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CODE UNLIMITED, LLC

Engineering Judgement Letter

Sandy 51 - EJ

Fire Protection-Steel Column

Client Name: TVA Architects

Client Address: 920 SW Sixth Avenue, Suite 1500 Portland, OR 97204

Date: 2/6/2020

Table of Contents

5 PROJECT OVERVIEW

Sandy.51 is a new mixed-use/multi-family project being developed in Portland, Oregon. It will be under the jurisdictional review of the City of Portland. The proposed design is six stories of Type III-B (Levels 2-6) over Type I-A (Level 1) construction. The design includes steel columns inside a rated wall assembly which do not meet the prescriptive code requirements or do not match a tested fire resistive column assembly. Since they are primary structural members supporting 2-hr exterior walls, they are required to be 2-hr fire resistance rated per 2014 OSSC §704.2.
Code Unlimited has been asked to provide an Engineering Judgment (EJ) to evaluate the proposed column protection measures. Since the column protection measures are similar, they have been presented in a single EJ letter.

6 APPLICABLE CODES, STANDARDS, AND GUIDES

- 2014 Oregon Structural Specialty Code

7 APPROACH

- The proposed assembly has been analyzed in accordance with 2014 OSSC §703.3 **Alternative Methods for Determining Fire Resistance**.
- Portions of the tested assembly are modified to suit the unique design condition. The modification is analyzed for equivalency using published fire test data and acceptable fire science principles.
- The proposed design has been evaluated by an Oregon Licensed Fire Protection Engineer.

8 PROPOSED DESIGN

The proposed design assemblies are for steel columns supporting the exterior wall above. The steel columns are to be individually encased and protected for a 2-hr fire resistance rated per 2014 OSSC §704.2.

As shown on Figures a (a,b), columns (Minimum HSS 4x4x1/4”) are protected within 1 hour or 2 hour rated walls. Gypsum wallboard (GWB) membranes or sacrificial wood on sides will provide protection as required.

These assemblies supporting the exterior walls above (highlighted in Figure 1c) are required to be 2-hour fire-resistance rated per OSSC.

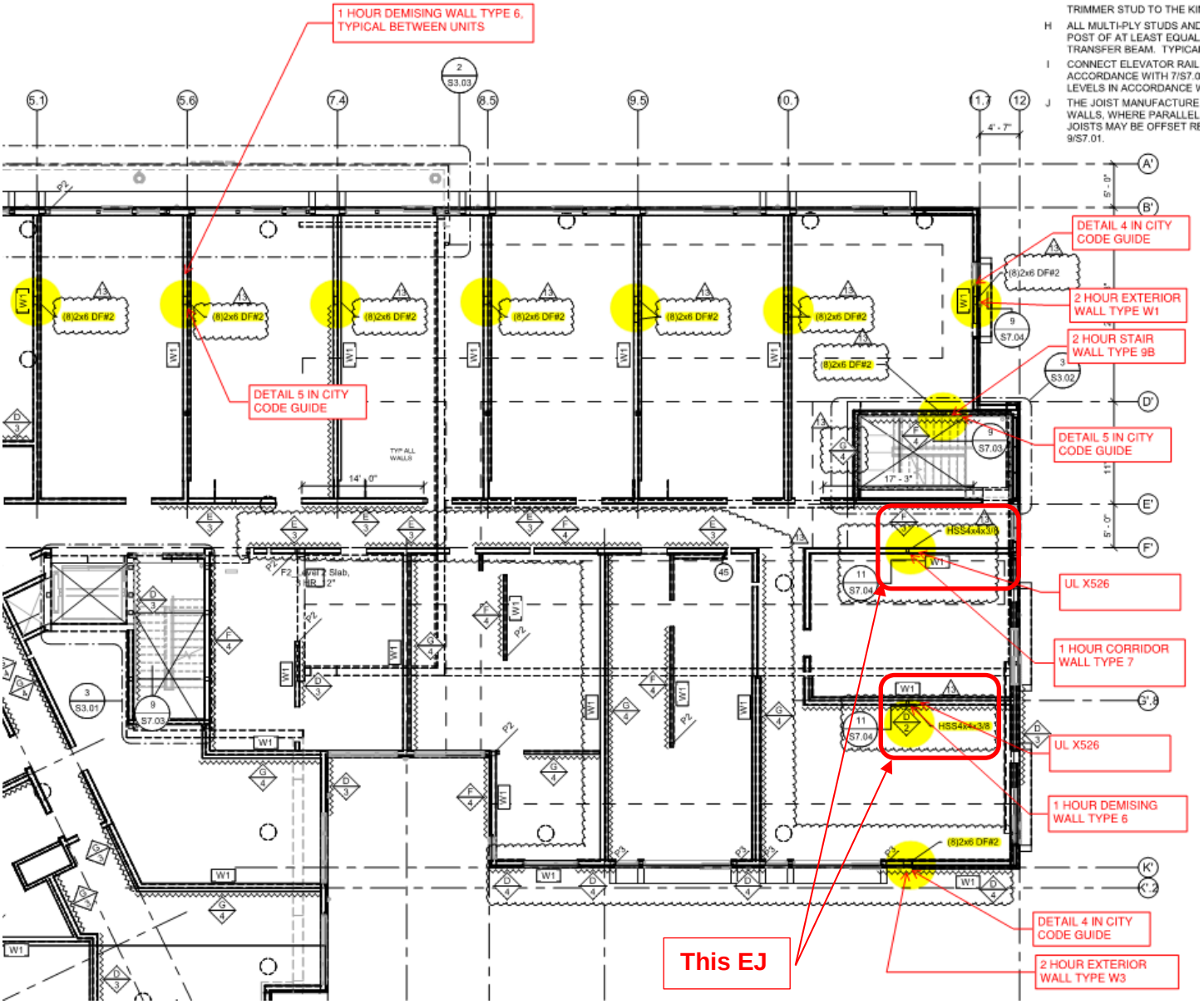

Figure 1a: *Column Locations (Level 2- Floor)*

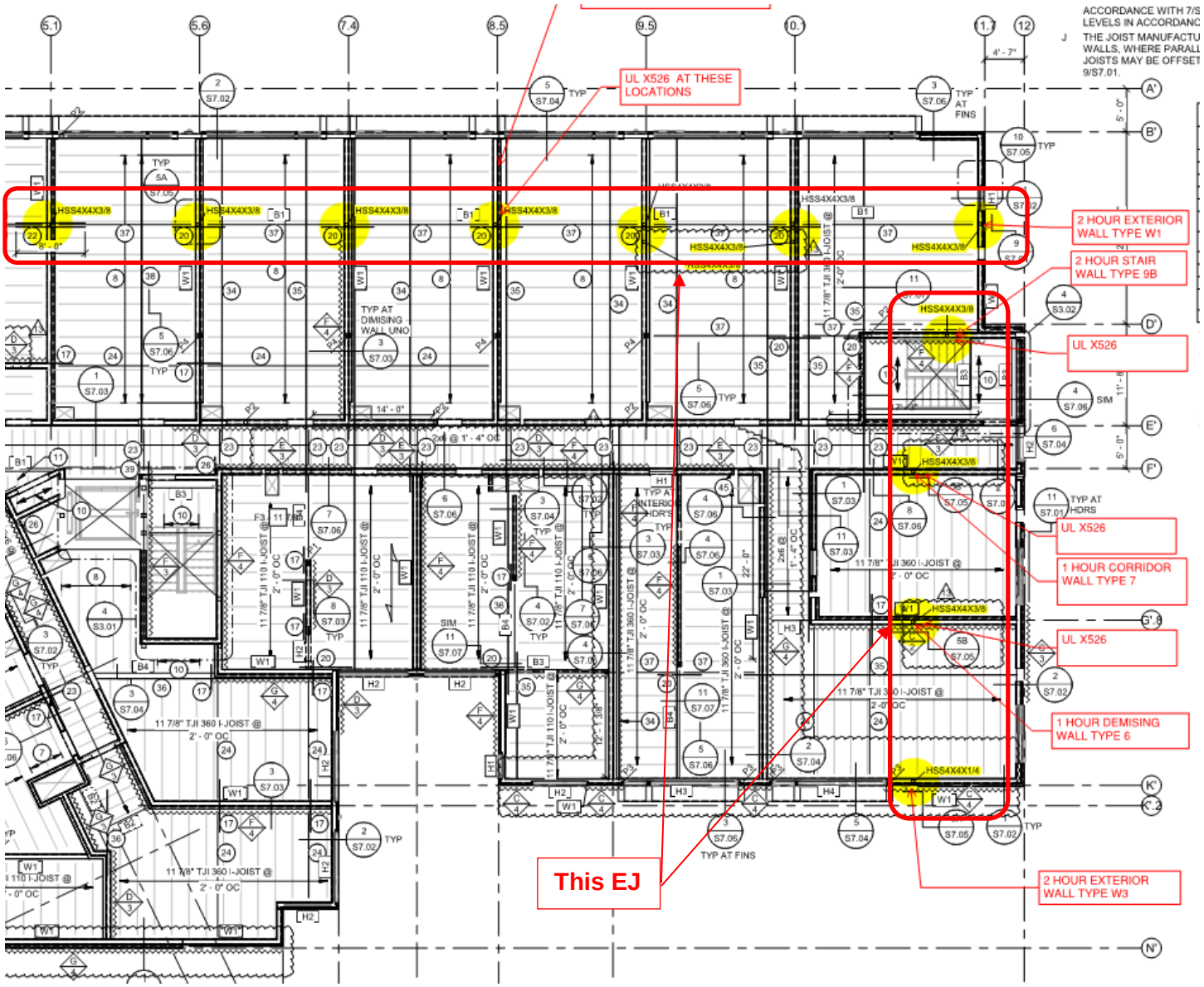

Figure 1b: *Column Locations (Level 3- Floor)*

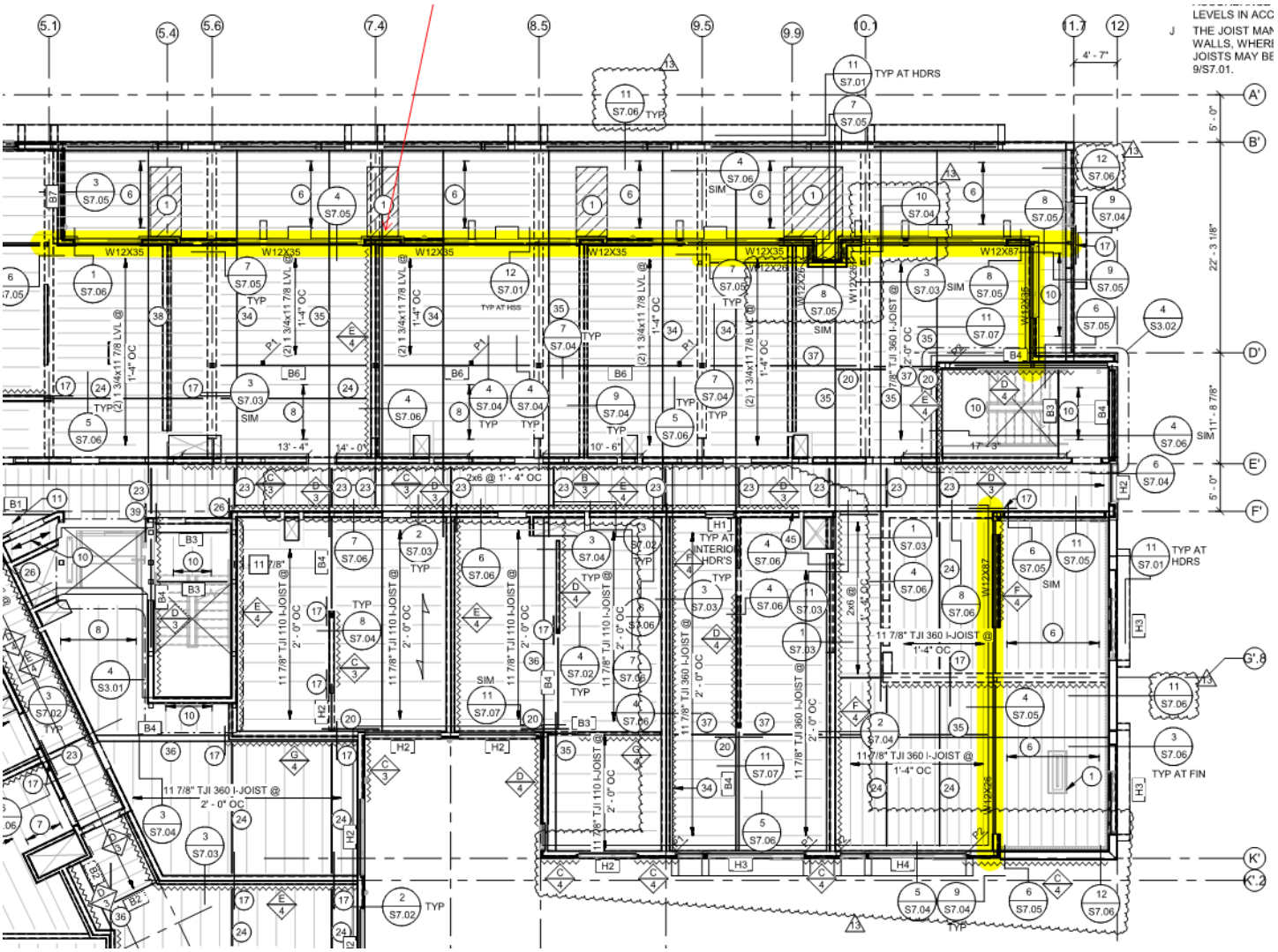

Figure 1c: *2-Hr Exterior Walls (Level 4- Floor)*

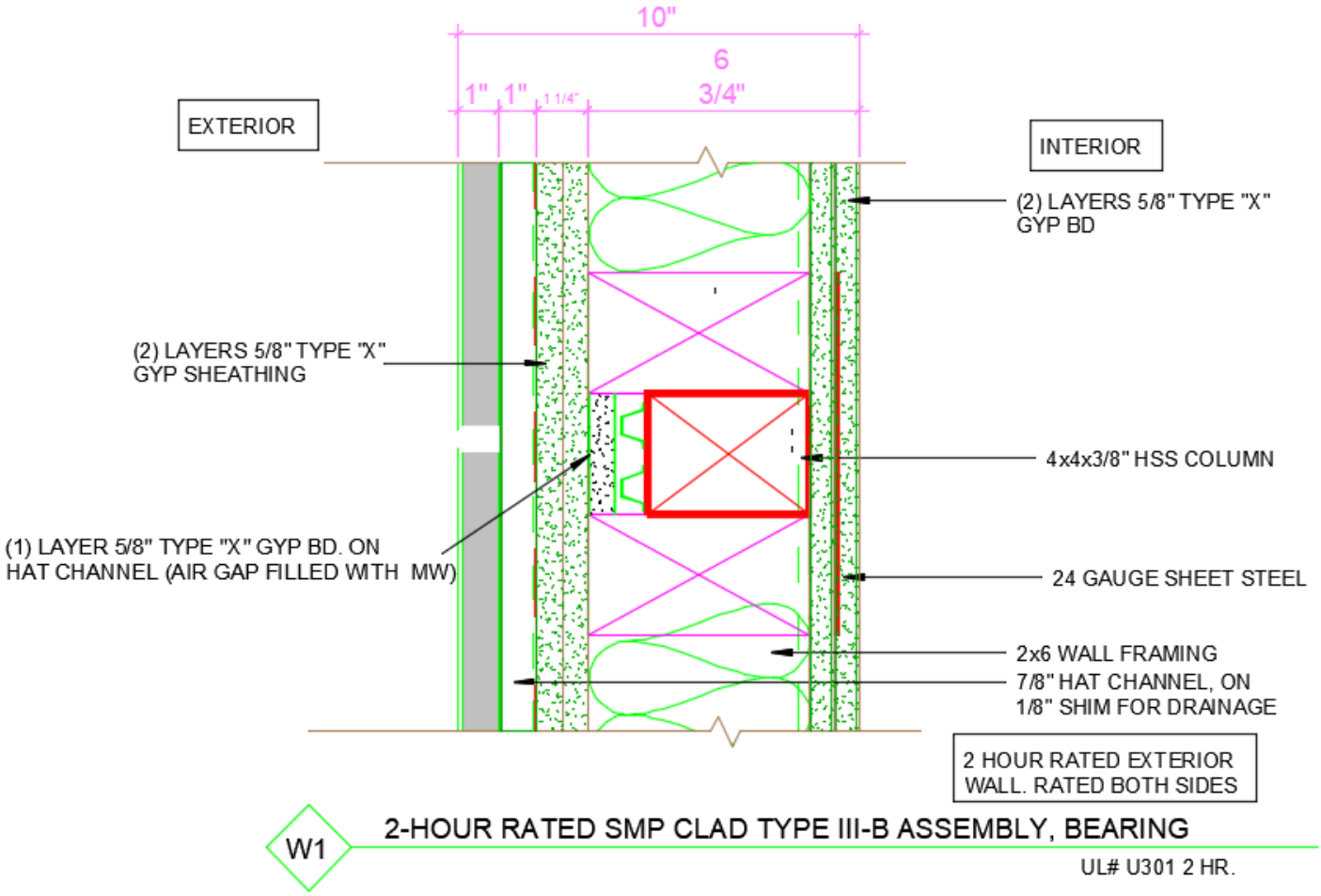

Figure 2a: *Exterior Wall Detail-W1(HSS-4x4x3/8")*

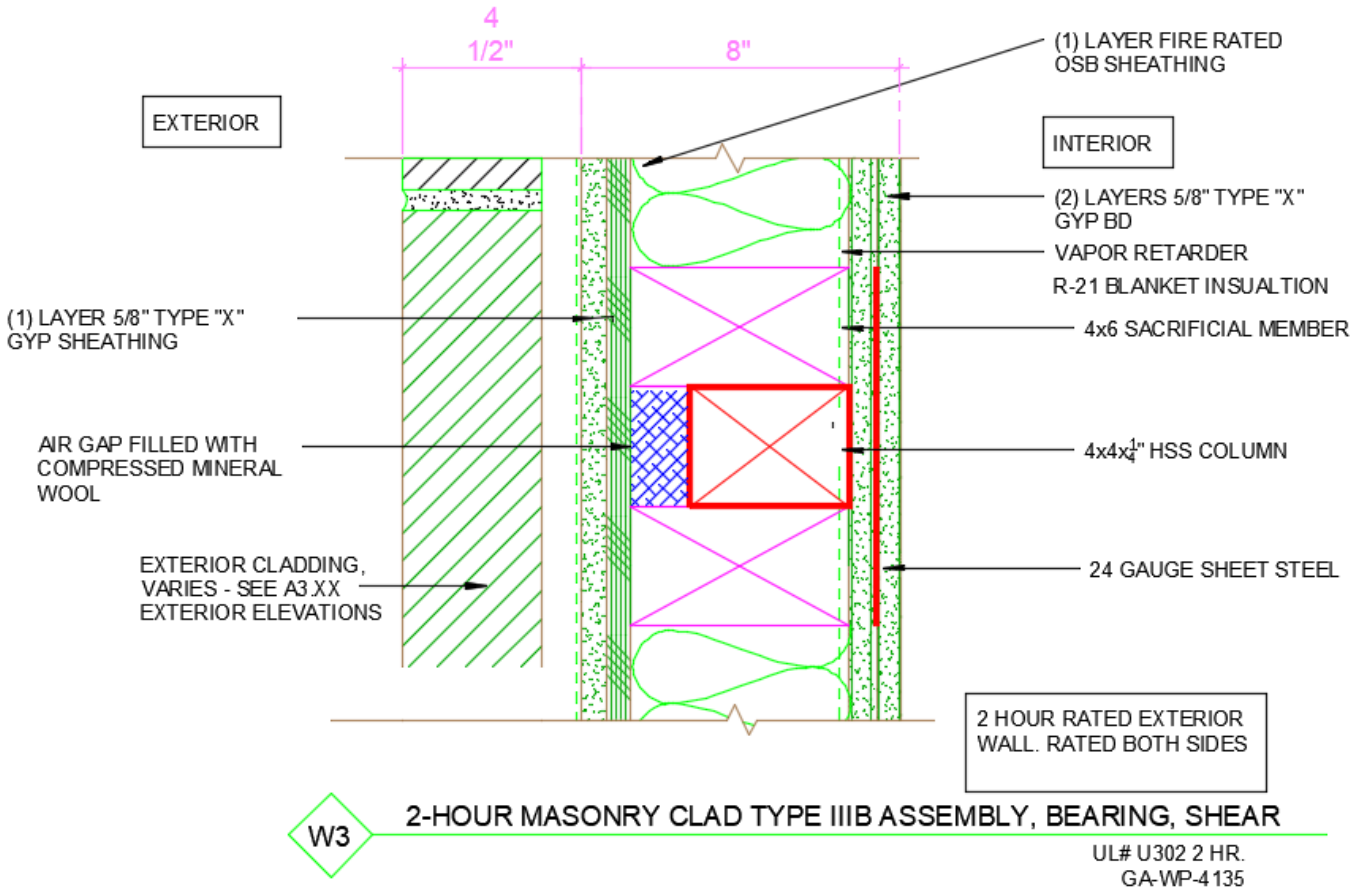

Figure 2b: *Exterior Wall Detail-W3 (**HSS-4x4x1/4”**)*

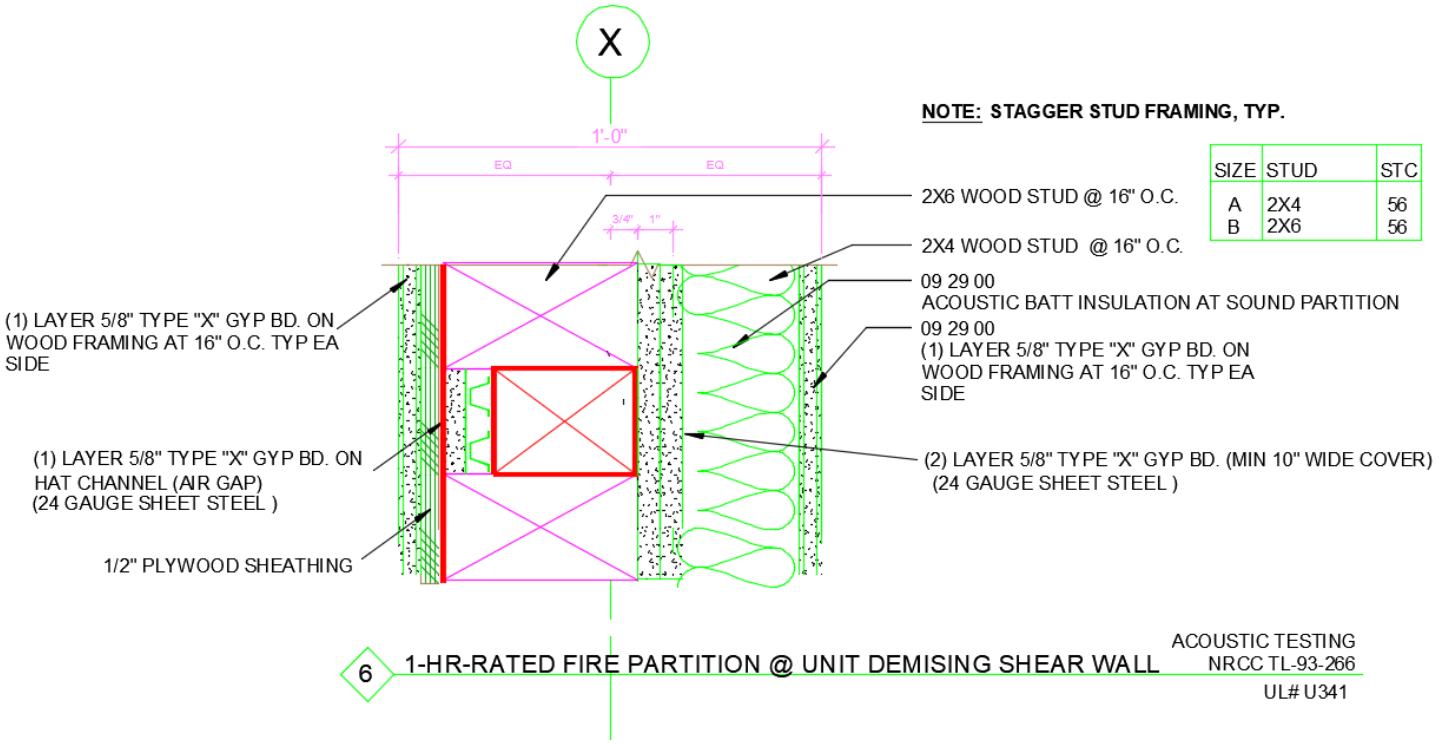

Figure 2c: *Interior Wall Detail-Wall#6*

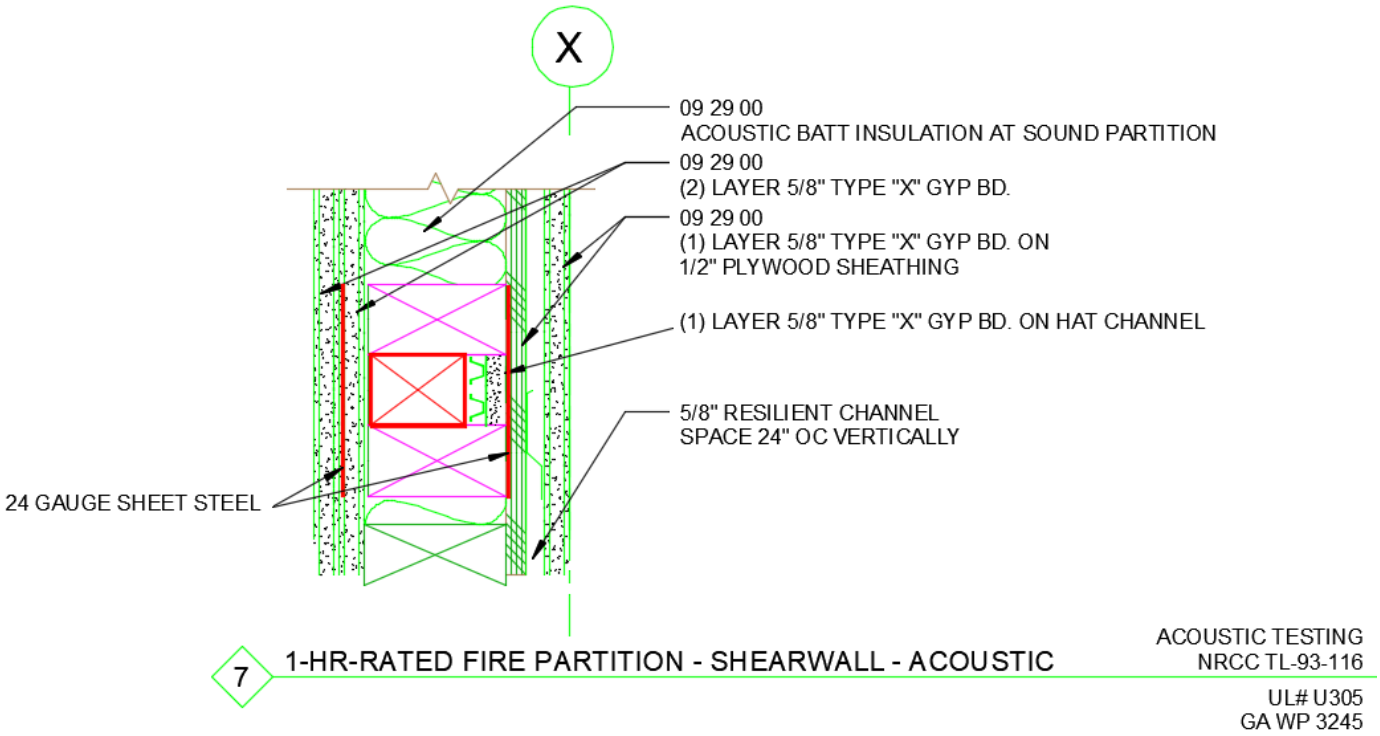

Figure 2d: *Interior Wall Detail- Wall#7*

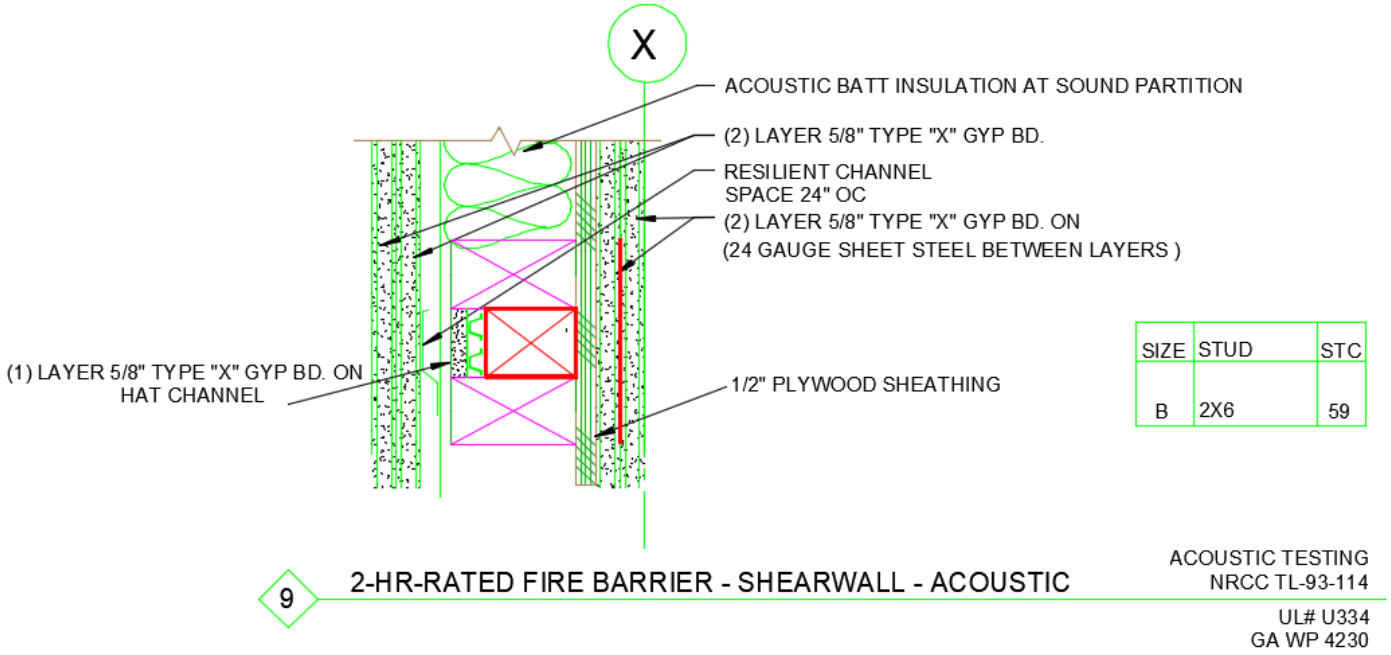

Figure 2e: *Interior Wall Detail- Wall#9*

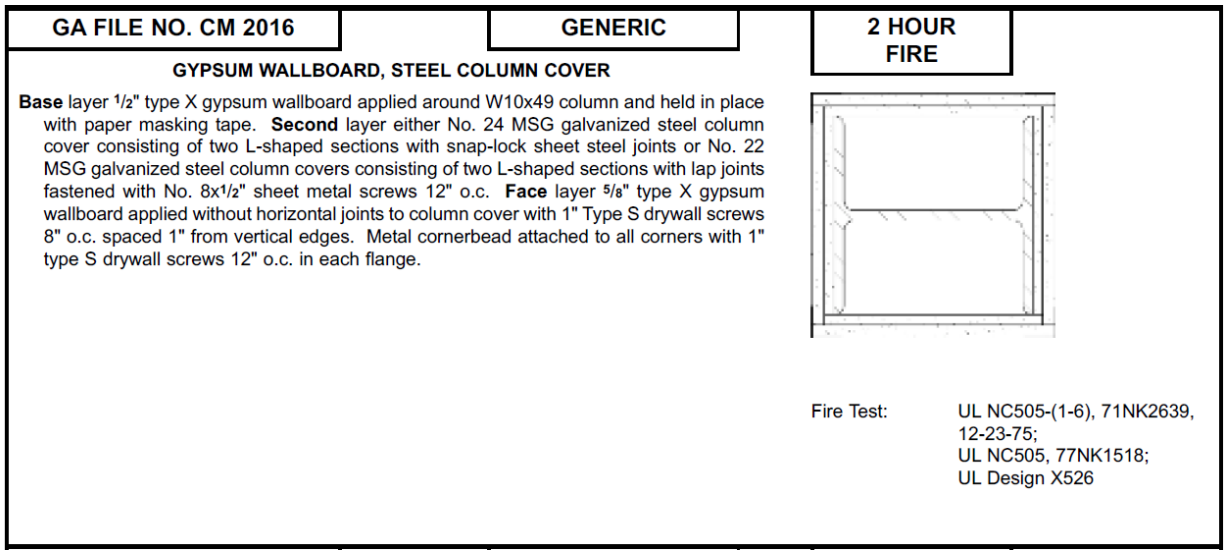

Figure 3a: *GA Manual-CM 2016 (Column Protection based on UL X526)*

5 ASSEMBLY ANALYSIS

The proposed structural columns (HSS 4x4x1/4(W/D=0.76) and HSS 4x4x3/8(W/D=1.10) supporting the wall above in the Type IIIB portion of the building and are required to be protected for a 2-hr rating per OSSC, Table 601.

The steel columns are installed within rated walls and will be supporting the exterior wall above as a protected assembly with the evaluation performed per requirements of OSSC 703.3. The W12x49 column used in the CM2016 evaluation(fig.3a) is based on UL test X526 assembly and has a W/D Ratio of 0.84.

It should also be noted the assembly will be installed in a rated wall, which will dramatically add to the fire resistance of the column protection on these gridlines.

The protection measures for the columns are analyzed in the sections below.

5.1 Wood charring evaluation

Each protected HSS column in the wall details above will be protected on the cavity faces with 4 x sacrificial wood columns (3.5” actual width).

The fire resistance of wood is permitted by OSSC Section 722.1 to be calculated using Chapter 16 of ANSI/AF&PA *National Design Specification for Wood Construction (NDS).* NDS TR10 specifies an effective char layer depth of **3.2”** where 2-hour of fire resistance is required based on equation 16.2-1 shown in ***Figure*** 4a. Table 16.2.1A of the NDS is reproduced below in **Figure** 4b.

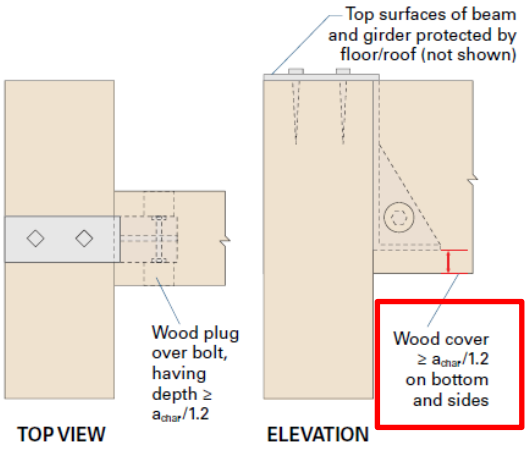

Figure 3-8 Beam to girder – concealed connection

Figure 4a: Figure 3-8 in the NDS

Table 16.2.1A Effective Char Rates and Char Depths (for β_n = 1.5 in./hr.)

Required Fire Endurance (hr.)	Effective Char Rate, β_{eff} (in./hr.)	Effective Char Depth, a_{char} (in.)
1-Hour	1.8	1.8
1½-Hour	1.67	2.5
2-Hour	1.58	3.2

Figure 4b: Table 16.2.1A of the NDS

5.2 HSS 4x4x3/8 in wall W1(Figure 2a)

These columns will be installed in the exterior wall W1. The evaluation will ensure 2 hours of continuous protection provided on each column face. Note: During assembly, if any gaps existing between column protection membranes (i.e hat channel) will be filled with mineral wool or a minimum ¼" wide fire caulking bead filling the vertical gap.

Table 5.2: Column protection evaluation (Wall W1)

Element	Minimum Protection required	Proposed Assembly
Location		• HSS 4x4x3/8 (W/D=1.10) (Exceeds minimum W/D requirement for CM2016 evaluation)
1. Left Side of assembly	• 2 hours (Exterior Face)	• 3 layers 5/8" Type X GWB (120 Min.) • Air Gap (Exceeds minimum requirement)
2. Cavity Sides of assembly	• 2 hours (Cavity)-Top and Bottom of detail.	• 3.5" Sacrificial Wood Blocking. See section 5.1 above) (Exceeds minimum requirement)

Element	Minimum Protection required	Proposed Assembly
3. Right side of assembly	• CM2016 • **Base** layer **1/2**" type X gypsum wallboard applied around W10x49 column and held in place with paper masking tape. • **Second** layer either No. 24 MSG galvanized steel column cover consisting of two L-shaped sections with snap-lock sheet steel joints or No. 22 MSG galvanized steel column covers consisting of two L-shaped sections with lap joints fastened with No. 8x**1/2**" sheet metal screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied without horizontal joints to column cover with 1" Type S drywall screws 8" o.c. spaced 1" from vertical edges. Metal cornerbead attached to all corners with 1" type S drywall screws 12" o.c. in each flange.	CM2016 equivalency • **Base** layer **5/8**" type X gypsum wallboard applied over HSS column. • **Second** layer 10" minimum width, No. 24 MSG galvanized steel cover sheet. fastened with 1" Type S drywall screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied with min. 1.5" Type S drywall screws 12" o.c. (Exceeds minimum requirement)
Fire-Resistance Rating	**2-Hour Required**	**2-Hour (minimum)**

5.3 HSS 4x4x1/4 W/D ratio evaluation (Figure 2b)

These columns will be installed in the exterior wall W3. The evaluation will ensure 2 hours of continuous protection provided on each column face. Note: During assembly, if any gaps existing between column protection membranes (i.e hat channel) will be filled with mineral wool or a minimum ¼" wide fire caulking bead filling the vertical gap.

The support columns with a W/D ratio larger than 0.84 will match the basis of the UL X526 design for the fire exposed face, while the lighter column (HSS 4x4x1/4) will be evaluated with respect to the effective heated perimeter.

As the column will be heated from one face, with the other faces protected with sacrificial wood or facing a separate space (other side of rated wall) , the effective W/D ratio will be calculated.

HSS 4x4x1/4-W/D=0.76 (Exposed to heat on 4 sides)

Fire exposure to ¼ of column. Effective W/D ratio is weight per unit length, divided by heated perimeter of 1/4th of column. Therefore, effective W/D ratio while in the proposed assembly.

(Modified HSS 4x4x1/4) **W/D ratio = 3.04**

Table 5.3: Column protection evaluation (Wall W3)

Element	Minimum Protection required	Proposed Assembly
Location		• HSS 4x4x1/4 (Effective W/D=3.04) (Exceeds minimum W/D requirement for CM2016 evaluation)
1. Left Side of assembly	• 2 hours (Exterior Face)	• Masonry brick (Table 722.4.1(1)= 100 Min. • 1 layer 5/8" Type X GWB (40 min.) • 1 Layer ½" Fire Rated OSB (15 min) • Compressed Mineral Wool (6" wide Compression 50%) (Standard Weight MW-2 PCF) (40 min) (Exceeds minimum requirement)
2. Cavity Sides of assembly	• 2 hours (Cavity)-Top and Bottom of detail.	• 3.5" Sacrificial Wood Blocking. (See section 5.1 above) (120 min. Exceeds minimum requirement)

Element	Minimum Protection required	Proposed Assembly
3. Right side of assembly	• CM2016 • **Base** layer **1/2**" type X gypsum wallboard applied around W10x49 column and held in place with paper masking tape. • **Second** layer either No. 24 MSG galvanized steel column cover consisting of two L-shaped sections with snap-lock sheet steel joints or No. 22 MSG galvanized steel column covers consisting of two L-shaped sections with lap joints fastened with No. 8x**1/2**" sheet metal screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied without horizontal joints to column cover with 1" Type S drywall screws 8" o.c. spaced 1" from vertical edges. Metal cornerbead attached to all corners with 1" type S drywall screws 12" o.c. in each flange.	CM2016 equivalency • **Base** layer **5/8**" type X gypsum wallboard applied over HSS column. • **Second** layer 10" minimum width, No. 24 MSG galvanized steel cover sheet. fastened with 1" Type S drywall screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied with min. 1.5" Type S drywall screws 12" o.c. (Exceeds minimum requirement)
Fire-Resistance Rating	**2-Hour Required**	**2-Hour (minimum)**

5.4 HSS 4x4x3/8 in wall #6(Figure 2c)

These columns will be installed in the interior wall #6. The evaluation will ensure 2 hours of continuous protection provided on each column face. Note: During assembly, if any gaps existing between column protection membranes (i.e hat channel) will be filled with mineral wool or a minimum ¼" wide fire caulking bead filling the vertical gap.

Table 5.4: Column protection evaluation (Wall #6)

Element	Minimum Protection required	Proposed Assembly
Location		• HSS 4x4x3/8 (W/D=1.10) (Exceeds minimum W/D requirement for CM2016 evaluation)
1. Left Side of assembly	• CM2016 • **Base** layer **1/2**" type X gypsum wallboard applied around W10x49 column and held in place with paper masking tape. • **Second** layer either No. 24 MSG galvanized steel column cover consisting of two L-shaped sections with snap-lock sheet steel joints or No. 22 MSG galvanized steel column covers consisting of two L-shaped sections with lap joints fastened with No. 8x**1/2**" sheet metal screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied without horizontal joints to column cover with 1" Type S drywall screws 8" o.c. spaced 1" from vertical edges. Metal cornerbead attached to all corners with 1" type S drywall screws 12" o.c. in each flange.	CM2016 equivalency • **Base** layer **5/8**" type X gypsum wallboard applied on hat channel over HSS column. • **Second** layer 10" minimum width, No. 24 MSG galvanized steel cover sheet. fastened with 1" Type S drywall screws 12" o.c. • **Third** layer ½" Plywood Sheathing fastened with min. 1" Type S drywall screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied with min 1.5" Type S drywall screws 12" o.c. (Exceeds minimum requirement)
2. Cavity Sides of assembly	• 2 hours (Cavity)-Top and Bottom of detail.	• 3.5" Sacrificial Wood Blocking. See section 5.1 above) (Exceeds minimum requirement)
3. Right side of assembly	• 2 hours (Right side of detail.)	• 3 layers 5/8" Type X GWB (120 Min.) • Fiberglass insulation • Air Gap (Exceeds minimum requirement)
Fire-Resistance Rating	**2-Hour Required**	**2-Hour (minimum)**

5.5 HSS 4x4x3/8 in wall #6(Figure 2d)

These columns will be installed in the interior wall #7. The evaluation will ensure 2 hours of continuous protection provided on each column face. Note: During assembly, if any gaps existing between column protection membranes (i.e hat channel) will be filled with mineral wool or a minimum ¼" wide fire caulking bead filling the vertical gap.

Table 5.5: Column protection evaluation (Wall #7)

Element	Minimum Protection required	Proposed Assembly
Location		• HSS 4x4x3/8 (W/D=1.10) (Exceeds minimum W/D requirement for CM2016 evaluation)
1. Left Side of assembly	• CM2016 • **Base** layer **1/2**" type X gypsum wallboard applied around W10x49 column and held in place with paper masking tape. • **Second** layer either No. 24 MSG galvanized steel column cover consisting of two L-shaped sections with snap-lock sheet steel joints or No. 22 MSG galvanized steel column covers consisting of two L-shaped sections with lap joints fastened with No. 8x**1/2**" sheet metal screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied without horizontal joints to column cover with 1" Type S drywall screws 8" o.c. spaced 1" from vertical edges. Metal cornerbead attached to all corners with 1" type S drywall screws 12" o.c. in each flange.	CM2016 equivalency • **Base** layer **5/8**" type X gypsum wallboard applied on hat channel over HSS column. • **Second** layer 10" minimum width, No. 24 MSG galvanized steel cover sheet. fastened with 1" Type S drywall screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied with min 1.5" Type S drywall screws 12" o.c. (Exceeds minimum requirement)
2. Cavity Sides of assembly	• 2 hours (Cavity)-Top and Bottom of detail.	• 3.5" Sacrificial Wood Blocking. See section 5.1 above) (Exceeds minimum requirement)

Element	Minimum Protection required	Proposed Assembly
3. Right side of assembly	• 2 hours (Right side of detail.) • CM2016 • **Base** layer **1/2**" type X gypsum wallboard applied around W10x49 column and held in place with paper masking tape. • **Second** layer either No. 24 MSG galvanized steel column cover consisting of two L-shaped sections with snap-lock sheet steel joints or No. 22 MSG galvanized steel column covers consisting of two L-shaped sections with lap joints fastened with No. 8x**1/2**" sheet metal screws 12" o.c. **Face** layer **5/8**" type X gypsum wallboard applied without horizontal joints to column cover with 1" Type S drywall screws 8" o.c. spaced 1" from vertical edges. Metal cornerbead attached to all corners with 1" type S drywall screws 12" o.c. in each flange.	CM2016 equivalency • **Base** layer **5/8**" type X gypsum wallboard applied on hat channel over HSS column. • **Second** layer 10" minimum width, No. 24 MSG galvanized steel cover sheet. fastened with 1" Type S drywall screws 12" o.c. • **Third** layer ½" Plywood Sheathing fastened with min. 1" Type S drywall screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied with min 1.5" Type S drywall screws 12" o.c. (Exceeds minimum requirement)
Fire-Resistance Rating	**2-Hour Required**	**2-Hour (minimum)**

5.6 HSS 4x4x3/8 in wall #6(Figure 2e)

These columns will be installed in the interior wall #9. The evaluation will ensure 2 hours of continuous protection provided on each column face. Note: During assembly, if any gaps existing between column protection membranes (i.e hat channel) will be filled with mineral wool or a minimum ¼" wide fire caulking bead filling the vertical gap.

Table 5.6: Column protection evaluation (Wall #9)

Element	Minimum Protection required	Proposed Assembly
Location		• HSS 4x4x3/8 (W/D=1.10) (Exceeds minimum W/D requirement for CM2016 evaluation)

Element	Minimum Protection required	Proposed Assembly
1. Left Side of assembly	• 2 hours (Left side of detail.)	• 3 layers 5/8” Type X GWB (120 Min.) • Air Gap (Exceeds minimum requirement)
2. Cavity Sides of assembly	• 2 hours (Cavity)-Top and Bottom of detail.	• 3.5” Sacrificial Wood Blocking. See section 5.1 above) (Exceeds minimum requirement)
3. Right side of assembly	• 2 hours (Right side of detail.) • CM2016 • **Base** layer **1/2**" type X gypsum wallboard applied around W10x49 column and held in place with paper masking tape. • **Second** layer either No. 24 MSG galvanized steel column cover consisting of two L-shaped sections with snap-lock sheet steel joints or No. 22 MSG galvanized steel column covers consisting of two L-shaped sections with lap joints fastened with No. 8x**1/2**" sheet metal screws 12" o.c. **Face** layer **5/8**" type X gypsum wallboard applied without horizontal joints to column cover with 1" Type S drywall screws 8" o.c. spaced 1" from vertical edges. Metal cornerbead attached to all corners with 1" type S drywall screws 12" o.c. in each flange.	CM2016 equivalency • **Base** layer ½” Plywood Sheathing fastened with min. 1" Type S drywall screws 12" o.c • **Second** layer **5/8**" type X gypsum wallboard applied over base layer fastened with min 1.5" Type S drywall screws 12" o.c. • **Third** layer 10” minimum width, No. 24 MSG galvanized steel cover sheet. fastened with min 1.5" Type S drywall screws 12" o.c. • **Face** layer **5/8**" type X gypsum wallboard applied with min 1.5" Type S drywall screws 12" o.c. (Exceeds minimum requirement)
Fire-Resistance Rating	**2-Hour Required**	**2-Hour (minimum)**

6 CONCLUSION

The column assembly protection as detailed above is a conservative application of ASTM, E119, UL X526, as well as acceptable materials to ensure 2-hour minimum fire resistance is provided.

Protection is provided with a GWB membranes, composed of 2 or 3 layers of 5/8” Type-X or solid wood sacrificial blocking. The assembly evaluation utilized protection guidelines as tested in UL X526, which is a conservative model with the tested member simultaneously exposed to heat on all sides. The protection level as proposed will be superior to the tested protection, as the modified proposed assemblies are only partially exposed to a fire from the left side, (cavity) side or right side of the subject column.

Based on the above evaluation, along with the referenced UL tested assembly, the columns will be protected for an equivalent 2-hour fire resistance. Through a combination of evaluated protection measures, the column assemblies will be conservatively protected for the minimum 2-hour fire-resistance.

Franklin Callfas
Principal/Fire Protection Engineer
Code Unlimited