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Assessment Number **BTC 13271FA**

FIRE RESISTANCE ASSESSMENT COVERING TWIN FRAME HORIZONTAL BRITISH GYPSUM SHAFTWALL CEILING MEMBRANE CONDUCTED IN ACCORDANCE WITH F.T.S.G RESOLUTION No. 82 / PFPF GUIDE.

Assessment Date: 22nd March 2004

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Applicant: **British Gypsum Limited**
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DETAILS OF THE REQUEST

It is required to assess the following construction for fire resistance performance if tested in accordance with BS EN 1364-2: 1999.

A twin frame British Gypsum ShaftWall ceiling membrane test specimen is constructed as follows:

Upper frame specification:

Gypframe 148EDC80 Extra Deep Flange Floor and Ceiling Channels and Gypframe 146TSC90 Tabbed Starter Channels are fixed to the perimeter of the restraint frame. Gypframe 146TI90 'Tabbed' I Studs are positioned between the channels at 600mm centres (spanning 4000mm).

One layer of Gyproc CoreBoard is positioned between the studs and secured in position with Gypframe G102 Retaining Channels inserted between the back of the Gyproc CoreBoard and the tabs in the stud. Joints in the Gyproc CoreBoard are positioned at mid-span and are backed 122mm wide Gyproc CoreBoard fire stops. 600mm wide Gyproc CoreBoard fire stops are positioned between the Gyproc CoreBoard and the lower flange of the end channel in between each stud.

The undersides of the studs are clad with a double layer of 15mm Gyproc FireLine fixed perpendicular to the studs as follows:

The inner layer of boards is fixed at 234mm centres (6 fixings per board width) within the field of the board, 234mm centres around the ceiling perimeter (4000mm frame edge) and 200mm centres (3000mm frame edge) with 25mm Gyproc Jack-Point Screws.

The outer layer of boards is fixed at 234mm centres (6 fixings per board width) within the field of the board, 234mm centres around the ceiling perimeter (4000mm frame edge) and 200mm centres (3000mm frame edge) with 42mm Gyproc Jack-Point Screws.

Lower frame specification:

Gypframe 148EDC80 Extra Deep Flange Floor and Ceiling Channels and Gypframe 146TSC90 Tabbed Starter Channels are fixed to the perimeter of the frame aperture 20mm below the surface of the Gyproc FireLine (upper flange of channel). Gypframe 146TI90 'Tabbed' I Studs are positioned between the channels at 600mm centres (spanning 4000mm).

One layer of Gyproc CoreBoard is positioned between the studs and secured in position with Gypframe G102 Retaining Channels inserted between the back of the Gyproc CoreBoard and the tabs in the stud. Joints in the Gyproc CoreBoard are positioned at mid-span and are backed

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122mm wide Gyproc CoreBoard fire stops. 600mm wide Gyproc CoreBoard fire stops are positioned between the Gyproc CoreBoard and the lower flange of the end channel in between each stud.

Gypframe MF6A Perimeter Channels are fixed to the perimeter of the test directly below the Gypframe 148EDC80 Extra Deep Floor & Ceiling Channel/146TSC90 Tabbed Starter Channel framework. Gypframe MF5 Ceiling Sections are positioned in the Gypframe MF6A Perimeter Channels at 450mm centres perpendicular to the Gypframe 146TI90 'Tabbed' 'I' Studs.

A double layer of 15mm Gyproc FireLine is fixed perpendicular to the Gypframe MF5 Ceiling Sections as follows:

The inner layer is fixed at 234mm centres (6 fixings per board width) within the field of the board. The ceiling perimeter is fixed at 234mm centres along the short edges of the frame and at 225mm centres along the long edges of the frame with 25mm Gyproc drywall screws.

The outer layer is fixed at 234mm centres (6 fixings per board width) within the field of the board. The ceiling perimeter is fixed at 234mm centres along the short edges of the frame and at 225mm centres along the long edges of the frame with 42mm Gyproc drywall screws.

All joints are staggered between layers and board ends coincided with the Gypframe MF5 Ceiling Sections.

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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 Limited 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

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Project Leader

Reviewing Assessor

Eur Ing. Paul Howard
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Assessment Date 22nd March 2004.

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

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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 12167F

A fire resistance test on a timber joist ceiling membrane incorporating a single layer of 12.5mm Gyproc FireLine TE and 150mm Rockwool Roll, conducted in accordance with BS EN 1364-2: 1999

The specimen was constructed in a refractory concrete lined restraint frame with an overall opening of 4000mm long by 3000mm wide.

150mm x 38mm C16 grade timber joists were placed, nominally, at 600mm centres, spanning 4000mm length of the test frame. 38mm x 38mm noggings were fixed at each end of the joists (within the test aperture) and at 1200mm centres with 100mm round nails.

The underside of the timber joists was lined with a single layer of 12.5mm Gyproc FireLine, fixed perpendicular to the joists. The boards were fixed at 234mm centres within the field of the board and at 200mm centres around the ceiling perimeter using 40mm Gyproc Nails. All joints were staggered.

150mm Rockwool roll was laid between the joists and flush with the board surface.

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

The tested construction achieved the following results:

Integrity	30 minutes
Insulation	22 minutes

The test was carried out in accordance with BS EN 1364-2: 1999 taking into account Fire Test Study Group standard interpretations where appropriate. The test was carried out on the 29th July 2002 at the Building Test Centre, UKAS accreditation No. 0296. The test was carried out on behalf of British Gypsum Limited.

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BTC 12247F

A fire resistance test on a timber joist ceiling membrane incorporating a double layer of 12.5mm Gyproc FireLine TE and 150mm Rockwool Roll, conducted in accordance with BS EN 1364-2: 1999

The specimen was constructed in a refractory concrete lined restraint frame with an overall opening of 4000mm long by 3000mm wide.

150mm x 38mm C16 grade timber joists were placed, nominally, at 600mm centres, spanning 4000mm length of the test frame. 38mm x 38mm noggings were fixed at each end of the joists (within the test aperture) and at 1200mm centres with 100mm round nails.

The underside of the timber joists was lined with a double layer of 12.5mm Gyproc FireLine, fixed perpendicular to the joists. The inner layer was fixed at 230mm centres within the field of the board with 40mm Gyproc Nails. The outer layer was fixed within the field of the boards at 230mm centres and to the end noggings at 200mm centres with 50mm Gyproc Nails. All joints were staggered.

150mm Rockwool roll was laid between the joists and flush with the board surface.

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

The tested construction achieved the following results:

Integrity	46 minutes
Insulation	37 minutes

The test was carried out in accordance with BS EN 1364-2: 1999 taking into account Fire Test Study Group standard interpretations where appropriate. The test was carried out on the 29th August 2002 at the Building Test Centre, UKAS accreditation No. 0296. The test was carried out on behalf of British Gypsum Limited.

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BTC 13191F

A fire resistance test on a twin frame horizontal British Gypsum ShaftWall clad with 15mm Gyproc FireLine, conducted in accordance with BS EN 1364-2: 1999

The specimen was constructed in a refractory concrete lined restraint frame with an overall opening of 4000mm long by 3000mm wide.

Upper frame specification:

Gypframe 148EDC80 Extra Deep Flange Floor and Ceiling Channels and Gypframe 146TSC90 Tabbed Starter Channels were fixed to the perimeter of the restraint frame. Gypframe 146TI90 'Tabbed' I Studs were positioned between the channels at 600mm centres (spanning 4000mm).

One layer of Gyproc CoreBoard was positioned between the studs and secured in position with Gypframe G102 Retaining Channels inserted between the back of the Gyproc CoreBoard and the tabs in the stud. Joints in the Gyproc CoreBoard were positioned at mid-span and were backed 122mm wide Gyproc CoreBoard fire stops.

The underside of the studs were clad with a single layer of 15mm Gyproc FireLine fixed perpendicular to the studs as follows:

The layer of board was fixed at 234mm centres (6 fixings per board width) within the field of the board, 234mm centres around the ceiling perimeter (4000mm frame edge) and 200mm centres (3000mm frame edge) with 25mm Gyproc Jack-Point Screws.

Lower frame specification:

Gypframe 148DC60 Deep Flange Floor and Ceiling Channels and Gypframe 146TSC90 Tabbed Starter Channels were fixed to the perimeter of the frame aperture 20mm below the surface of the Gyproc FireLine (upper flange of channel). Gypframe 146TI90 'Tabbed' I Studs were positioned between the channels at 600mm centres (spanning 4000mm).

One layer of Gyproc CoreBoard was positioned between the studs and secured in position with Gypframe G102 Retaining Channels inserted between the back of the Gyproc CoreBoard and the tabs in the stud. Joints in the Gyproc CoreBoard were positioned at mid-span and were backed 122mm wide Gyproc CoreBoard fire stops.

Gypframe MF6A Perimeter Channels were fixed to the perimeter of the test directly below the Gypframe 148DC60 Deep Floor & Ceiling Channel/146TSC90 Tabbed Starter Channel framework. Gypframe MF5 Ceiling Sections were positioned in the Gypframe MF6A Perimeter Channels at 450mm centres perpendicular to the Gypframe 146TI90 'Tabbed' 'I' Studs.

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A double layer of 15mm Gyproc FireLine was fixed perpendicular to the Gypframe MF5 Ceiling Sections as follows:

The inner layer was fixed at 234mm centres (6 fixings per board width) within the field of the board. The ceiling perimeter was fixed at 234mm centres along the short edges of the frame and at 225mm centres along the long edges of the frame with 25mm Gyproc drywall screws.

The outer layer was fixed at 234mm centres (6 fixings per board width) within the field of the board. The ceiling perimeter was fixed at 234mm centres along the short edges of the frame and at 225mm centres along the long edges of the frame with 42mm Gyproc drywall screws.

All joints were staggered between layers and board ends coincided with the Gypframe MF5 Ceiling Sections.

All joints and screw spots were finished using Gyproc Joint Tape and Gyproc Joint Filler.

The tested construction achieved the following results:

Integrity	117 minutes
Insulation	117 minutes

The test was carried out in accordance with BS EN 1364-2: 1999 taking into account Fire Test Study Group standard interpretations where appropriate. The test was carried out on the 3rd February 2002 at the Building Test Centre, UKAS accreditation No. 0296. The test was carried out on behalf of British Gypsum Limited.

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DISCUSSION

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

The constructions detailed under DETAILS OF REQUEST have the same level of lining protection to the lower frame. The only change to the tested construction being the addition of an extra layer of board to the upper frame and the addition of fire stops in the end channels of both frames.

Changes in the ceiling board can only be assessed where appropriate test evidence exists.

The above test evidence shows the fire rated performance achieved by the timber joist ceiling membranes increased with the addition of an extra layer of board. The ceiling membrane with the double layer of 12.5mm Gyproc FireLine achieved an increase in performance of 68% over the single layer ceiling.

Even though this increase is based on test data from timber-joisted ceilings the same theory can be applied to metal framed ceilings. The additional layer of board will provide better protection to the metal framing because the board joints are staggered, therefore the hot gases cannot directly affect the studs. Also increasing the overall board thickness reduces the rate of heat transferred to the metal framework, hence the specimen will distort less quickly.

The increase in performance is based on single frame test specimens so applying the same percentage increase to a twin construction would not be suitable. The second frame would be subjected to a temperature around 1000°C not the initial temperature of an unlit furnace. Instead the increase in performance should be applied to the upper frame's ability to resist the fire, e.g. the time it takes for the board to fall into the furnace. This is a valid assumption because it keeps the increase in performance relative to the actual specimen and the furnace conditions.

Applying the total percentage increase in performance from adding an extra layer of board to a ceiling membrane would, perhaps, give an over optimistic prediction so using a conservative percentage increase in performance of 50% would be a more suitable.

Therefore it can be assumed that increasing the number of layers of boards from one to two on the upper frame of a twin frame construction will increase the fire resistance performance of the upper frame by 50%.

The metal framework of a ceiling can support a maximum load over a certain span but an extra layer of boards may take the total ceiling weight over this limit. The metal studs used in

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BTC 13191F were 146mm deep x 0.9mm thick Gypframe 146TI90 'Tabbed' I Studs which are able to support a load of 79kg/m^2 over a span of 4000mm. A single layer of 15mm Gyproc FireLine subjects the framework to only 15% of the maximum design load and a double layer of 15mm Gyproc FireLine will subject the framework to only 30% of the maximum design load. Therefore the metal framework will be able to support the extra layer of boards without exceeding its maximum design load. {See Appendix One for calculation details}.

Positioning fire stops, sections of 19mm Gyproc CoreBoard, in the end channels of both frames would not affect the fire performance detrimentally. The fire stops will reduce the volumes of hot gases penetrating the perimeter of the ceiling and affecting the upper surface of the frame by creating a seal between the Gyproc CoreBoard, Gypframe metal framework and the fire stop. The fire stops shall be friction fitted in between the studs.

From observations made during the fire test of BTC 13191F we can calculate the increase in fire resistance performance. The upper frame was fully exposed to the furnace conditions after 1 hour and 40 minutes when the lower frame fell into the furnace. The single layer of boards stayed in position until 1 hour 55 minutes, which equates to a performance of 15 minutes. Applying the above assumption to the performance of the single layer it would be expected that a double layer of boards would achieve a fire resistance performance of 22 minutes. This would increase the overall fire resistance performance to 124 minutes.

The combination of the above test evidence suggests that a twin frame horizontal British Gypsum ShaftWall with the lower frame clad with a double layer of 15mm Gyproc FireLine fixed to Gypframe MF5 Ceiling Sections and the upper frame clad with a double layer of Gyproc FireLine fixed directly to the studs, with fire stops positioned in the end channels of both frames, will achieve a fire rated performance of 120 minutes according to BS EN 1364-2: 1999.

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CONCLUSION

In view of the foregoing evidence, it is our opinion that if the construction described under DETAILS OF THE REQUEST were subjected to fire resistance testing, in accordance with BS EN 1364-2: 1999, it would provide the following periods of fire:

Integrity:	**120 minutes**
Insulation:	**120 minutes**

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 .....

For and behalf of British Gypsum Limited.

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AUTHORITY FOR USE OF TEST EVIDENCE

Test Report Numbers: BTC 12167F, BTC 12247F & BTC 13191F

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

FIRE RESISTANCE ASSESSMENT COVERING TWIN FRAME HORIZONTAL BRITISH GYPSUM SHAFTWALL CEILING MEMBRANE CONDUCTED IN ACCORDANCE WITH F.T.S.G RESOLUTION No. 82 / PFPF GUIDE.

Assessment client: British Gypsum Limited

Signed: ..... Print Name .....

Job Title: .....

Department: .....

For and behalf of **British Gypsum Limited**

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APPENDIX ONE

Calculation method used to determine the maximum load a steel stud can support.

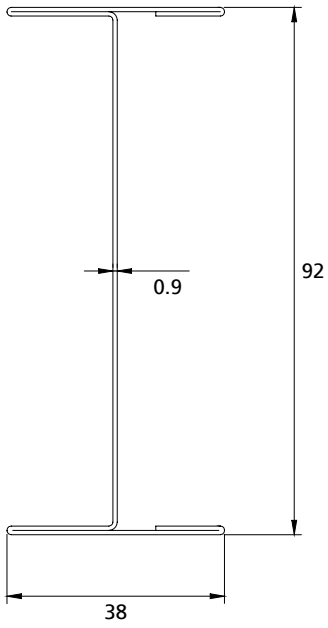

Figure 1. Cross-sectional view of a Gypframe 92I90 'I' Stud.

Stud properties:

Moment of inertia, I	=	30.52 cm^4
Section modulus, Z	=	6.7 cm^3
Modulus of Elasticity, E	=	205GPa
Yield stress, Y	=	140Gpa
Deflection limit, δ	=	200mm
Stud centres, c	=	600mm
Factor of safety, fs	=	1.6
Gravity	=	9.81 ms^{-2}

Step 1. Calculate the load capacity of the stud at certain spans (in mm) to determine the maximum load the stud can support.

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$$\text{Load capacity} = \frac{\frac{8 \times \text{Bending Moment}}{\text{Span}}}{\text{Factor of safety}}$$

where Bending moment = Yield stress x Section modulus

$$\therefore \text{ Load capacity} = \frac{\frac{8 \times Y \times Z}{L}}{fs}$$

Step 2. Calculate the load required to deflect the stud over the deflection limit at certain spans.

$$\text{Deflection, d} = \frac{\text{span}}{\text{deflection limit}}$$

$$\text{Deflection load} = \frac{384}{5} \times \frac{\text{deflection} \times \text{Modulus of Elasticity} \times \text{Moment of inertia}}{\text{span}^3}$$

$$\therefore \text{ Deflection load} = \frac{384}{5} \times \frac{d \times E \times I}{L^3}$$

Step 3. Determine the minimum of the two loads and calculate the maximum surface density the metal stud framework can support.

$$\text{Maximum surface density} = \frac{\text{Minimum load}}{\frac{\text{Span}}{1000} \times \frac{\text{Stud centres}}{1000} \times \text{gravity}}$$

$$\therefore \text{ Maximum surface density} = \frac{\text{Miminum load}}{\frac{L}{1000} \times \frac{c}{1000} \times g} \quad \text{kg/mm}^2$$

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