



Passive Fire Protection



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Time allowance:	1 hour
Presentation CPD Points:	5 CPD Points
Post presentation online quiz:	5 CPD points



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**What is a fire
resistance rating?**

What is a Fire Resistance Rating?

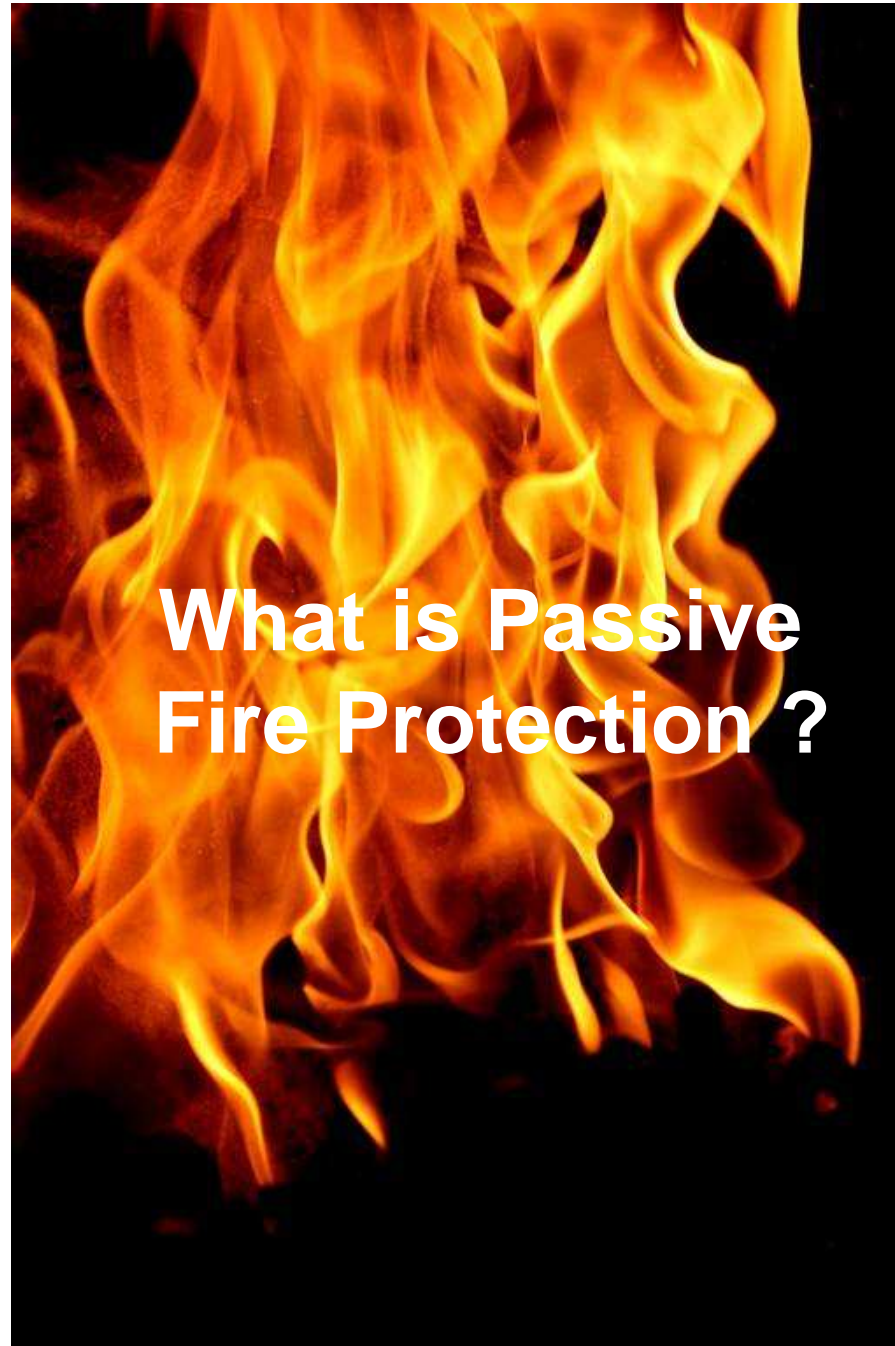
- The period of time for which the element must remain protected is the Fire Resistance Rating (FRR)
- The FRR is the term used to describe “the minimum *fire* resistance required of *primary* and *secondary elements* as determined in the *standard test* for *fire* resistance, or in accordance with a specific calculation method verified by experimental data from standard *fire* resistance tests” (NZBC).
- It comprises three numbers (e.g.. 60/60/60) giving the time in minutes for each of the three criteria:
 - *Stability*
 - *Integrity*
 - *Insulation*
- They will range from 0 to 240 minutes under each of the criteria e.g.. 60/60/0 and are always stated in that order



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What is Passive Fire Protection ?

What is passive fire protection?

- Passive fire protection, as the name suggests, is:

“the non active elements that are built into the building fabric to provide protection for the structure and occupants in the event of a fire”

- Typically, the purpose of passive fire protection products are to maintain the temperature on the protected side of an element, such as a wall, below 140 degrees C for a prescribed period of time

- Or, in the case of a structural element, to maintain the temperature of the element below 450 degrees C, as this is the temperature above which steel will deform and/or lose strength



What is passive fire protection?

- Passive Fire Protection includes the separation into compartments of the overall building through the use of fire-resistance rated walls and floors
- It may also involve the organization into smaller fire compartments, consisting of one or more rooms or floors
- The goal of passive fire protection is to prevent or slow the spread of fire from the room or place of fire origin to other building spaces
- It is also designed to limit the damage to the source and surrounding buildings
- Most importantly however, the goal of passive fire protection is to provide sufficient time for the building occupants to either evacuate the building, or to reach an area of safe refuge

What is passive fire protection?

Passive fire protection includes:

- penetration management
- cavity barriers
- ceiling systems
- compartment walls
- ducting
- gap and joint seals
- structural steel protection

It is one of the three components offering protection in a commercial building

The other two are:

- Active fire protection such as heat sensors, smoke detectors, curtains and alarms, sprinklers, fire doors, etc.
- Fire prevention includes minimizing ignition sources, as and emergency procedures such as notification for fire service response and emergency evacuation

The current state of passive fire protection

- A recent survey carried out by the Passive Fire Association revealed that many buildings have inadequate, incorrectly installed, poorly maintained and/or compromised passive fire protection
- The survey stated that the fundamental problem with passive fire protection is that “a very minor omission can have catastrophic consequences with respect of the overall fire safety of the building occupants”
-



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The current state of passive fire protection



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The current state of passive fire protection

- They go on to state that “this is in stark contrast to general building construction where minor omissions are dealt with very effectively by safety factors and redundancy in design”
- The most common area for non compliance was ‘services’ penetrating through fire rated elements; often due to the lack of co-ordination of different trades
- In new buildings the survey found that there is a lack of understanding of the requirements under the Building Act
- This extended from the installers, though the other trades, the building inspectors and building managers.
- This was further complicated by the lack of industry knowledge of the requirements and specifications of the products being used
- There are further little in the way of checks and balances to ensure the correct product has been specified, the same product has been supplied and that it has been correctly installed, and maintained.

The current state of passive fire protection

- In older buildings the survey found that one of the greatest issues was the continued upgrade and refurbishment work was often done, leaving old services in place
- Further, in older buildings, where passive fire protection had been installed, new penetrations were often not carried out in compliance with the NZBC
- The fire stopping membrane had been penetrated and the fire stopping was then not reinstated to the requirements of the NZBC.

Passive fire products can be broken down into 4 main areas of application:

- Structural steelwork (Framework)
- Spread of flame to adjacent spaces
- Plenum spaces (including ducts)
- Service penetrations through walls and floors



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What is Passive Fire Protection to Structural Steel ?

Passive Fire Protection for structural steel

- In order to maintain a structural steel elements integrity over time in a fire, the steel structure will generally require protection
- The amount of protection required is dependant on the elements ability to absorb heat without the temperature of the element reaching a point at which there is the potential for failure of the steel
- This degree of protection requirement is determined by calculating its mass and surface area to establish the steel's Heated Perimeter / Area factor or "**Hp/A factor**"
- The Hp/A factor relates the time, in a fire, that it would theoretically take the beam to heat to a temperature of 450 degrees C.
- Above this temperature, steel will weaken and may collapse under load
- The higher the Hp/A, the more protection is required to achieve the same fire rating; be it 30, 60, 90, 180 minutes

Hp/A factors

➤ The Hp/A factor of a beam or column varies according to both its:

- cross sectional size
- its proportions (of width to height)
- its density (or weight per lineal metre)

➤ For example:

A 610 x 305mm beam with a mass of 179kg/m will have an Hp/A of 80

A 250 x 102mm beam with a mass of 25kg/m will have an Hp/A of 110

- While both beams have similar sectional proportions, the higher density of the first beam means it is more able to absorb heat; hence it has a lower Hp/A

Hp/A factors

- To reduce the Hp/A on a steel section, and reduce the passive fire requirements you might consider:
 - increasing its sectional thickness/mass
 - Changing the proportions or cross sectional area; a tall, narrow beam will have a higher Hp/A than a short, wide beam
- It is important also to note that the number of exposed sides will also greatly affect a column or beams Hp/A factor

For example, for the 610 x 305mm beam above

- A four sided exposure means an HPA of 80
- A three sided exposure means an Hp/A of 70
- And to an Hp/A of just 40 if only two sides are potentially exposed

Passive fire protection to structural steel

To provide passive fire protection to structural steel, there are two primary options:



Claddings

Which are made up of various board products



Coatings

Which are made up of sprayed cementitious or gypsum based high build coatings and intumescent paints

Board products

- The board products are generally manufactured from:
 - non-combustible ceramic fibre
 - mineral fibres, such as gypsum, calcium silicate
 - Rockwool/Stone wool
 - Vermiculite containing materials
- They are specifically designed to absorb and dissipate heat
- They have a measurable time/temperature performance for thickness
- And can be easily specified by thickness to achieve an acceptable passive fire rating



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Board Products

Board products

- Like all products that contribute to the structural integrity of the building, the installation of the board product is critical
- In particular, joints and junctions should be handled as per the manufacturers recommendations
- However, unlike specialist coatings, board products can generally be installed without the preparation or priming of the structural steel element
- Further, they can be installed using normal wood working tools and without the need to engage a specialist sub trade
- Board products will also not give off toxic smoke or gases in the event of a fire

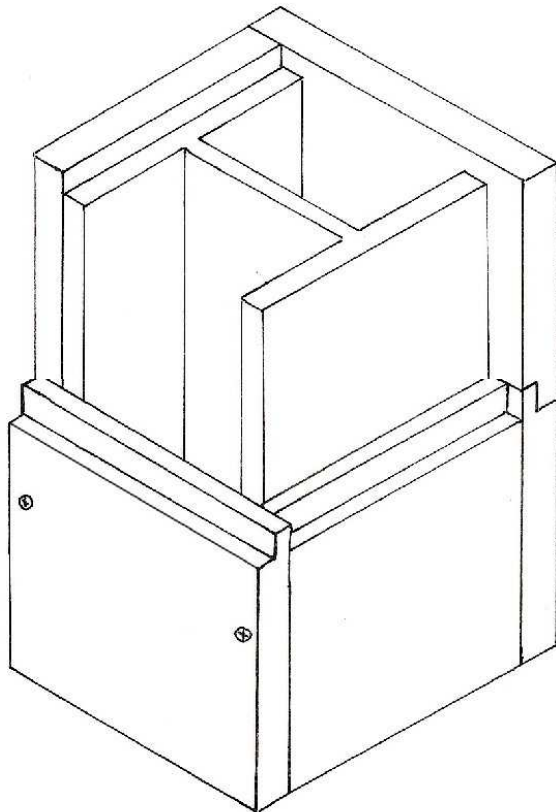


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Board products - Calcium Silicate core board



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High Density Rockwool Board

- High Density Rockwool Board is manufactured from a melt of volcanic rock. The molten rock is spun into a wool and immediately impregnated with special resins for handling and shaping
- The material is then compressed, cured and formed into boards.
- They are engineered to provide the maximum fire protection for the least possible weight and thickness
- They can be used to provide up to 120 minute fire resistance ratings to ventilation and smoke extract steel ductwork
- They can provide up to 240 minutes fire resistance ratings to structural steel
- Can be used for the protection of structural steel, ducting and concrete floors

Board products – Rockwool board

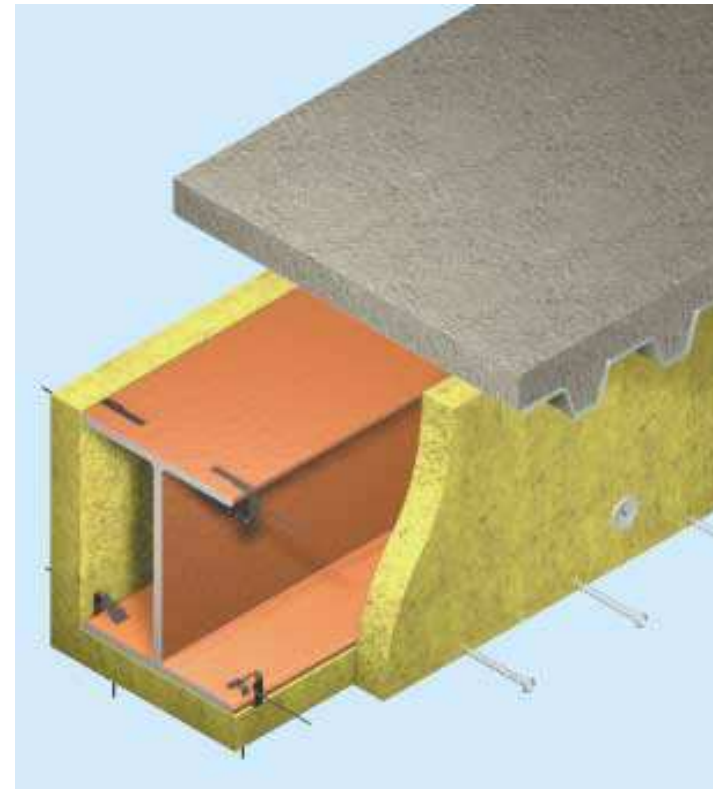


Board products with compressed, resin bonded Rockwool core; available with plain, foil of white glass tissue face



High Density Rockwool Board

- Square edged board eliminates the need for framing around structural members
- Alternatively stud welds can be used to eliminate the need for noggings
- Advantages include:
 - Single layer
 - Fast installation
 - Dimensionally stable
 - Moisture repellent





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Coatings for Structural Steel



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Intumescent Paints



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Intumescent Paints

- Intumescent coatings offer the most complex method of providing structural fire protection
- They work by changing their nature from a decorative paint into an intumescent layer of carbonaceous char
- The use of intumescent paints on steel **requires blast cleaning of the steel and suitable primers and topcoats**
- **A sealer coat is normally required** and steel again must be blast cleaned and primed
- Without specialist equipment, it is very difficult to check the quality and thickness of the application
- It is very important therefore to use manufacturer approved applicators and to ensure they follow the manufacturers recommendations

How Intumescent Work

- When the intumescent is heated to above 200C, the resin system will melt
- This melting allows the release of a mineral acid, which reacts with a carbon rich element in the paint
- Also released at the same time is a 'spumific', which provides a gas which expands the foam; forming a thicker layer
- As the fire progresses and time passes this layer of char grows thicker thus increasing the insulation provided
- The outer surface of it finally becomes soft and friable rather in the same way as the charcoal on a barbecue turns into a dry white powder
- This layer of char can be up to 50 times the thickness of the initial coat





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Sprayed cementitious or gypsum products



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Sprayed cementitious or gypsum products

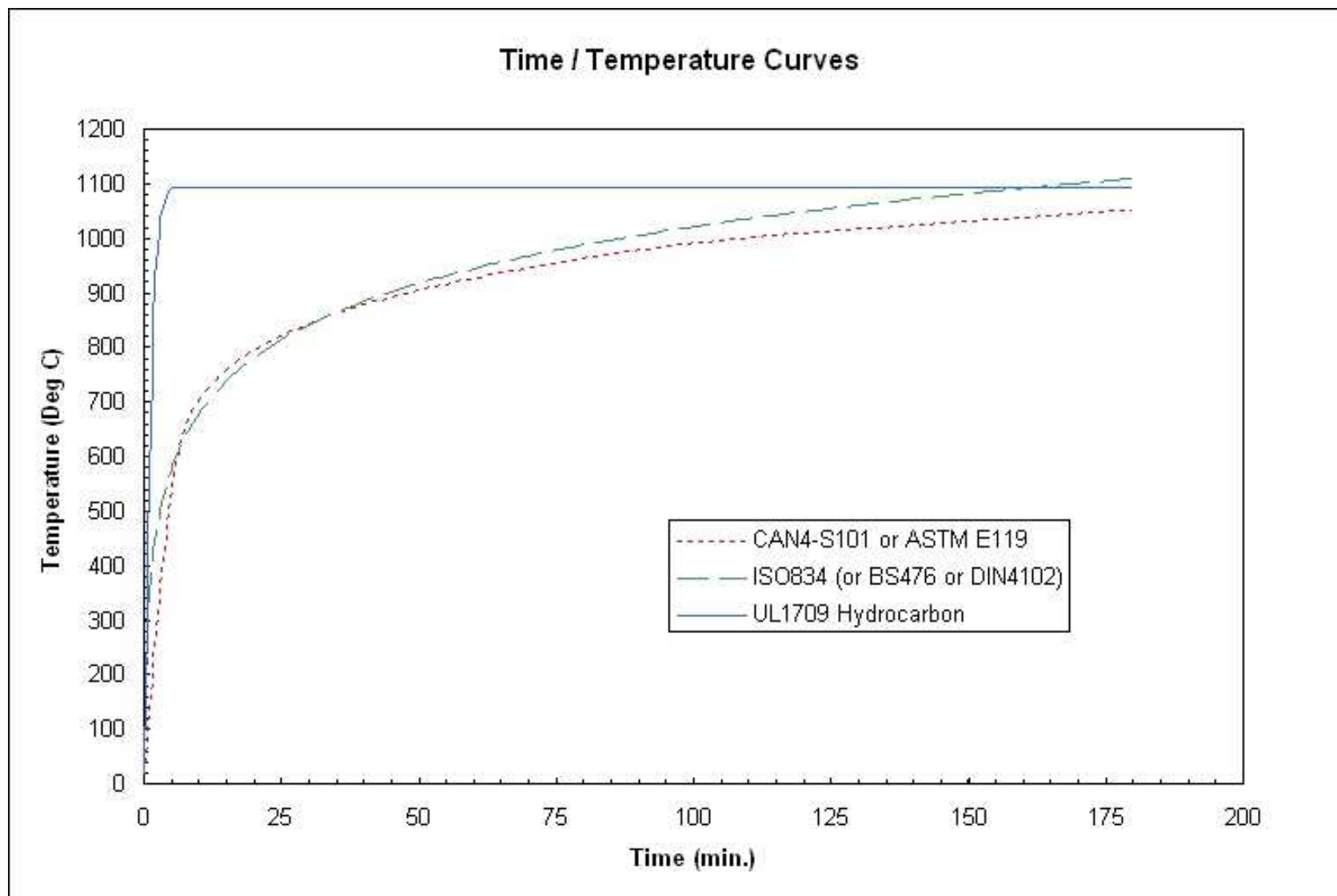
- Spray applied fire resistant materials are the most common and widely used fire protection for structural steel
- It is a technology that has been around for some time
- It is quick, relatively forgiving of complex structural connections and cost effective where the architectural appearance is not required.
- The high build coatings are applied as a wet spray, where the product is pre mixed with water, or as a dry spray, where the water is added at the nozzle.
- Can provide up to 4 hours passive fire protection
- As with intumescent paint coatings, the manufacturers recommendations need to be followed closely to ensure the correct preparation, including primers and bond coats, have been used
- The high build cementitious coating system was used on structural beams in the Christchurch Police Station; it has survived two close proximity large fires, without any degradation of the steel it protects

Sprayed cementitious or gypsum products

- In addition to its use as a coating over structural steel, high build cementitious coating system can also be used as an applied protection over other flammable linings and coatings
- These include applications such as for the fire rating of polystyrene lined buildings and polyurethane sprayed cool stores
- Sprayed cementitious coating systems are also available for the hydrocarbon fires
- Hydrocarbon fires have a very different time temperature curve with a much more rapid increase in temperature and burn at a much higher temperature



Time Temperature Curves





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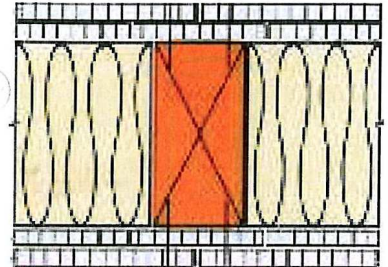
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Passive Fire Protection to Adjacent Spaces

Passive fire protection to adjacent spaces

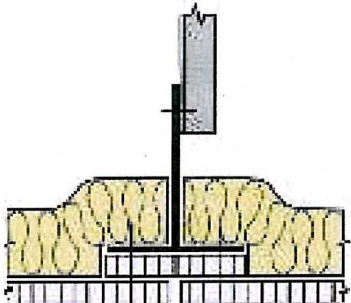
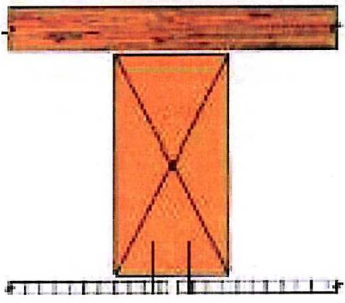
- This is an area very well served by Winstone Wallboards
- Forman do however have tested fire rated wall systems using various combinations of board product on steel or timber framing
- These are designed to prevent the spread of fire and protect adjacent spaces

	<p> FRR: Test Method: Authority Steel Frame: Mineral wool: 9mm Supalux coverstrips: Estimated Sound Reduction: </p>	<p> -/30/30 BS476 : Part 8 : 1972 FIRTO Report TE 4566 48mm x 35mm x0.5mm channel studs at max. 610mm centres 60mm thick (23kg/m³ density) between studs 75mm wide, behind horizontal joints, fixed on both sides of the joint with 19mm x No. 8 self-tapping screws. All fixings at max. 300mm centres 35dB in the range 100 to 3150 Hz </p>
	<p> FRR: Test Method: Authority: Timber Frame: Mineral Wool: 9mm Supalux Coverstrips: 9mm Supalux: </p>	<p> -/120/120 BS476 : Part 8 : 1972 LPC letter CC 10947 RHE/MB Nominal 100mm x 50mm studs at max. 610mm centres 100mm thick (100kg/m³ density) between studs 75mm wide, behind horizontal joints fixed on both sides </p>

Passive fire protection to adjacent spaces



These tested systems also include protection for ceiling and soffit applications

	<p> FRR: Test Method: Authority Grid: Mineral wool: 9mm Supalux fillets: 9mm Supalux ceiling: </p>	<p> 120/120/120 BS 476 : Part 8 : 1972 FROSI 6554 38mm x 38mm x 20g steel main and cross tees\ Min 30mm thick (64kg/m3 density) To face of grid 1200mm x 1200mm fixed with 30mm x no.6 self-tapping screws in the position indicated under suspended fixing details. </p>
	<p> FRR: Test Method: Test Report/Opinion Flooring: Timber Joists: Ceiling: Fixings </p>	<p> 30/30/30 BS 476 : Part 8 : 1972 TRADA Report FR303 T & G Board minimum 19mm Minimum 45mm thick at maximum 406mm centres 6mm Supalux 50mm nails at 200mm centres </p>



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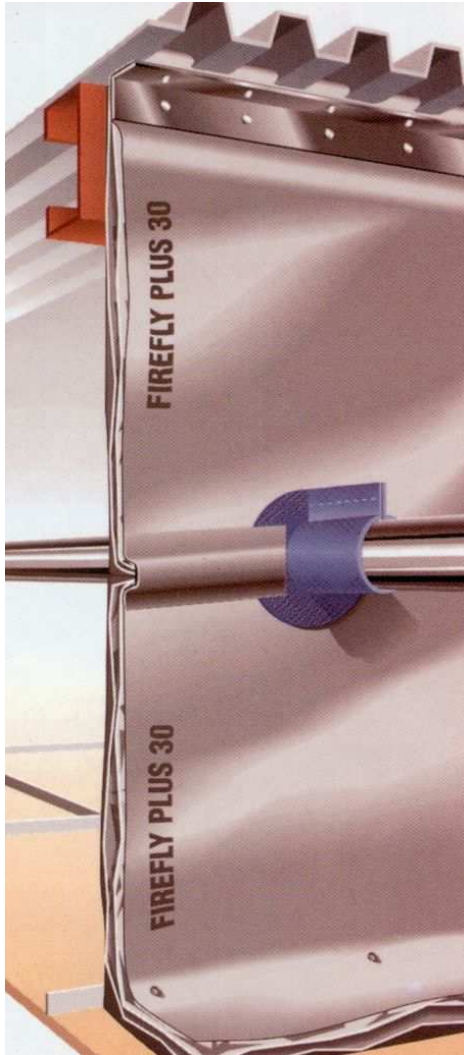


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Passive Fire Protection to Plenum Spaces

Passive fire protection to plenum spaces



- The service spaces above suspended ceilings provide an excellent path for the spread of fire in a building
- Internal walls often stop at the underside of the suspended ceiling, leaving the spaces above open for services and ducting
- With the modern day expectation of flexibility and re-use, the ability to provide contained fire compartments also becomes more complex
- Light weight and flexible, smoke and flame barriers allow the designer the ability to compartmentalize the ceiling space along with the spaces beneath
- They can also be used as down light covers in fire rated ceilings
- Further, as the building layout and/or use changes over time, a barrier can be removed or installed with relative simplicity

Passive fire protection to plenum spaces



Passive fire protection to plenum spaces



- Also available are canopies and down light covers that give up to a FRR -/60/60 under concrete and steel and up to a -/60/30 FRR under timber flooring
- Manufactured from clean, lightweight, non-respirable materials, can be fitted in minutes and no additional support hangers are required
- Suitable for both exposed grid, plasterboard and suspended ceilings and can be fitted from above or below



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Fire Rated Access Hatches



- Where access is required to services concealed in the plenum space (such as mechanical equipment, electrical installations and data cabling), the integrity of the fire cell needs to be maintained
- Fire rated access can be achieved with the use of fire rated access hatches
- These can provide a FRR of up to 120/120/120
- They ensure maintenance, upgrade and refurbishment work does not compromise the integrity of the fire compartment





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The background of the slide is a large, vertical image of intense orange and yellow flames against a black background. The title 'Passive Fire Protection to Ducts' is centered over the flames in white text.

Passive Fire Protection to Ducts



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Passive fire protection to ducts



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Passive fire protection to ducts

- Another significant potential source of fire spread in a building are the air conditioning ducts
- Sheetmetal air ducts are a great way to transfer a fire both horizontally and vertically throughout a building
- When specifying the passive fire protection of a duct you need to consider the potential location of the fire source; is the source external, internal or both?
- You also need to consider contributing factors that may not be present at the time of design and installation; such as the build up of grease in the extraction system of a kitchen
- External protection is generally provided with a calcium silicate board, Rockwool, mineral wool or a high build cementitious spray



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Passive Fire Protection to Penetrations in Walls and Floors

Penetrations through walls and floors

- The performance of a fire wall is only as good as its weakest point
- When penetrations are made through a wall they need to be treated correctly
- As was highlighted at the start of this presentation, penetrations through fire walls are an area where there is much room for improvement

Penetrations through walls and floors

Depending on the penetration type, a range of solutions can be used

The main types of passive fire protection for penetrations are:

- Cementitious Mortars
- Pillows
- Intumescent and Smoke Sealants
- Expanding felts
- Intumescent Collars
- External and Internal Dampers
- Intumescent Wraps

Penetrations through floors

- In the case of vertical penetrations such as pipe risers and ducting the most cost effective solution is the use of a **Cementitious Mortar**
- Specialist fire rated mortars allow the achievement of fire resistance ratings over and above that which would be achieved with a standard concrete of the same thickness
- For example one proprietary product achieves a 2 hour FRR with only 75mm of thickness
- For larger penetrations, **Fire Rated Board** systems, offering fire resistance ratings of up to 4 hours, are also available
- They can be supplied as non load bearing or with plywood facings, suitable for carrying small loads



Penetrations through floors

- For smaller penetrations, such as cable trays and pipe penetrations where the use of a mortar or sealant is impractical, **Fire Proof Pillows** are an excellent option
- Filled with either Rockwool or intumescent material, fire pillows come in a range of standard sizes
- They can be compressed to fill small openings (up to 0.5m²)
- Remaining voids (those less than 20mm in width) are then dealt with via an intumescent type sealant





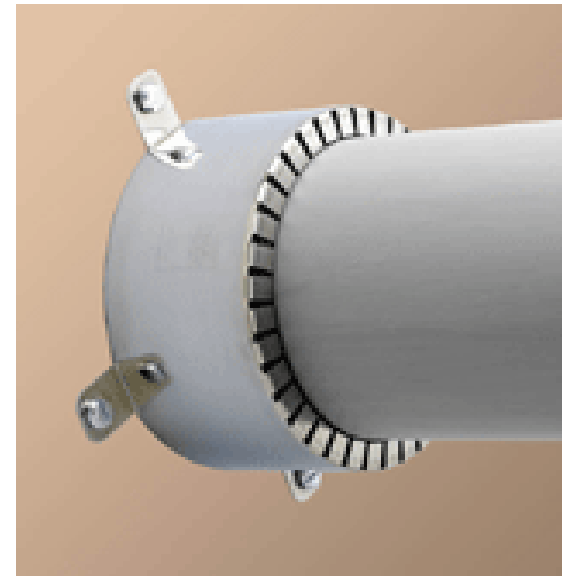
Penetrations through walls and floors

- For construction joints of up to 50mm wide a high temperature, organic binder free, **'Superwool' ceramic fibre blanket** can be used
- The joint is filled at 20% compression
- Dependant on the concrete thickness and the depth of the blanket, this solution can offer a FRR of up to 4 hours
- For joints subject to movement, **Expanding Felts** are often specified
- Expand up to 300% of their original volume when heated
- Offer excellent protection from fire and smoke
- Suit applications such as seismic joints and can be used on joints up to 140mm in width and offer a FRR of up to 4 hours



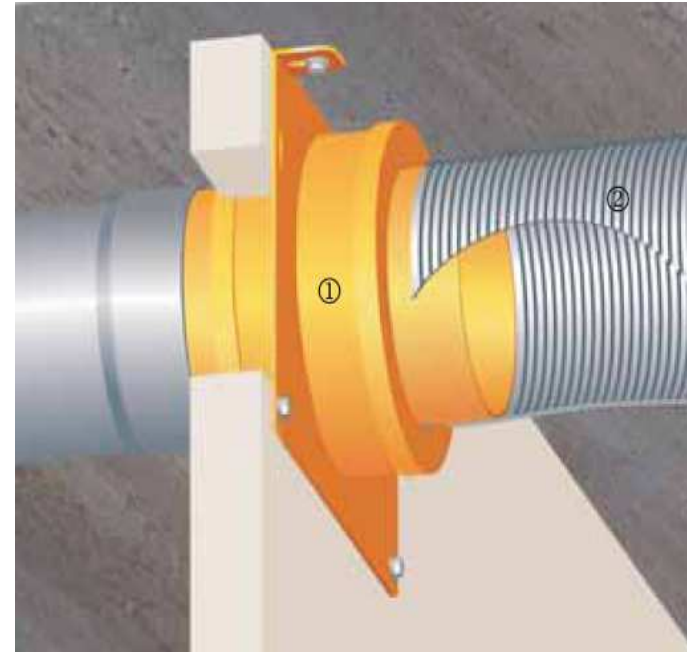
Penetrations through walls and floors

- For smaller penetrations in new and existing fire walls, such as for conduit and pipe work **Fire Collars and Sleeves** are most commonly specified
- Fire collars and sleeves utilize intumescence; when they are heated to above 200 degrees C, the intumescent resin system melts
- The heating of the collar allows the release of a mineral acid, which reacts with a carbon rich element in the paint to form a carbon char
- This char can be up to 50 times the thickness of the original material
- When the char is allowed to expand in only one direction, it is very effective at sealing a penetration
- With a PVC pipe, the pipe simply melts away and the collar expands inward, sealing the penetration
- For steel pipes, the primary factor is heat transfer; therefore a high temperature insulation blanket is generally applied to reduce heat flow through the pipe



Penetrations through walls and floors

- For lightweight flexible ducting (such as would service a clothes drier in an apartment building), a **Fire Damper** would be used
- **External or Ring Dampers** operate much the same way as collars; utilizing intumescences
- However, as a flexible duct will burn away very quickly in a fire, the intumescent material used must react much more quickly to seal the penetration
- **Internal fire dampers** operate using thermally sensitive actuators (solder that melts at 70 degrees) releasing spring loaded blades that seal the penetration in the event of fire
- The main disadvantage of internal dampers is that regular maintenance and testing is required to ensure they stay free from blockages (such as lint) and remain operational; access for cleaning and testing can also be problematic



Penetrations through walls and floors

- Fire Resistant Wraps are used in a similar fashion to collars and sleeves
- They are however primarily used in retrofit situations
- In applications such as the sealing around a pipe passing through a core hole in a concrete wall or floor
- They are supplied as a plastic bag of intumescent material and are simply slid into position and held in place with an intumescent sealant
- The containment of the intumescence is done by the surrounding wall of the concrete



Passive Fire Protection

- There is no New Zealand Standard for the installation of passive fire protection
- It is therefore up to the project team to ensure the client is getting what they are paying for
- There is a lack of understanding among many key personnel in the industry as to how passive fire protection works
- This is evidenced in a recent example where a fire wall stopped at the underside of a suspended ceiling
- This lack of understanding has, by implication, led to a lack of enforcement of the specification
- Ongoing maintenance, upgrades and changes in tenancies further undermine the 'as designed' passive fire protection systems

Passive Fire Protection

- The designer may not have been able to indicate everywhere that there is a need for passive fire protection, but it should be fitted wherever it is needed.
- It is therefore often up to the installers to identify where it is needed and to ensure it is installed as most often the protection is covered up prior to completion.
- To ensure the job is done right, seek advice from industry organizations such as the Passive Fire Protection Association and/or Industry recognized suppliers
- Depending on the scope of the works, consider engaging a specialist such as a fire engineer, to certify the installation

Passive Fire Protection

- Passive Fire Protection is not generally perceived as being of high value by other trades
- They will not think twice about poking a hole through a fire seal, or removing an area of board or spray
- The assumption is that someone else will fix it if necessary and/or that no one will ever notice
- This should be properly addressed in the contracts of those other sub trades
- And should ensure that excessive damage is not caused and that proper reinstatement occurs
- Careful programming to ensure that passive fire protection works are done after more invasive trades are completed

Passive Fire Protection

It is therefore critical that all parties involved in a project understand the importance of:

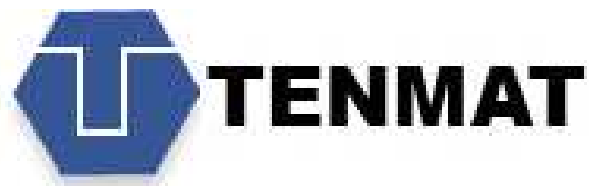
- Correct specification
- Correct installation
- Using licensed or approved installers where possible/practical
- Not allowing substitution (unless equivalence can be clearly demonstrated)
- Maintenance
- Implications of any changes (throughout building life)

Depending on the scope of the works, it would be well worthwhile to consider engaging a specialist such as a fire engineer, to certify the installation of Passive Fire Protection

Passive Fire Protection Products



Forman represent a range of world leading passive fire products including:





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Questions!!!