>2. Height</b>	Maximum fire rated height obtainable	3m	3m
<b>3. Insulation</b>	25mm or 50mm	None	50mm APR 1200
<b>4. Insulation and integrity performance</b>	120 minutes	154 minutes	154 minutes

### **Stud dimension and channel**

The stud section dimensions and shape may be changed provided that:

- i) the proposed section has increased bending stiffness to the section tested (a C-stud can be substituted for an I-stud)
- ii) the stud gauge is not decreased
- iii) the stud material specification is not changed
- iv) the overall thickness of the partition is not decreased

The studs proposed under DETAILS OF REQUEST satisfy the above requirements.

### **Extension of height**

The fire resistance test standard BS EN 1364-1:1999 limits the height to which a fire rated partition may be built to a maximum of 4m using the concept of direct field of application. In order for the system to be built at a height greater than 4m an expert judgement must be conducted to ensure that the system wall will be stable in view of the induced thermal bow and strength loss in the studs in the fire state condition.

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To conduct an expert judgement it was necessary to position additional thermocouples on the hot and cold flanges of the studs during a standard 3m test. This data was then used to establish the height at which the system will be stable for a given fire duration. The Building Test Centre has developed a standard calculation protocol for evaluating the partition height of stud and sheet partition systems in the fire condition. The calculation protocol used is given in Appendix A

#### **BTC 12785F**

At the duration of 120 minutes the direct field of application lateral deflection rule does not limit the partition system (i.e. the specimen had not deflected more than 100mm) and the specimen had sufficient strength to allow an expert judgement to be conducted.

At a fire height of 6000mm and a duration of 120minutes, the partition is stable with head movement of 33.56mm. The partition becomes unstable at a height of 6100mm, at 113 minutes, with head movement of 26.77mm

#### **BTC 12804F**

At the duration of 120 minutes the direct field of application lateral deflection rule does not limit the partition system (i.e. the specimen had not deflected more than 100mm) and the specimen had sufficient strength to allow an expert judgement to be conducted.

At a fire height of 5000mm and a duration of 120minutes, the partition is stable with head movement of 40.87mm. The partition becomes unstable at a height of 5100mm, at 107 minutes, with head movement of 32.10mm

A negative head drop indicates the specimen has dropped vertically. A positive head drop indicates the specimen has expanded vertically.

It should be noted that the head drop of the system needs to be accommodated by the designer. A lesser head drop would be experienced if the system were to be constructed below the maximum height quoted above. Please consult the system manufacturer for more details on the design requirements.

#### **Height Restriction**

The specimen height shall be limited to either the maximum cold state height, or the maximum fire height of the partition, whichever is lower.

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### Insulation

BTC 12785F provides an accurate representation of the requested construction, without insulation. BTC 12804F provides an accurate representation of the requested construction, with 50mm APR insulation. It is therefore reasonable to assume, that the insulation and integrity performance of the requested construction, incorporating 25mm APR, would be at least equal to BTC 12785F

### CONCLUSION

In view of the foregoing evidence, it is our opinion that if the constructions described under DETAILS OF THE REQUEST were subjected to fire resistance testing, in accordance with BS EN 1364 - 1:1999, they would provide the following periods of fire:

Double layer 15mm Gyproc FireLine each side:

<b>Integrity:</b>	<b>120 minutes</b>
<b>Insulation:</b>	<b>120 minutes</b>

### LIMITATIONS

This assessment addresses itself solely to the ability of the partition system described to satisfy the criteria of the fire resistance test and does not imply any suitability for use with respect to other unspecified criteria.

This assessment is issued on the basis of test data and information to hand at the time of issue. If contradictory evidence becomes available to the assessing authority the assessment will be unconditionally withdrawn and the applicant will be notified in writing. Similarly the assessment is invalidated if the assessed construction is subsequently tested since actual test data is deemed to take precedence over an expressed opinion. The assessment is valid initially for a period of five years after which time it is recommended that it be submitted to the assessing authority for re-appraisal. The opinions and interpretations expressed in this assessment are outside the scope of UKAS accreditation.

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## **DECLARATION BY THE APPLICANT**

We the undersigned confirm that we have read and complied with the obligations placed on us by FTSG Resolution No. 82.

We confirm that the component or element of structure, which is the subject of this assessment, has not to our knowledge been subjected to a fire test to the Standard against which this assessment is being made.

We agree to withdraw this assessment from circulation should the component or element of structure be subjected to a fire test to the Standard against which this assessment is being made.

We are not aware of any information that could adversely affect the conclusion of this assessment.

If we subsequently become aware of any such information we agree to ask the assessing authority to withdraw the assessment.



Signed: ..... Print Name JONATHAN YOUNG

For and behalf of British Gypsum.

**Applicant:** British Gypsum



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**AUTHORITY FOR USE OF TEST EVIDENCE**

Test Report Numbers:        BTC 12785F and BTC 12804F

We the undersigned agree to the above Test Report being used as supporting evidence for the following assessment:

**A FIRE TEST ASSESSMENT TO BS EN 1364-1: 1999 ON A 5.0m BRITISH GYPSUM CLASSIC PARTITION CLAD WITH A DOUBLE LAYER OF 15mm GYPROC FIRELINE EACH SIDE OF GYPFRAME 92S50 STUDS INCORPORATING ISOVER APR 1200 IN THE CAVITY, CONDUCTED IN ACCORDANCE WITH F.T.S.G. RESOLUTION No. 82 /PFPF GUIDE.**

Assessment client:        British Gypsum

Signed: .....        Print Name JONATHAN YOUNG

Job Title:        PLASTERBOARD TECHNOLOGIST

Department: TECHNICAL

For and behalf of **British Gypsum**

**Applicant:** British Gypsum



## APPENDIX A- CALCULATION PROTOCOL

Below is the calculation protocol developed by The Building Test Centre for evaluating the partition height of stud and sheet partition systems in the fire condition.

### Step 1

Calculate weight  $\omega$  of wall per square metre i.e.  $\text{kg/m}^2 \times 9,81$ , and select a test height  $L$  mm.

It is essential to start with a low height such as 4000mm and work upwards in 1000mm increments. Once the shaft wall becomes unstable reduce the increments to 100mm until the critical height is found for the duration in question.

### Step 2

Obtain stud thickness  $t$  mm, stud spacing  $m$  mm, stud depth  $d$  mm, flange width  $f_w$  mm (Note 2). The yield stress  $\sigma$  is assumed to be  $= 210 \text{ N/mm}^2$

The Young's modulus  $E$  is assumed to be  $205000 \text{ N/mm}^2$ .

Obtain hot flange temperature  $T_h$  in deg C and cold flange temperature  $T_c$  at the time at which the stability is to be checked. (Note 3)

### Step 3:

Calculate the following terms:

$$k_h = 1 - T_h / 800$$

$$k_c = 1 - T_c / 800$$

$$k = k_c - k_h$$

### Step 4

Calculate the neutral axis  $y_n$  from the cold end:

$$y_n = \frac{f_w \cdot (k_h \cdot d + k_c \cdot t/2) + d^2 \cdot (k/6 + k_h/2)}{(k_h + k_c) \cdot (f_w + d/2)}$$

### Step 5

Calculate  $e = d - y_n$

and calculate the second moment of area of the stud  $I_h$  at elevated temperature:

$$I_h = t \cdot (f_w \cdot (k_h \cdot e^2 + k_c \cdot y_n^2) + e^3 \cdot (k_h/3 + k \cdot e/(12 \cdot d)) + y_n^3 \cdot (k_c/3 - k \cdot y_n/(12 \cdot d)))$$

### Step 6

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Calculate the Euler height under the above conditions:

$$L_e = ((2 \cdot \pi^2 \cdot E \cdot I_h \cdot 10^6) / (\omega \cdot m))^{0.3333}$$

Step 7

Check that height  $L$  is a lower value than the Euler height  $L_e$ .

If it is not lower then the shaft wall will be unstable regardless of any thermal bow. Otherwise proceed to step 8.

Step 8

Calculate the moment capacity  $M_s$  of the stud at elevated temperature:

$$M_s = t \cdot (f_w \cdot (k_h \cdot e + k_c \cdot y_n) + e^2 \cdot (k_h / 2 + k \cdot e / (6 \cdot d)) + y_n^2 \cdot (k_c / 2 - k \cdot y_n / (6 \cdot d))) \cdot \sigma$$

Step 9

Calculate the moment capacity  $M_c$  of the stud frame per metre width:

$$M_c = M_s \cdot 1000 / m$$

Step 10

Calculate the load  $P_e$ :

$$P_e = \pi^2 \cdot E \cdot I_h \cdot 1000 / (L^2 \cdot m)$$

Step 11

Calculate the thermal bow  $b$ :

$$b = ((14 \times 10^{-6}) \cdot L^2 \cdot (T_h - T_c)) / (8 \cdot d)$$

Step 12

Calculate the total weight  $P$  per metre width:

$$P = \omega \cdot L / 1000$$

Step 13

Calculate the additional bow  $b_e$  due to self weight from

$$b_e = b / (2 \cdot P_e / P - 1)$$

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**Step 14**

Calculate the term:

$$\alpha = 2 \cdot \tan^{-1} (2 \cdot (b + b_e) / L) \text{ ( in radians)}$$

**Step 15**

Calculate the moment  $M$  produced by the self-weight acting eccentrically:

$$M = (\omega \cdot L^2 \cdot \alpha \cdot (1 - \cos \alpha)) / (4 \cdot 1000 \cdot \sin^2 \alpha)$$

**Step 16**

Now compare the moment  $M$  with the moment capacity  $M_c$ .

If  $M$  is greater than  $M_c$  then the wall will be unstable and collapse.

If the wall is stable return to step 1 and increment the test height repeat this process until the maximum fire rated height is established to the nearest 100mm.

Note 1: Wall comprising metal C or I-studs lined each side with plasterboard. Plasterboard assumed to provide no extra stiffness to wall but its full weight to act downwards at all times. Wall assumed to be free at each side edge and with unrestrained head.

Note 2: Where the flange has a turn down this is included in  $f_w$  and where an I-stud has a double thickness due to folding, this is included in  $f_w$ .

Note 3: Temperature information can be obtained from a normal fire resistance test and should be available at every minute during the test. The calculation will need to be done at all time increments in case conditions exist whereby stability failure occurs. A number of studs will need thermocouples attached the data should be used from the most onerous stud position it is not correct to average this data. In the calculation, hot flange temperature  $T_h$  must be assigned a value of no greater than 800 deg C since metal strength is effectively zero above this value. If information is available on metal temperatures then this model assumes a linear temperature distribution across the web and the data must be persuaded to fit the model.

**Design aspects of fire rated shaft walls within buildings**

There are various design aspects which must be considered such as the total movement due to the bow and the movement at the head of the shaft wall.

Dealing with the total bow first, this can be calculated by adding the result from Steps 11 and 13 i.e. the thermal bow and the self-weight induced bow.

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The extent of the head movement depends on the net result of the vertical upward expansion due to temperature and the drop caused by the thermal bow.

The thermal expansion coefficient of steel is approximately  $14 \times 10^{-6}$  (between 100 and 700 degC) and therefore the upward expansion at the head  $y_u$  mm of the shaft wall is:

$$y_u = (14 \times 10^{-6}) \cdot L \cdot T_s$$

$T_s$  = stud average temperature in deg C (above ambient)

If the cladding material does not protect the steel studs adequately, then quite large expansion at the head is possible and clearly therefore, it is best not to allow the metal to get too hot!

This upward deflection however could be reduced by the effect of thermal bowing (and self weight) of the shaft wall and when a large bow is expected then the head detail might need to accommodate the shaft wall dropping at the head and yet still be adequately restrained laterally.

The head drop  $y_d$  mm caused by the bow is:

$$y_d = L \cdot (\alpha - \sin \alpha) / \sin \alpha$$

where  $\alpha = 2 \cdot \tan^{-1} ((2 \cdot b_t) / L)$  ( in radians)

and  $b_t$  = the total bow in mm (addition of Steps 11 and 13)

The resulting net movement at the head is  $y_u - y_d$