



**FP103 – Fire Rated Assemblies**  
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**2018**

# Introduction

Building codes such as International Building Code (IBC), NFPA 101: Life Safety Code or NFPA 2000: Building Construction and Safety Code, highlight two methods of fire protection, active and passive.

The very commonly known and easily spotted are the active systems such as sprinkler and fire alarm, which need a trigger, such as opening of a sprinkler head or detection via a smoke detector to operate and activate the system.

The other, passive systems, require no intervention. These are simply in place acting to segment rather compartmentalize building spaces so that smoke, heat and fire will not spread beyond the area, containing them while protecting adjacent spaces.

Examples of these are: fire rated walls, barriers, partitions, fire doors, dampers. There has been little attention given to passive systems and poor understanding and inadequate details result in significant delays and increase cost of projects during inspections and maintenance for the life of the building.

# What are fire rated assemblies?

Fire rated assemblies are combination of materials that together achieve a desired fire and/or smoke rating. ASTM E 119 and ANSI/UL 263, are two Standard for Fire Tests of Building Construction and Materials, referenced by both NFPA and IBC that indicate methods and test procedures to achieve ratings.

Similarity, for fire doors there is NFPA 80, *Standard for Fire Doors and Other Opening Protectives* and for penetrations, ASTM E 814, *Standard Test Method for Fire Tests of Through Penetration Fire Stops*, or ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*. Codes may allow for other approved tested agencies and standard to be used.

Known as fire rated walls but specific to fire walls, fire separation walls, fire barriers, fire partitions, smoke barriers, horizontal (floor) assemblies; they are designed to limit the spread of smoke and fire.

Each terms used above has a different meaning, is designed, required and constructed differently, therefore it is very important to use and cite correct terminology when classifying such assemblies. Example fire partition is not same as fire wall nor a fire barrier.

# What are fire rated assemblies?

Note that for columns and beams ratings are also achieved via fire assemblies ex thickness of concrete will provide a specific rating, beams incased in gypsum board layer (boxed out), column sprayed on with fire proofing, etc. Ratings are established for the entire assembly not for any one element such as concrete masonry unit (CMU), gypsum layer, steel, studs, etc. There are hundreds to thousands of listed assemblies, each of which has either been tested or approved by a recognized listed agency. UL website contains one of the largest databases for these assemblies [http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/bxuv\\_search.html](http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/bxuv_search.html) .

# Example

## **BXUV - Fire Resistance Ratings - ANSI/UL 263**

## **BXUV7 - Fire Resistance Ratings - CAN/ULC-S101 Certified for Canada**

See General Information for Fire-resistance Ratings - ANSI/UL 263

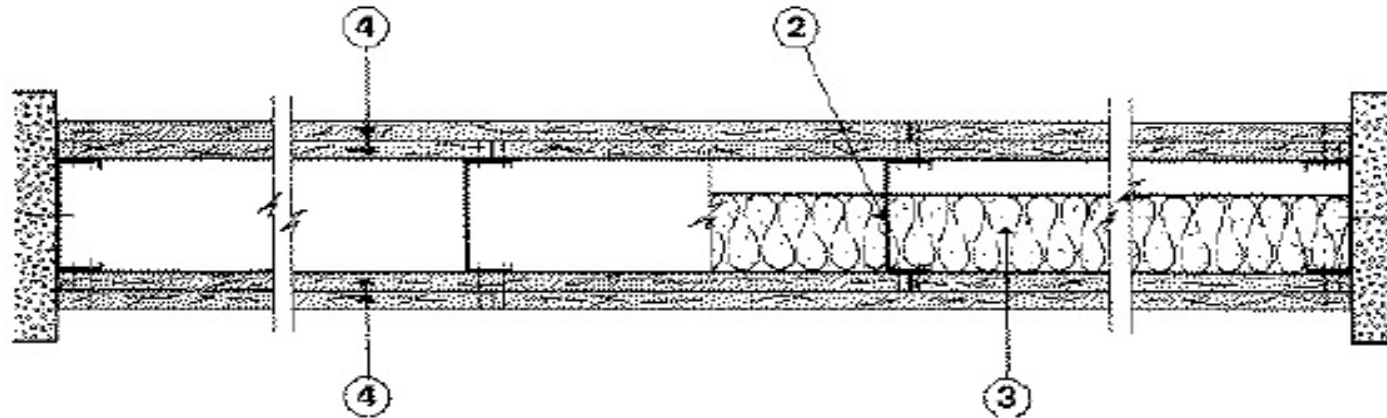
See General Information for Fire Resistance Ratings - CAN/ULC-S101 Certified for Canada

### **Design No. U411**

October 23, 2015

**Nonbearing Wall Rating – 2 HR.**

\* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.



- See link below for entire document (only portion shown below).
- From UL website: [http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/showpage.html?name=BXUV.U411&ccnshorttitle=Fire-resistance+Ratings+-+ANSI/UL+263&objid=1074330485&cfgid=1073741824&version=versionless&parent\\_id=1073984818&sequence=1](http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/showpage.html?name=BXUV.U411&ccnshorttitle=Fire-resistance+Ratings+-+ANSI/UL+263&objid=1074330485&cfgid=1073741824&version=versionless&parent_id=1073984818&sequence=1)

# What are fire rated assemblies?

The intent of ratings are not to indicate that the system will actually withstand against the fire for the rating shown but rather serve as a guideline. Remember, tests are done in a controlled environment. Out in the field construction is only perfected to materials and craftsmanship.

However, the codes require these the assembly to adhere to strict requirements of the manufacturer and UL documents to achieve proper design and construction for compliance. Specified types of screws must be used, screw spacing must not exceed what is stated in documents ex 10" apart, thickness of gypsum board cannot be less than indicated, orientation of the boards whether vertical or horizontal, staggering, etc – these details are unique to each assembly.

Even the slightest modification will result in a non-compliant assembly and will result in not meeting the approved testing agency requirement or AHJ. Any modification will require engineering judgement (to be discussed later) and approval by AHJ which can be challenging.

# What are fire rated assemblies?

Another key point to make about fire rated assemblies is that supporting construction (example floor supporting a 2hr column) must be able to support the rating for same duration. It does not make sense to build a room of say 2hr fire rated construction on 3<sup>rd</sup> floor when the floor supporting it has 1hr or worst has no rating. Therefore, all supporting members must be protected with same rating unless explicitly excluded by the code.

Be careful in type IIB building (see IBC construction definition chapter 6) or other building construction where existing or new structural elements can be of non-rated construction and even non-combustible. They may need to be changed from non-rated construction elements to fire rated for compliance.

# When are fire rated assemblies required?

Fire rated assemblies are required by building or life safety codes adopted by State or locality. They are called out by IBC, NFPA 101, NFPA 5000 as either fire rated or fire resistance rating. Some examples of fire rated construction required by code are:

- Fire walls used to separate building to meet building area requirements, separate buildings due to difference in construction types, or because of height limitations, separate non-sprinklered building from sprinklered building
- Fire barriers used to create separate fire area including separating one floor level from another, shaft wall, exit enclosures, exit passageways
- Occupancy separation for mixed use and incidental area separations, separation from higher hazard uses, atriums, special hazards separation
- Smoke barriers to separate smoke zones
- Separation of exits, refuge areas, exit passageways, shafts, rated enclosures
- Performance based methods when need to achieve alternative method



# Construction of assemblies

The entire assembly must be constructed per the manufacturer's requirement which must be listed as an approved assembly. You must follow details of the data sheet and use the exact materials mentioned. A table/matrix should be provided to show the design number for each structural element. Image on next slide shows different ways to present a table/matrix to indicate the identification for each assembly.

# Examples

UL LISTED FIRE RATED ASSEMBLIES

FLOOR	FLOOR CONSTRUCTION	EXTERIOR WALLS - LIMITED AREAS		SHEAR / BEARING / ELEVATOR WALLS	NON-BEARING WALLS		SHAFTS	COLUMNS
		(@ STAIR A)	(@ STAIR C)		GYP BOARD	CMU		
1	D902	-	U040	12" THICK REINF. CAST-IN-PLACE CONC	U411	U906	U415, SYSTEM B	X723 (2-HRS)
2	D902	V454	V454, U040	12" THICK REINF. CAST-IN-PLACE CONC	U411	U906	U415, SYSTEM B	X723 (2-HRS THROUGHOUT, 1-HR AT CLINIC COLUMNS SUPPORTING ROOF ONLY)

FIRE RESISTANCE RATING - BUILDING ELEMENTS

TABLE	BUILDING ELEMENT	TYPE I B
601	PRIMARY STRUCTURAL FRAME	2-HRS THROUGHOUT, 1-HR FOR PRIMARY STRUCT FRAME AND BEARING WALLS WHERE SUPPORTING A ROOF ONLY (FOOTNOTE a)
601	BEARING WALLS EXTERIOR	2
601	BEARING WALLS INTERIOR	2
602	NON BEARING	0
601	FLOOR CONSTRUCTION	2
601	ROOF CONSTRUCTION	1
708	VERTICAL SHAFT	2
708	ELEVATOR SHAFT	2
708	STAIR TOWERS	2

# Examples

FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (TYPE IB):	
PRIMARY STRUCTURAL FRAME (TABLE 601)	2-HOUR (1-HOUR PER IBC 403.2.1.1 (2) - FIRE-RESISTANCE RATINGS OF THE BUILDING ELEMENTS IN TYPE IB CONSTRUCTION SHALL BE PERMITTED TO BE REDUCED TO THE FIRE-RESISTANCE RATINGS IN TYPE II A) UL ASSEMBLY - DESIGN X854
EXTERIOR BEARING WALLS (TABLE 601):	2-HOUR UL ASSEMBLY - N/A
EXTERIOR NON-BEARING WALLS (TABLE 602):	
> 20' (FOOTNOTE H) FROM LOT LINE:	0-HOUR
10' > 20' (FOOTNOTE H):	1 HOUR
5' > 10':	1 HOUR
< 5':	1-HOUR
INTERIOR BEARING WALLS (TABLE 601):	2-HOUR
FLOOR CONSTRUCTION (TABLE 601):	2-HOUR (1-HOUR PER IBC 403.2.1.1 (2) - FIRE-RESISTANCE RATINGS OF THE BUILDING ELEMENTS IN TYPE IB CONSTRUCTION SHALL BE PERMITTED TO BE REDUCED TO THE FIRE-RESISTANCE RATINGS IN TYPE IIA) UL ASSEMBLY - DESIGN D985
ROOF CONSTRUCTION & SECONDARY MEMBERS (TABLE 601):	1-HOUR



# Construction of assemblies

The designer should include a detail sheet, showing all the different fire rated assemblies to be used on the project. Detail for each rated assembly should be provided with head of walls details, where different rated or non-rated assemblies meet each other, joints, listed penetration details for structural members and MEP.

Not only will providing information listed above help get your plans approve faster but it will also provide clarity to the contractor on what is the level of craftsmanship required for these assemblies.

# Penetrations

Penetration through fire rated assemblies must be done correctly meeting code otherwise it can compromise the entire system i.e. There must be an approved detail showing how penetration is secured in the fire rated assembly. You must have a listed assembly to penetrate the wall/floor whether is through-and-through or inside a membrane OR have the penetrating item tested with the wall assembly (this is typically not done due to cost and the specification of items).

Through-stop fire penetrations system allow for the most common compliant method to achieve penetrations in a listed assembly and are classified under a F, T, L rating system.

F rating is the time period that the *through-penetration firestop system* limits the spread of fire through the penetration when tested in accordance with ASTM E 814 or UL 1479 (IBC).

T rating is the time period that the *penetration firestop system*, including the penetrating item, limits the maximum temperature rise to 325°F (163°C) above its initial temperature through the penetration on the non-fire side when tested in accordance with ASTM E 814 or UL 1479.

L rating is the air leakage rating of a *through penetration firestop system* or a fire-resistant *joint* system when tested in accordance with UL 1479 or UL 2079, respectively.

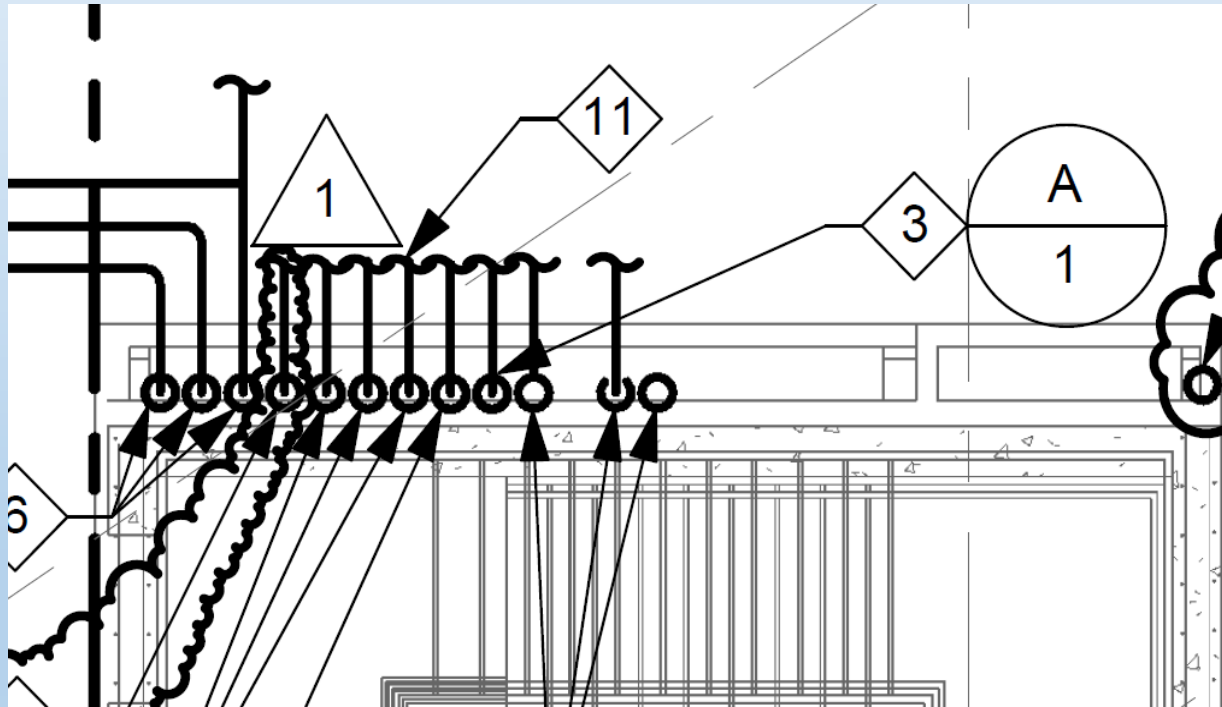
# Penetrations

Fire walls, barriers, partition need to carry F rating while floor and membrane penetrations need to have both F & T rating. Smoke barriers require L ratings while smoke partitions penetrations can be any approved material that limits free passage of smoke allowed by the code (does not have to be a listed fire stop assembly).

Consider penetrations such as pipe running in cavity of the wall or beams location with reference to head of wall details. Running combustible pipes or wood studs for supporting TV, cabinets, etc should be avoided and only installed when approved by AHJ, prior to installation, as it may not be acceptable. When there is no choice but to run combustibles pipes in a rated wall cavity (usually found in lab spaces with control areas), consider wrapping the combustible pipe or filling wall cavity with mineral wool as a solution to submit to AHJ. Use fire retardant treated wood in walls cavity to limit exposure.

# Example

Below is an example of multiple plumbing pipes exiting a shaft at the same elevation. These 4inch pipes are shown very close together. Pipes are turning up to go through floor slab to the level above. What we need to ask is: Which UL firestop through penetration allows for all these pipes to penetrate the floor to achieve F & T rating seeing that they are so close to each other?



Above is image of multiple plumbing pipes penetrating the floor assembly.

# Penetrations

Three popular manufacturers that have good penetration system selectors are 3M (<https://submittalwizard.3m.com/>) STI (<https://systems.stifirestop.com/>) and Hilti (<https://www.hilti.com/firestops>). Utilizing their system selector one can quickly find UL approved systems along with the necessary submittals.

Another problem that frequently occurs in the field is the track at the head of wall. Modification of the track will void the approved assembly. Most of the time electrical contractor runs his conduits tight to deck and cuts through the track without knowing that it is part of the rated assembly.

There is also the importance of proper fire resistance joint system such as head of wall, base of wall, curtain/perimeter wall (where the rated floor meets the exterior wall). There needs to be details of listed system and specify the type of joint system used for the connection. Be aware of static vs dynamic and that different joints must not be combined.

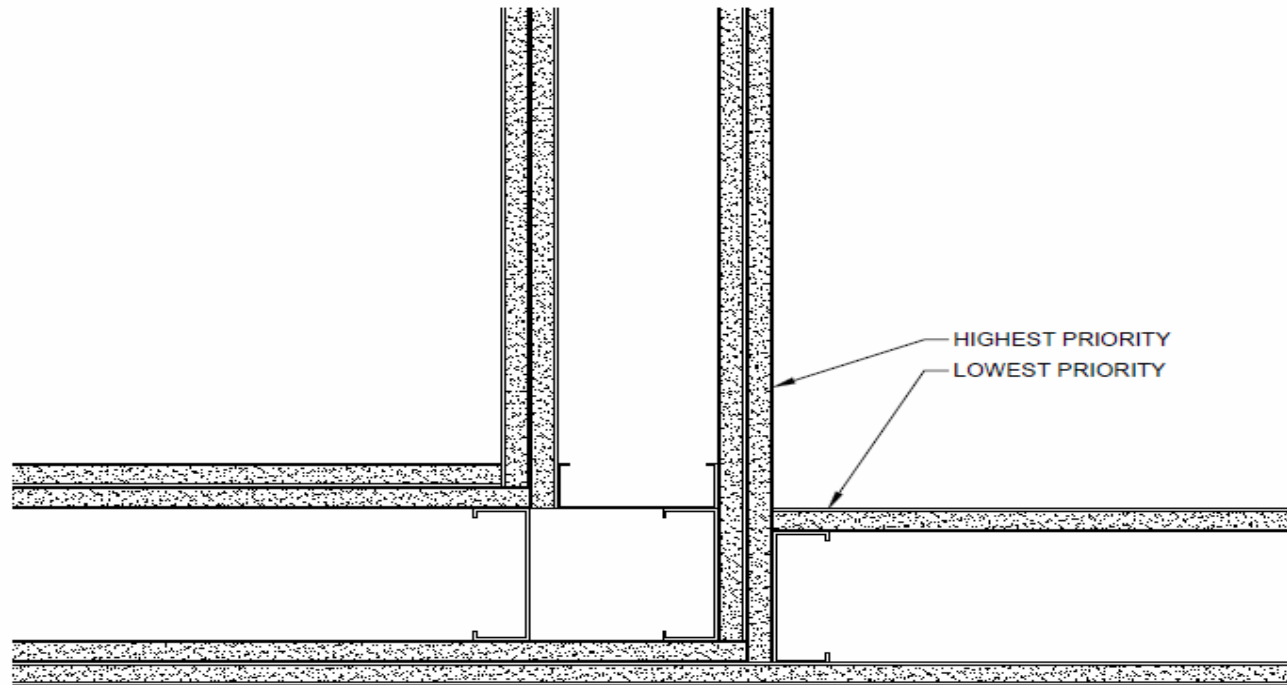


# Penetrations

Shaft wall assembly is special design that allows construction of rated assembly to occur from one side. It can be used anywhere and does not have to be only for shafts.

Pay special attention to where two different rated walls meet, where rated walls turn, where rated wall meet non-rated walls. Look at manufacturers details which show priority level ex gyp board. See example next slide.

# Example



WALL PRIORITY LEGEND	
2 HOUR FIRE AND SMOKE WALL	PRIORITY 1
2 HOUR FIRE WALL	PRIORITY 2
2 HOUR SHAFTWALL	
1 HOUR FIRE AND SMOKE WALL	PRIORITY 3
1 HOUR FIRE WALL	PRIORITY 4
NON-RATED WALL	PRIORITY 5

Think about weakest points of where the fire can get through. How would fire compromise the integrity? A good resource from National Gypsum is the Purple book

[https://www.nationalgypsum.com/file/PURPLEbook\\_May2014.pdf](https://www.nationalgypsum.com/file/PURPLEbook_May2014.pdf). Note that the

details contained here are to be used when using the manufacturer products.

You cannot mix and match the manufacturers. The details by the manufacturer should be considered equivalent to listed assembly. Take some time now to go over the purple book and the US gypsum board guide – link in course outline

# Proper planning and review

Items to consider:

- Coordinate all fire rated assemblies with structural elements, mechanical, electrical, plumbing, fire.

Example

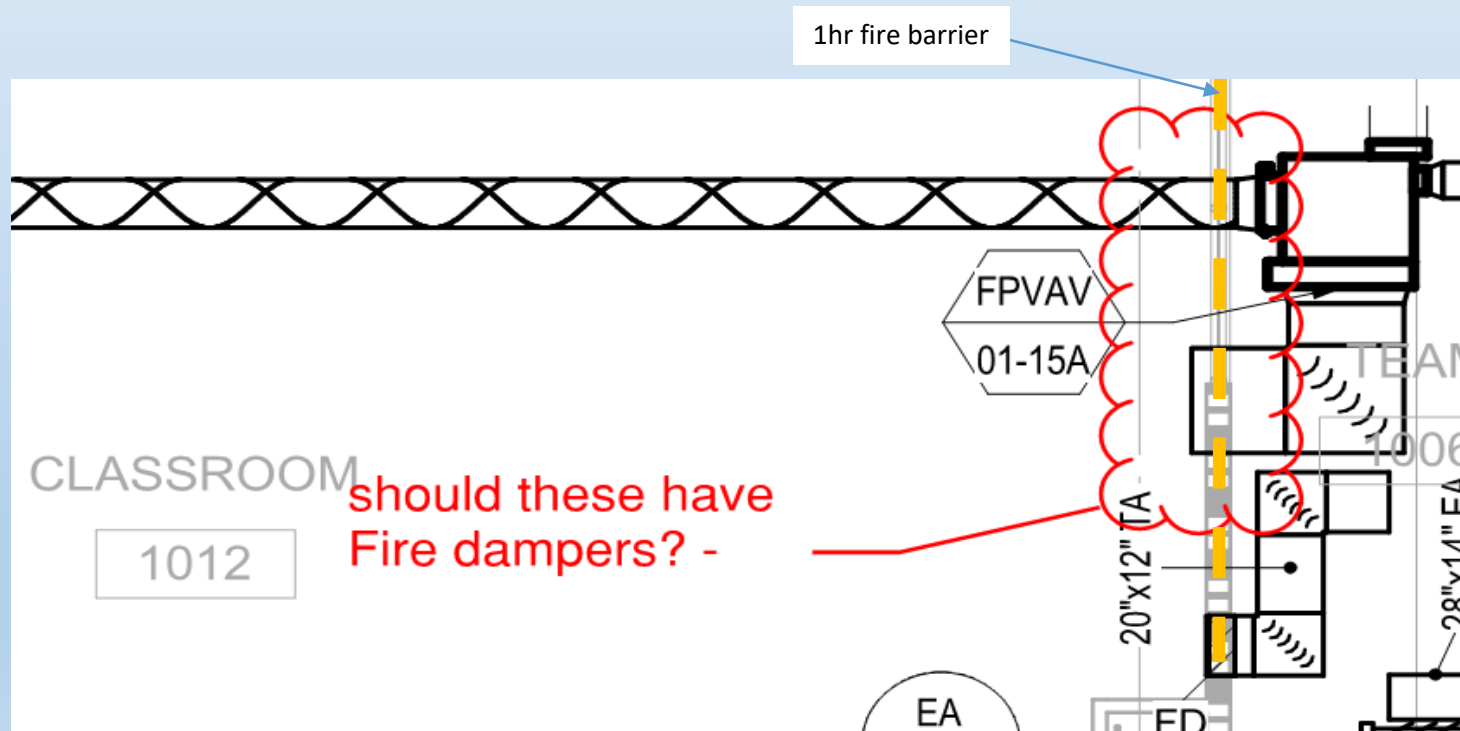


Image above shows ducts penetrating fire rated wall without dampers

# Example

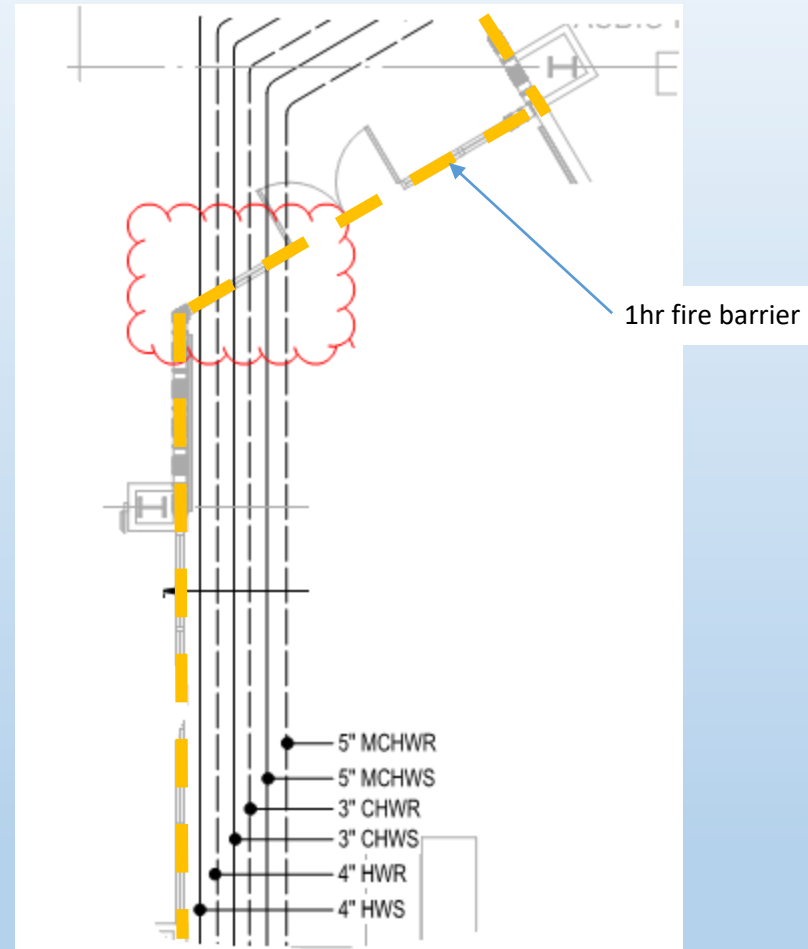


Image above shows pipes penetrating fire rated wall at an angle. What UL assembly exists pipe penetrating wall at an angle?

# Proper planning and review

- Confirm head of wall can be constructed with reference to beam. Overlay structural drawings on architectural plans showing rated walls.
- Example: The image below shows plan view of a stairway in a 6 story building. The structural AutoCAD drawings were x-referenced on top of architectural drawings. Stairway is an exit and is required to be enclosed in a fire barrier consisting of 2hr fire resistance rating (per IBC). The beam W18x35 is shown above this wall. The question to ask here is how can the head of the fire barrier be constructed with the beam not running parallel with the top?



The head of fire rated wall cannot be constructed. Engineering judgment or complex design detail will be required if either the wall or beam cannot be aligned with each other. Coordinating early prior to issuance of construction document can prevent change order and construction cost in field.

# Proper planning and review

- Overlay MEP trades on plan – see locations where duct runs over walls, multiple pipes shown in wall cavity (penetration detail and how wall around will be built, construction of rated enclosures. All MEP drawings should clearly delineate the fire rated walls and their ratings.
- Structural drawings must be consistent with the rated floor assembly ex cannot use HSS tube or C channel when UL assembly shows W style beams.
- If the beam penetrates a rated wall then it must be treated as a penetration. Need to find an approved assembly that allows the penetration and understand the logistic of its construction.
- Make sure fire doors and dampers in rated walls are detailed correctly on the drawings and installed per manufacturer details. Door and windows are their own assemblies. Some common items include latching, self or automatic closing and rated frames.

# Proper planning and review

- At pre-construction meeting go over all the rated walls with all the contractors. In the field, spray paint the wall locations on the floor slab and underside of slab so that the contractors know where the rated walls are to avoid problems and so that the inspectors can easily verify locations. Have inspectors perform regular walkthroughs at the rated walls.
- The fire rated walls and assemblies should be constructed early. Many times the contractors begins to hang duct and pipe to get ahead. This has resulted in rework when it was discovered that the duct was placed too close to the edge of a rated wall thereby not allow for its construction, or a large electrical box with all rigid conduits was installed at the same location as the rated wall.
- Complete only one side of the rated walls to allow for inspections from other side.
- Other items to consider for fire rated construction include identify location of fire rated assemblies and shaft walls for demoing and renovation project and how removal/modification can result in noncompliance.
- Any openings such as windows and doors must be rated when in rated enclosures.

# Proper planning and review

Fire Rated walls shall not be used for supporting any building element or utilities ex ducts, pipes penetrating the rated walls, etc. The rated walls are typically not tested as loadbearing.

Also, be aware of modification to horizontal assemblies (rated floors). The rated floors and roof systems are also assemblies where any modification to the structural elements results in a noncompliance and can jeopardize the entire system. An example demonstrates this concern:

A statue is to be placed inside a building on 3<sup>rd</sup> floor of the building, above grade. The base of it requires modification to the slab thickness cutting 1" to set the base for proper height. Luckily prior to construction it is discovered that the floor is 1hr horizontal assembly consisting of a minimum 5" concrete slab and sprayed on fire proofed W21 beams. Cutting the slab would have reduce the slab thickness resulting in a non-compliant assembly.

Engineering judgements sometimes are needed where the assembly cannot be built per the listing. Engineering judgements are composed by fire protection engineer or professional engineers, are altered details of the listed and tested assemblies and need to be approved by AHJ.

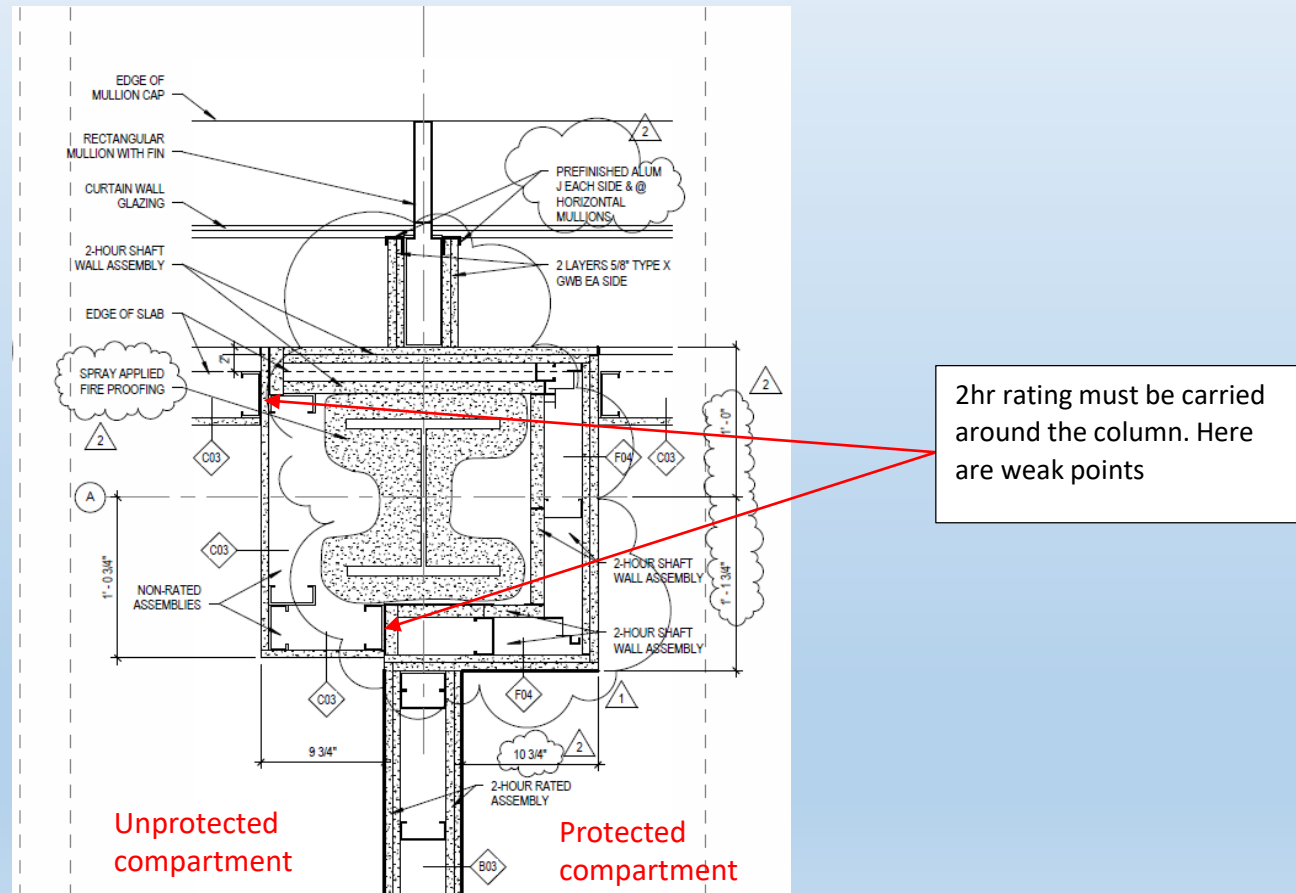


# Sprinkler substitution for fire rated assembly

- You may think that having full sprinklered building will allow for substitution of fire rated assemblies. Both IBC and NFPA are very clear against this.
- Per IBC 2015 - 703.4 Automatic sprinklers Under the prescriptive fire-resistance requirements of the *International Building Code*, the fire-resistance rating of a building element, component or assembly shall be established without the use of *automatic sprinklers* or any other fire suppression system being incorporated as part of the assembly tested in accordance with the fire exposure, procedures, and acceptance criteria specified in ASTM E 119 or UL 263. However, this section shall not prohibit or limit the duties and powers of the *building official* allowed by Sections 104.10 and 104.11.
- For NFPA codes, it requires meeting the UL testing methods, where sprinklers are not utilized during the test, sprinklers cannot be used unless approved by AHJ.
- Fire rated assemblies are passive system and codes already consider the sprinkler effectiveness in the design. One popular exception to the above has been ICC Evaluation Service (ES) report ESR-2397- [http://www.icc-es.org/Reports/pdf\\_files/load\\_file.cfm?file\\_type=pdf&file\\_name=ESR-2397.pdf](http://www.icc-es.org/Reports/pdf_files/load_file.cfm?file_type=pdf&file_name=ESR-2397.pdf). This allows for use of window sprinklers to achieve a 2hr fire resistance rated assembly. The requirements are very specific as to the type of partitions, the use area the complying code and standard sections.

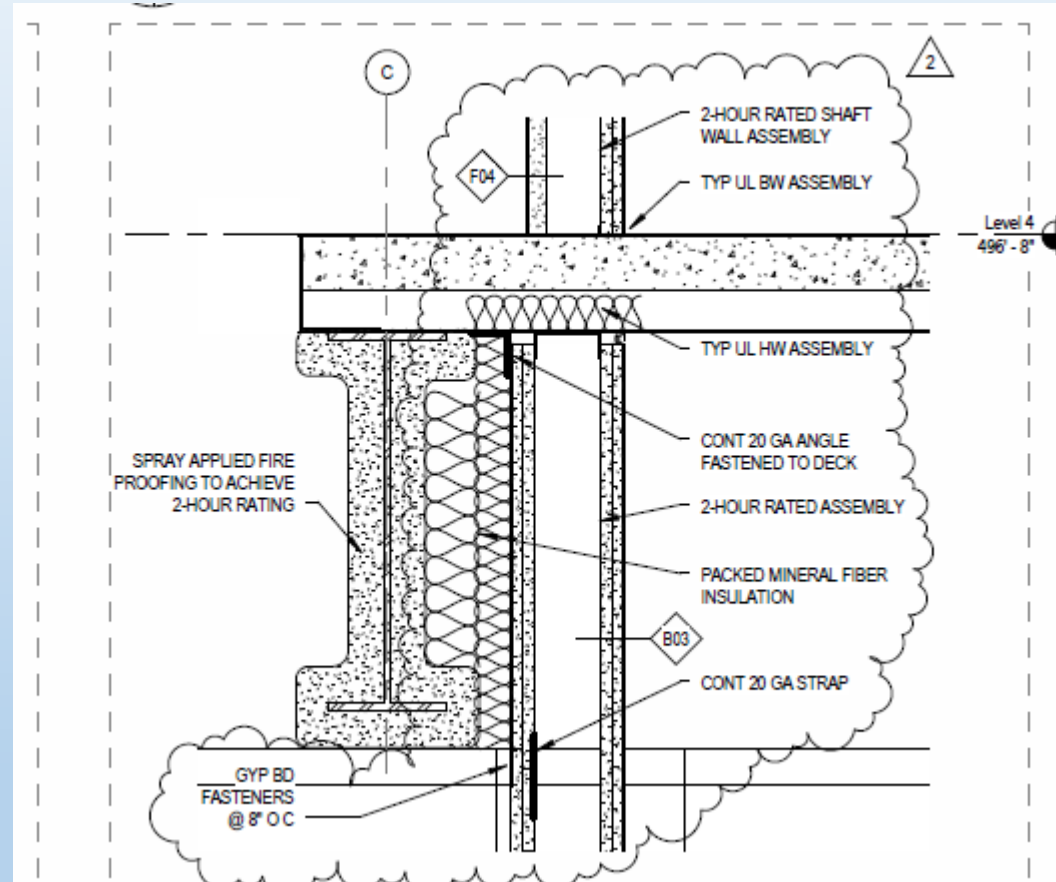
# Example

- Following are some examples to help you think about fire rated construction. Key thing is to not overthink rather think about how the assembly is to be constructed.



Above is plan view detail of 2hr wall at column

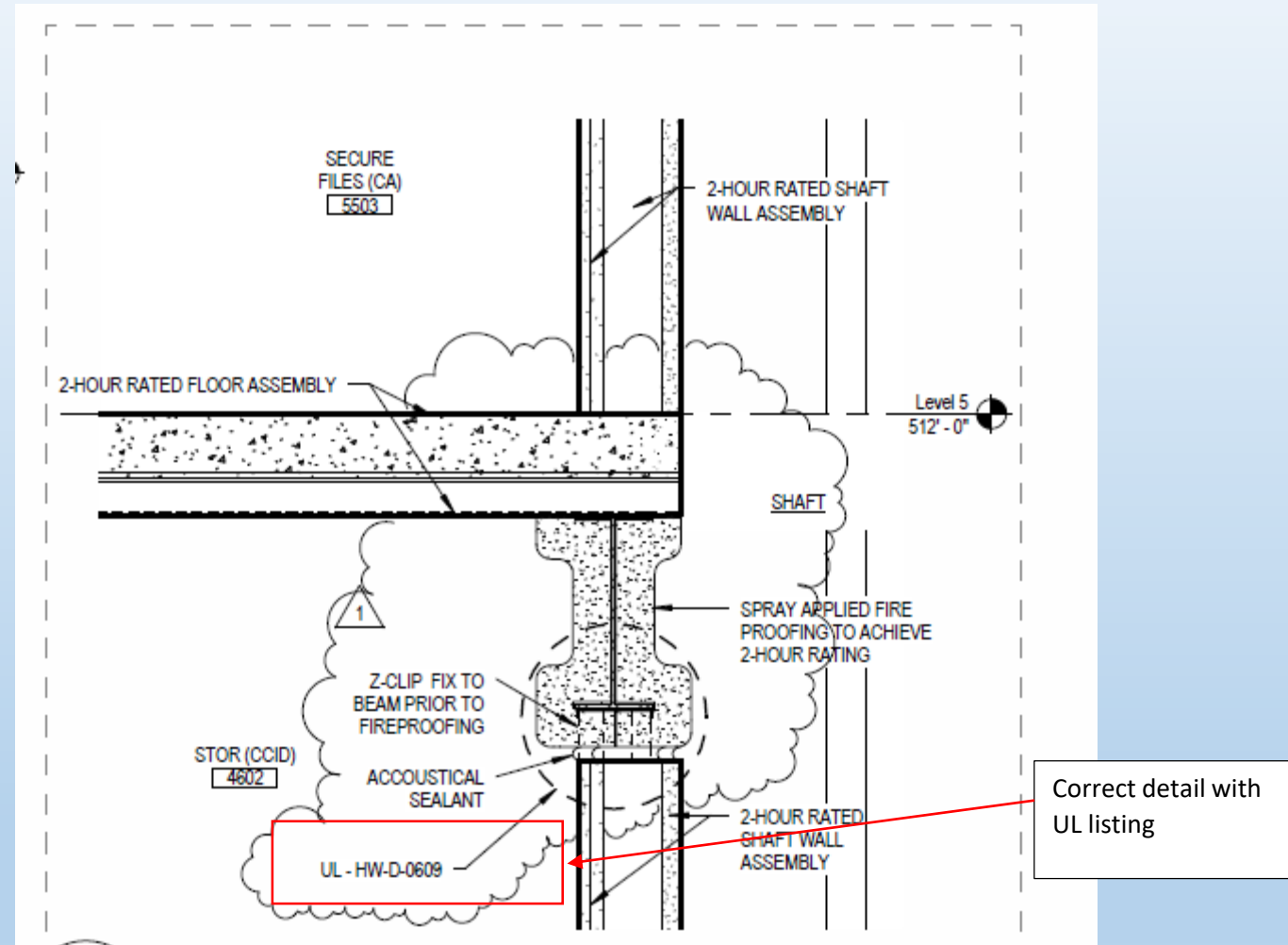
# Example



What head of wall assembly is this?? Needs to indicate UL design number

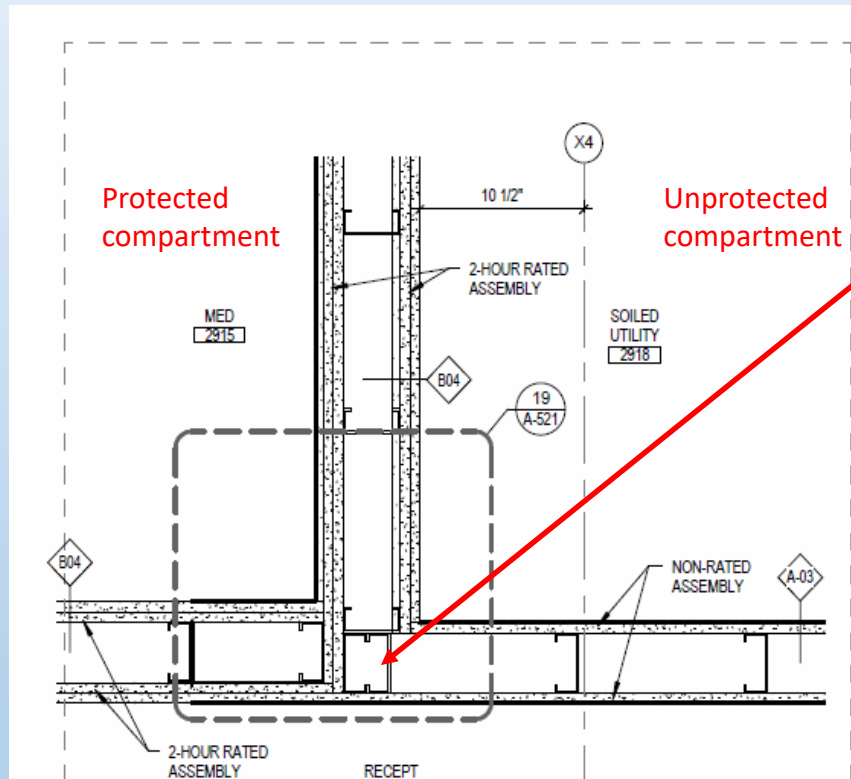
Above is cross section at beam detail and 2hr rated wall

# Example



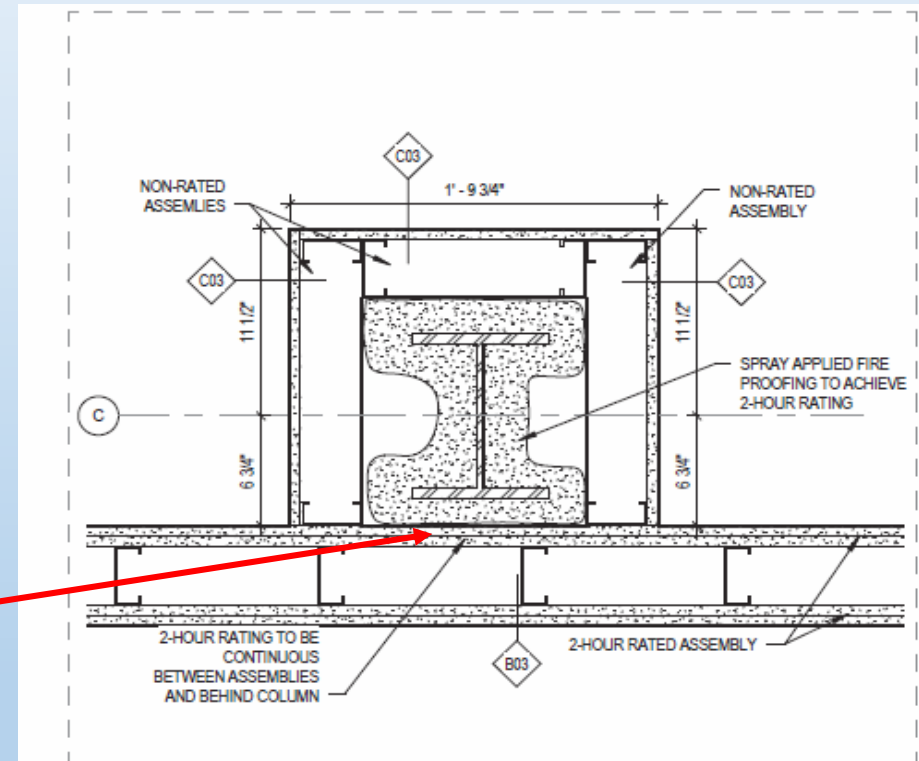
Above is cross section detail of beam in relation to head of wall

# Example



Opening allows for fire entry. 2hr rating compromised

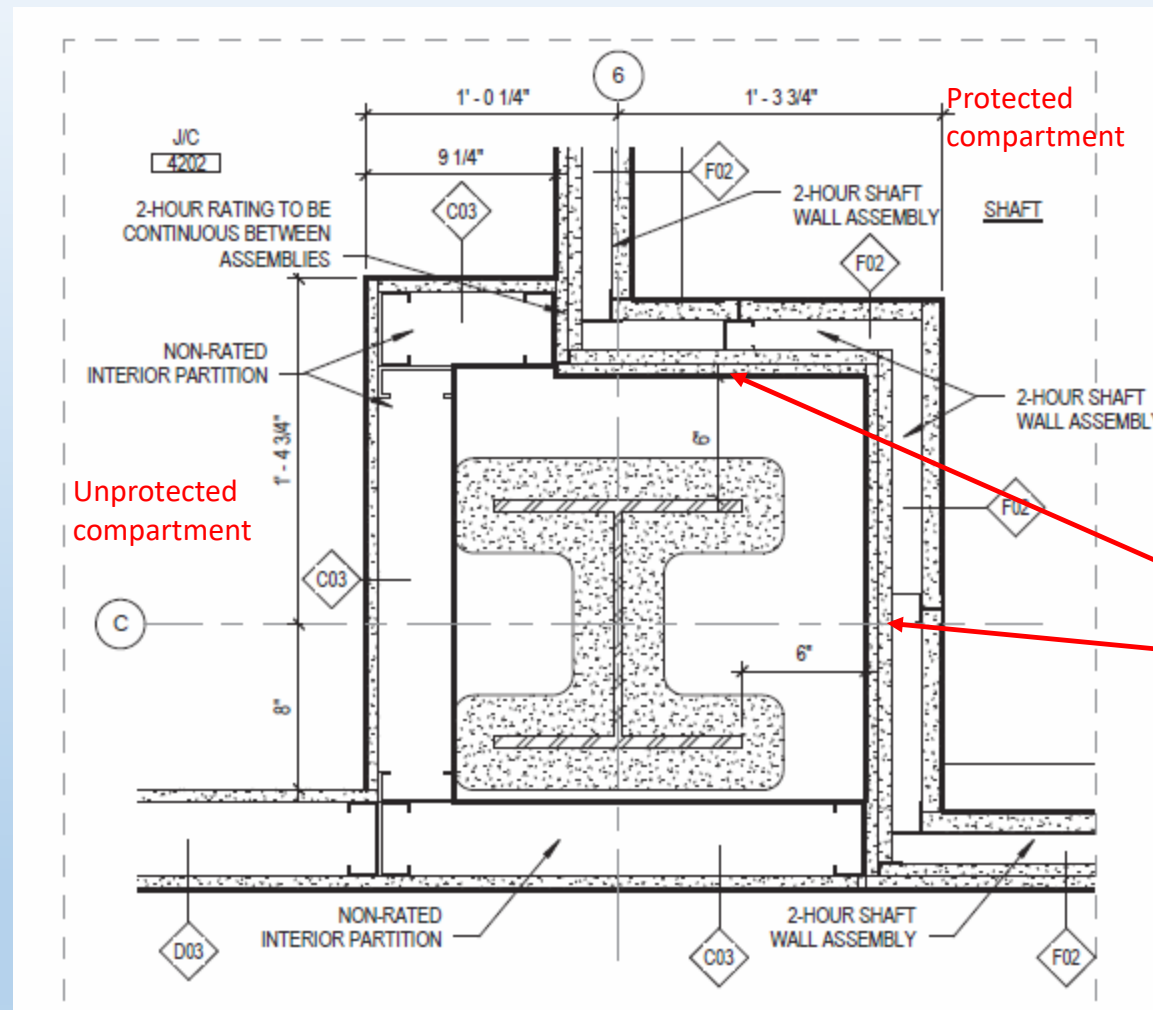
How to screw 2 layer of gypbd to stud with fire proofing in way? Note: This is not specified as shaft wall construction



Above is plan view detail of two rated assemblies' intersecting each other

Above is plan view detail of 2hr rated wall at column

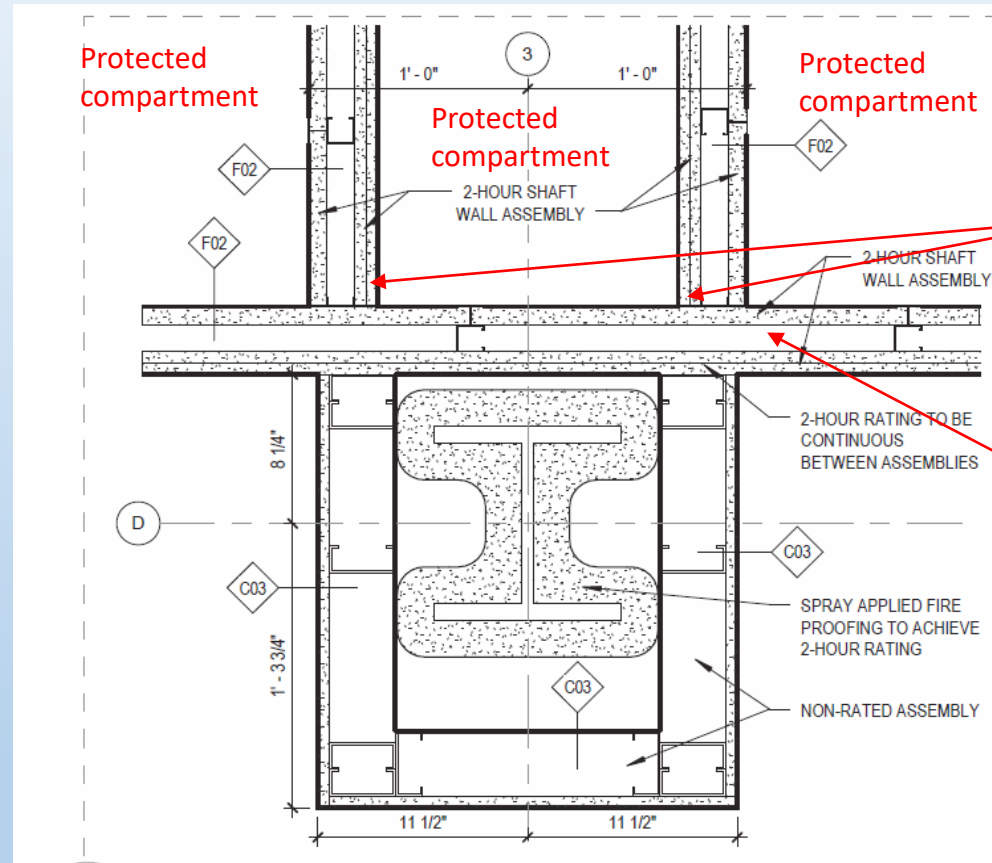
# Example



How to screw 2 layers of gypbd to stud? The column does not allow drill or screw to secure screw. No room to get in and build assembly

Above is plan view detail of 2hr rated wall at column

# Example



How to screw these in stud within such a small space?

Rating compromised here. The vertical 2 layers of gypbd need to tie in the horizontal 2 layers

Above is plan view detail of 2hr rated wall at column

If you haven't already, at this time go to the course outline and click on the links provided for the reference section.

# Summary

Fire rated assemblies are passive systems that serve an integral part of the building's fire protection feature. They are rated assemblies that limit the spread of fire, smoke heat, containing the fire in the area of origin and limiting its spread to adjacent spaces. When required by code they are independent of other fire protection system such as sprinklers or fire alarm. The proper selection – listed and tested assemblies from approved testing agencies such as Underwriter Laboratories (UL), design – assembly of components, review – ensuring that the assemblies are constructible, coordination with building and MEP elements, construction, and inspection of fire rated assemblies cannot be emphasized enough. Following these basics steps can prevent reworks, save thousands of dollars and time on project completion.



THANK YOU FOR CHOOSING

