HAI Project 1AJP00083.000

Fire Protection for Residential Floor/Ceiling Assemblies Using Light Framed Construction

Prepared for

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EXECUTIVE SUMMARY

Section R501.3 was recently added to the 2012 International Residential Code (IRC) to require additional levels of protection for floor assemblies incorporating lighter floor joist members not elsewhere in the Residential Code required to be fire-resistance rated. Per Section R501.3, Floor assemblies shall be required to be provided with ½-inch (12.7 mm) gypsum wallboard membrane, ⅝-inch (16 mm) wood structural panel membrane, or equivalent on the underside of the floor framing member.

Equivalency of a proposed Armstrong World Industries (AWI) ceiling tile system with the code prescribed membrane protection system was accomplished by conducting a comparative large-scale fire-resistance test. Two nominally 9-½ foot long by 13-ft wide TJI wood framed floor/ceiling assemblies were constructed by Intertek testing Services NA, Inc. (Intertek) and subjected to the fire exposure conditions specified in ASTM E119 until collapse of the floor assembly occurred or was imminent.

The underside of the prescriptive floor/ceiling assembly was finished with the installation of a single layer of 21/32-inch thick plywood. The underside of the comparative floor/ceiling assembly was protected with the AWI ⅝-inch thick Armstrong Sahara™ Angled HumiGuard™ Plus Acoustical Material ceiling tiles (Product No. 271) installed in a residential fire-rated ceiling grid system with fire relief notches (Product No. 7400RWH).

During the fire exposure test, the plywood floor/ceiling assembly started to deflect 12-½ minutes into the test and collapsed into the test furnace at 14minutes 47 seconds. The test assembly protected by the AWI ceiling tile system began deflecting approximately 21 minutes into the test, at which time the test was terminated (furnace burners turned off). The floor assembly collapsed into the furnace at 23 minutes 40 seconds. Based on the testing, it was concluded that the floor/ceiling assembly protected with the AWI HumiGuard ceiling tile system provided an additional 6 minutes of protection to the floor system compared to the code prescribed protection system, this meeting the intent of the code for an “equivalent” membrane protection material.

Additional small-scale testing was conducted on similar ceiling tile products to extrapolate the testing results to include other similar ceiling tile products and sizes of ceiling tiles. The small-scale testing indicated that a suspended ceiling grid system incorporating either 2-ft x 2-ft or 2-ft x 4-ft HumiGuard ceiling panels would provide the required level of protection. The FireGuard™ ceiling panels, which are more commonly used in fire-resistance rated suspended ceiling grid systems, can also be in the suspended ceiling system to meet the requirements specified in Section R501.3 of the 2012 IRC.

Based on the testing and analysis described above, it was concluded that the following ceiling tile panels meet the intent of Section R5013 of the 2012 IRC for providing protection to a non fire-resistance rated residential floor/ceiling assembly:

- ⅝-inch thick HumiGuard Plus ceiling panels:
    - 2-ft x 2-ft Fine Fissured™ (Product No. 928)
    - 2-ft x 2-ft Fine Fissured (Product 932)
    - 2-ft x 2-ft Supertuff™ (Product 241)

    - 2-ft x 2-ft Sahara (Product No. 273)
    - 2-ft x 2-ft Sand Pebble™ (Product No. 269A)
    - 2-ft x 2-ft Sahara (Product No. 271)
    - 2-ft x 4-ft Dune™ (Product No. 1773)

- ⅝-inch thick FireGuard ceiling panels:
    - 2-ft x 2-ft Fine Fissured Black (Product No. 1728ABL)
    - 2-ft x 2-ft Classic Fine Fissure (Product No. 954)
    - 2-ft x 4-ft Textured FireGuard (Product No. 915)
    - 2-ft x 4-ft Fine Fissured (Product No. 922)

Any of the ceiling panel products listed above, shall be installed in a residential-grade fire-rated ceiling grid system, incorporating main runners with fire-relief notches (Product No. 8300RWH and 7400RWH), 4-ft cross tee (Product No. XL7348RWH), 2-ft cross tee (Product No. XL7328RWH), wall molding (Product No. 7800RWH), and installed a minimum of 4-inches below the bottom of the wood floor joists

FIRE PROTECTION FOR RESIDENTIAL FLOOR/CEILING ASSEMBLIES USING LIGHT FRAMED CONSTRUCTION

1.0 BACKGROUND

Section R501.3 was recently added to the 2012 International Residential Code (IRC) to require additional levels of protection for floor assemblies incorporating lighter floor joist members not elsewhere in the Residential Code required to be fire-resistance rated.

Section R501.3 states the following:

R501.3 Fire protection of floors. Floor assemblies, not required elsewhere in this code to be fire-resistance rated, shall be provided with a ½-inch (12.7 mm) gypsum wallboard membrane, ⅝-inch (16 mm) wood structural panel membrane, or equivalent on the underside of the floor framing member.

Exceptions:

1. *Floor assemblies located directly over a space protected by an automatic sprinkler system in accordance with Section P2904, NFPA 13D, or other approved equivalent sprinkler system.*
2. *Floor assemblies located directly over a crawl space not intended for storage of fuel-fires equipment.*
3. *Portions of floor assemblies can be unprotected when complying with the following:*
   - *3.1 The aggregate area of the unprotected portions shall not exceed 80 square feet per story*
   - *3.2 Fire blocking in accordance with Section R302.11.1 shall be installed along the perimeter of the unprotected portion to separate the unprotected portion from the remainder of the floor assembly.*
4. *Wood floor assemblies using dimensional lumber or structural composite lumber equal to or greater than 2-inch x 10-inch (50.8 mm by 254 mm) nominal dimension, or other approved floor assemblies demonstrating equivalent fire performance.*

The charging statement in Section R501.3 lists two prescriptive membrane protection options which will provide the code required level of protection to the wood floor joist members. The prescriptive materials (gypsum wallboard and plywood) provide varying degrees of fire protection, so the level of protection to the wood floor joists will be dependent on the installed membrane material. The option for other membrane materials which will provide “equivalent” levels of protection is also included. Any testing or analysis of a new membrane material or system must, therefore, demonstrate equivalency to at least one of the two prescriptive membrane materials.

2.0 OBJECTIVE

The objective of this analysis was to demonstrate that a TJI joist floor assembly incorporating a residential grade fire-rated suspended ceiling grid system with fire relief notches (Product No. 7400 RWH) and the Armstrong World Industries (AWI) ⅝-inch thick Armstrong Sahara™ Angled HumiGuard™ Plus Acoustical Material ceiling tiles (Product No. 271) would provide the equivalent fire performance as a similarly constructed floor assembly protected with a membrane system which meets the intent of Section R501.3 of the 2012 IRC.

3.0 APPROACH

To meet the objective above, a series of small-scale fire performance tests were initially conducted to determine the fire performance of the two prescriptive ceiling membrane materials specified in Section R501.3 along with other membrane materials and the AWI HumiGuard Plus ceiling tile. Using small-scale testing data, a floor/ceiling assembly protected with the AWI suspended ceiling tile system was constructed and tested to document the fire performance and compared to a similarly constructed floor/ceiling assembly incorporating one of the code prescribed protection membrane materials.

Equivalency between the code prescribed membrane protection system and the suspended ceiling tile system was demonstrated by conducting a comparative full-scale floor/ceiling assembly test in general accordance with ASTM E119. Two identical floor/ceiling assemblies (framing, floor joists, and subfloor) were constructed with each test assembly being approximately 123 square feet in size (9-½ feet long x 13-feet wide). Membrane protection for one floor/ceiling assembly was provided by installing a single layer of nominal ⅝-inch thick plywood (actual 21/32-inch thick) on the underside of the floor joists. Membrane protection for the second floor/ceiling assembly was provided by the installation of the AWI suspended ceiling system incorporating the ⅝-inch thick Armstrong Sahara Angled HumiGuard Plus Acoustical Material ceiling tiles nominally 4-inches below the bottom of the floor joists. The two floor/ceiling assemblies were placed on the large horizontal furnace at Intertek Testing Services NA, Inc. (Intertek) with a superimposed live load of 40 pounds per square foot (psf). When installed on the horizontal furnace, both test assemblies were subjected to the ASTM E119 fire exposure conditions until loss of structural integrity was observed in both test assemblies.

4.0 SMALL-SCALE TESTING

A series of small-scale fire exposure tests were conducted on candidate membrane materials (prescriptively allowed materials, other membrane materials, and AWI HumiGuard Plus ceiling tile product) to determine the finish rating of each material. The finish rating is defined in the front of the UL Fire Resistance Directory as the time that the temperature on the unexposed side of a membrane material exposed to the fire exceeds an individual temperature rise of 325°F (180°C) above the ambient starting temperature or an average temperature rise of 250°F (139°C) above the ambient starting temperature. ASTM E119 specifies a maximum starting ambient temperature of 90°F (18°C), therefore, the maximum individual unexposed surface temperature would be 415°F (213°C) and the maximum average unexposed surface temperature would be 340°F (171°C) during an ASTM E119 test. While the finish rating temperature limits are the same as the unexposed surface temperature limits used in ASTM E119 for fire-resistance rated assemblies, the finish rating is not a rating *per se* for the membrane material. Rather the finish rating time is a fire performance parameter which is used to predict performance of a single component used in a fire-resistance rated assembly and compare the fire performance of one product to another.

The finish rating was used to compare the thermal performance of the candidate membrane materials when subjected to the ASTM E 119 fire exposure to the two code prescribed membrane materials. This testing was utilized to confirm the ceiling tile material would be expected to meet the project goals but would also be an economical product for use in a residential ceiling system.

4.1 Testing Matrix and Results

AWI acquired the code prescribed membrane materials and a sheet of OSB from a local building supply warehouse for the testing; the 2-ft x 4-ft ceiling tile sample (Product No. 1773) was obtained from manufacturing stock. The two code prescribed membrane materials and the OSB material were cut to 2-ft wide x 4-ft long samples to match the size of the AWI ceiling tile sample. All test samples were tested individually on top of AWI's small-scale horizontal furnace and subjected to the fire exposure conditions specified in ASTM E119. The opening at the top of the furnace is 4-ft square and the 2-ft x 4-ft membrane sample was positioned in the center of the furnace supported on ceiling grid runners. Two border panels (1-ft x 4-ft each) were fitted on each side of the test sample to close off the furnace opening. Two Type K welded junction thermocouples (TCs) were symmetrically positioned on the unexposed surface of the membrane material; each covered by TC pads specified in ASTM E119. Figure 1 shows the unexposed surface of a representative membrane material resting on top of the furnace prior to instrumentation placement and testing.

Each membrane material was subjected to the fire exposure conditions specified in ASTM E119 until either of the individual unexposed surface temperatures exceeded a temperature rise of 325°F (180°C) above the ambient starting temperature or the average temperature rise of both TCs exceeded an average temperature rise of 250°F (139°C) above the ambient starting temperature and/or the test material burned-through or collapsed into the test furnace. A summary of the test results is provided in Table 1. Figure 2 shows the average furnace temperature measured in each of the four tests. The nearly identical furnace temperatures indicated that the exposure to each membrane material was very similar; supporting the premise that comparison of the finish rating data in Table 1 is appropriate.

The results of the small-scale finish rating testing indicated that the prescriptive membrane materials and the OSB provided finish ratings of 14 to 17 minutes. One each of the samples, the unexposed surface temperature increased until the finish ratings temperatures were exceeded, at which time, the wood based membrane materials burned through and collapsed into the test furnace. The gypsum wallboard sample exceeded the finish rating temperatures at approximately 17 minutes and fell into the test furnace at approximately 20 minutes. The candidate ceiling tile material had a finish rating time of 9 minutes as determined by the unexposed surface TCs. However, the sample remained in-place for approximately 45 minutes before falling into the furnace.

Table 1. Small-scale finish rating testing results

Membrane Material	Time to Exceed Temperature Limits (min)		Finish Rating (min)	Comments
	Individual	Average		
21/32" plywood	15.7	14.7	14	Sample burned through and fell into furnace at approximately 17-½ minutes
½" gypsum wallboard	17.0	17.5	17	Sample fell into furnace at approximately 20-½ minutes
21/32" OSB	14.9	15.5	15	Sample burned through and fell into furnace at approximately 18-½ minutes
⅝-inch thick Sahara HumiGuard Plus (2-ft x 4-ft panel)	9.8	9.2	9	Sample remained on furnace for approximately 45 minutes (Product No. 1773)

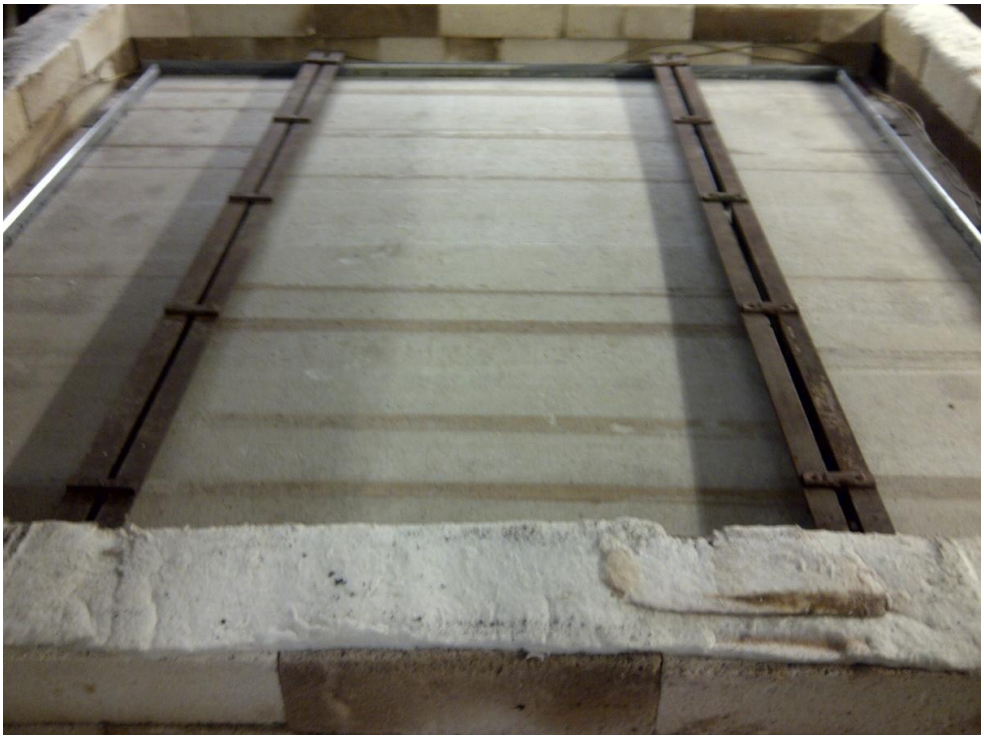


Figure 1. Candidate membrane material on small horizontal furnace prior to testing. The test sample is located in the middle of the 4-ft x 4-ft furnace.

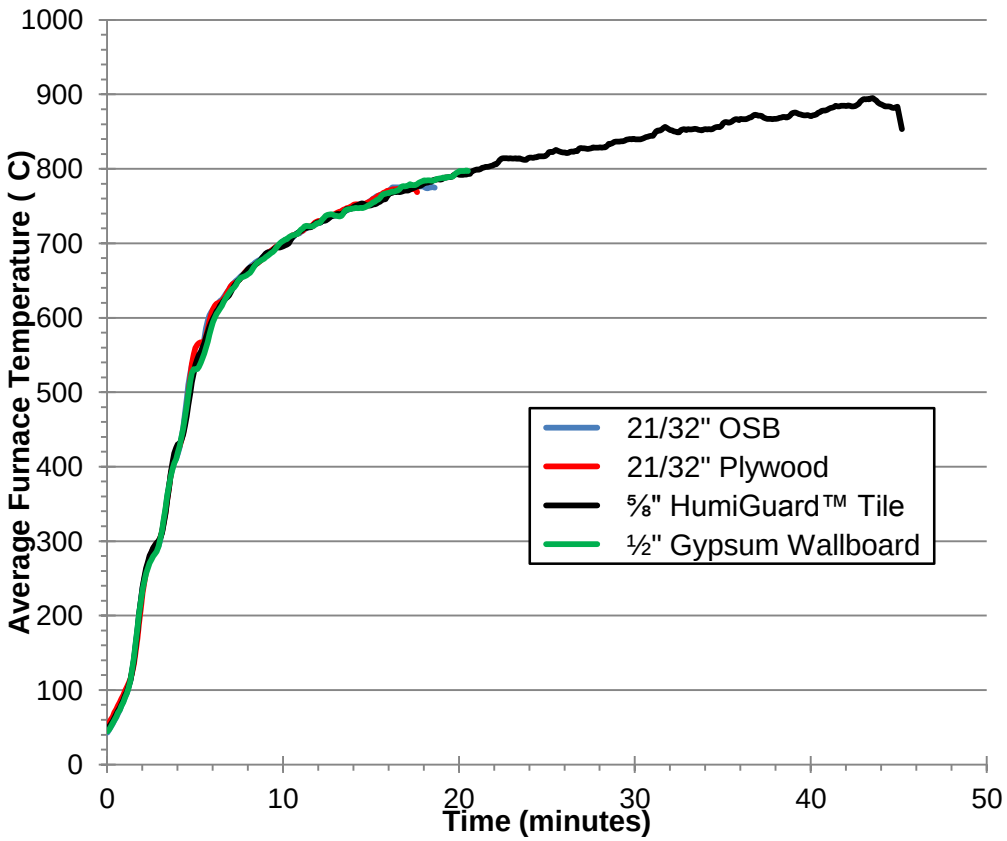


Figure 2. Average furnace temperatures measured during small-scale finish rating tests

While the prescriptive membrane protection materials provided a longer finish rating time than the ceiling tile material, the mechanism of failure for the prescriptive materials was burn-through or collapse. The unexposed surface temperature data showed a gradual increase in the unexposed surface temperature, followed by a dramatic increase after burn-through and/or collapse occurred, as shown in Figure 3. Literature sources give a temperature at which wood beings to char at approximately 536°F to 572°F (280°C to 300°C) and an auto-ignition temperature range of approximately 572°F to 752°F (300°C to 400°C) [1,2]. The code prescribed membrane protection materials would, therefore, be expected to limit fire penetration until the finish rating time. After this time, fire would penetrate up into the floor joist cavity, resulting in ignition of the wood floor joists.

The ceiling tile sample showed a quicker time to exceed the finish rating temperature limits; however, it remained in-place for a significantly longer period of time. The ability of the ceiling tile to remain in-place would delay direct fire penetration, requiring the interstitial floor/ceiling assembly space to heat up to the auto-ignition temperature of wood, which is significantly higher than the finish rating temperature. This would be expected to result in increased protection to the floor/ceiling assembly, assuming that the heat migration time through the membrane material plus the finish rating time would exceed the finish rating time of the code prescriptive membrane materials.

Based on the small-scale finish rating testing results, the ⅝-inch thick plywood code prescribed membrane protection material was selected for large-scale testing. This material would be expected to prevent fire penetration into the floor joist space for approximately 14 minutes, which was approximately three minutes less than the gypsum wallboard.

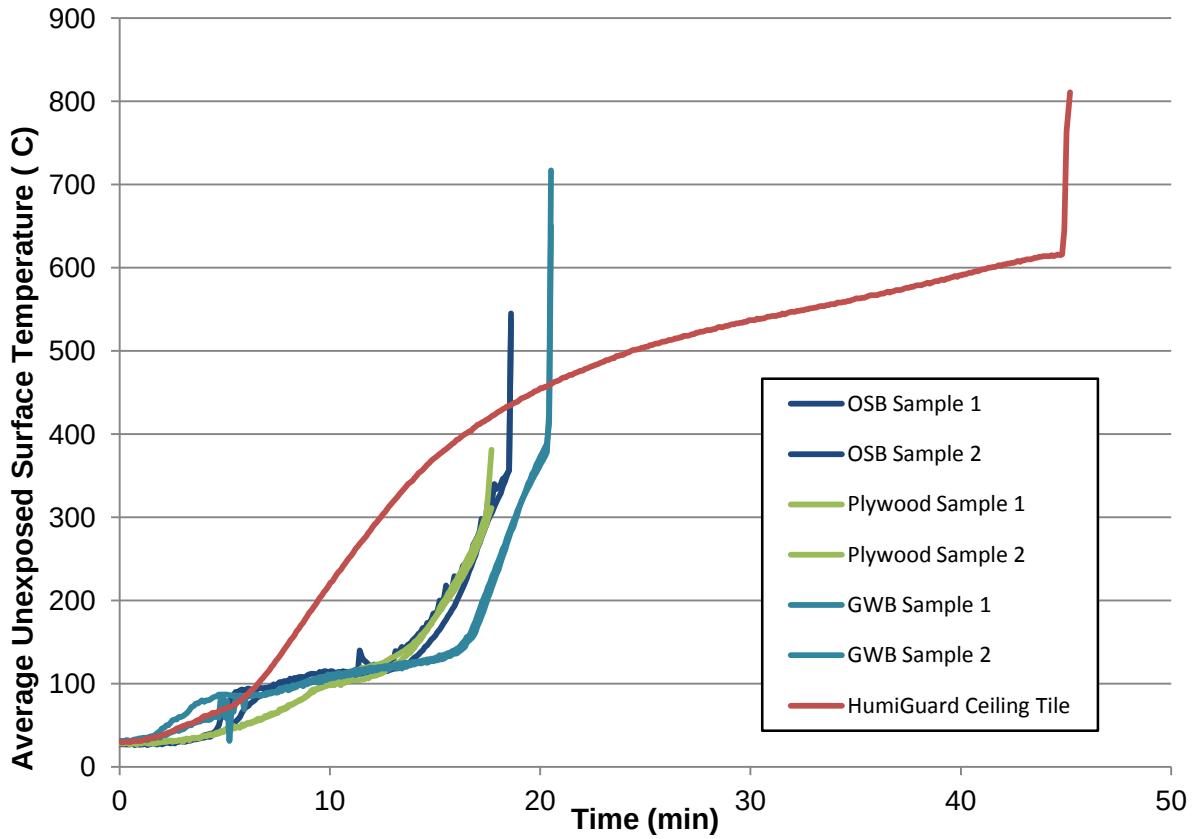


Figure 3. Average unexposed surface temperatures of ceiling membrane materials

5.0 LARGE-SCALE COMPARATIVE TESTING

Equivalency of the AWI ceiling tile system with the code prescribed membrane protection system was accomplished by conducting a comparative large-scale fire-resistance test. Two nominally 9-½ foot long by 13-ft wide wood framed floor/ceiling assemblies were constructed by Intertek. Construction drawings for the test assemblies are provided in Intertek Report No. 100841605SAT-001_Rev. 1, dated February 13, 2013 and included in Appendix A of this report.

Both test assemblies incorporated 11-⅞ inch deep x 1-¾ inch Weyerhaeuser Trus Joist TJI joists spaced 24-inches on center. Nominally 1-¾ inch thick Weyerhaeuser 1.9E LVLs were used as the rim joists for each floor/ceiling assembly with the center span over the horizontal furnace reinforced with a double LVL and protected with two layers of ⅝-inch thick Type X gypsum wallboard. A single layer of ¾-inch thick plywood was installed on the unexposed side of each test assembly as the subfloor. Figure 4 shows a view of the floor/ceiling assembly prior to the installation of the membrane protection system on the underside of the TJI floor joists. Visible in Figure 4 is the instrumentation installed within the floor/ceiling interstitial space, including TCs on the underside of the TJI bottom chord (finish rating TCs), TCs installed on the web of the TJI, and air cavity TCs. Additional TCs were installed on the unexposed surface of the floor/ceiling assembly in accordance with ASTM E119. The construction drawings contained in Appendix A show the locations of the TCs installed within the floor/ceiling assembly. Both test assemblies were loaded with concrete block to achieve a uniform superimposed live load of approximately 40 psf.

The underside of the prescriptive floor/ceiling assembly was finished with the installation of a single layer of 21/32-inch thick plywood as shown in Figure 5. The underside of the comparative floor/ceiling assembly was protected with the AWI ⅝-inch thick Armstrong Sahara Angled HumiGuard Plus Acoustical Material ceiling tiles (Product No. 271) installed in a residential fire-rated ceiling grid system with fire relief notches (Product No. 7400RWH). The back of the ceiling tiles were positioned nominally 4-inches below the underside of the TJI floor joists. The finished floor/ceiling assembly is shown in Figure 6. All ceiling tiles were 2-ft x 2-ft, not the 2-ft x 4-ft panel tested in the small-scale finish rating testing discussed in Section 4.1. This resulted in more joints and seams in the tested assembly.

Figure 4. Underside of floor/ceiling assembly prior to installation of membrane protection system (typical)

Figure 5. Exposed surface of prescriptive code compliant floor/ceiling assembly.

Figure 6. Exposed surface of comparative floor/ceiling assembly protected with AWI suspended ceiling tile system

5.1 Comparative Testing Results and Conclusions

A complete description of the construction of each of the floor/ceiling assemblies and the results of the testing are provided in Intertek Report No. 100841605SAT-001_Rev. 1, dated February 13, 2013. By simultaneously evaluating the fire performance of the two floor/ceiling assemblies on the large horizontal furnace, both samples were subjected to the same fire exposure conditions specified in ASTM E119 and allowed for a direct comparative fire performance evaluation.

The test was initiated at 12:08 pm on December 14, 2012. The TCs installed on the underside of the TJI bottom chords in the plywood floor/ceiling assembly (finish rating TCs) exceeded the temperature limits specified in Section 4.0 approximately 9 to 9-½ minutes into the test. This time is quicker than predicted by the small-scale tests and could have been attributed to fire penetration through joints in the plywood sheets installed under the TJIs which were not accounted for in the small-scale testing. Approximately 10 to 10-½ minutes into the test, the TCs installed within the interstitial space (web TCs and air cavity TCs), exceeded 572°F (300°C), indicating that the onset of the burning of the combustible floor/ceiling assembly members had likely occurred. Deflection of the plywood floor/ceiling assembly was observed to start approximately 12-½ minutes into the test and at 14:47, the deck collapsed into the test furnace. A cover deck was placed over the furnace where the plywood floor/ceiling assembly was positioned to allow the test of the suspended ceiling tile system assembly to continue.

The TCs installed on the underside of the TJI floor joists in the ceiling tile floor/ceiling assembly (finish rating TCs) exceeded the finish rating temperatures specified in Section 4.0 approximately 7-½ to 8 minutes into the test. This finish rating time was approximately equal to

the small-scale testing predicted performance times with the slight difference in time likely attributed to the multiple joints in the complete ceiling grid system. The air cavity and TJI web surface TCs exceeded 572°F (300°C) approximately 16-½ minutes into the test. The test was terminated (furnace burners turned off) at 21 minutes when significant sagging of the suspended ceiling tile floor/ceiling assembly was observed. This floor/ceiling assembly eventually collapsed into the test furnace at 23:40. Figures 7, 8, and 9 compare the average bottom chord temperatures, center web temperatures and interstitial air space air temperatures as measured in each test specimen during the comparative fire test.

The thermocouples installed within the floor/ceiling assembly indicated that relatively quickly, heat migrated through the ceiling grid system into the interstitial space. Approximately 7 minutes into the test, the expansion notches in the main grid runners activated closing some of the gaps and slowing the heat migration into the floor interstitial space. The heat movement up through the ceiling tiles was gradual throughout the remainder of the test, peaking at approximately 700°F to 800°F at the end of the test.

The heat from the fire began to quickly migrate through the plywood membrane as evidenced by the thermocouples installed on the underside of the TJI joists. The accumulation of heat within the interstitial space quickly jumped approximately 8 minutes into the test when the plywood membrane likely burned through, allowing fire up into the floor cavity space. By 10 minutes, the temperatures within the floor cavity were rising quickly as the combustible floor components were burning, leading to the eventual system collapse at 14:47.

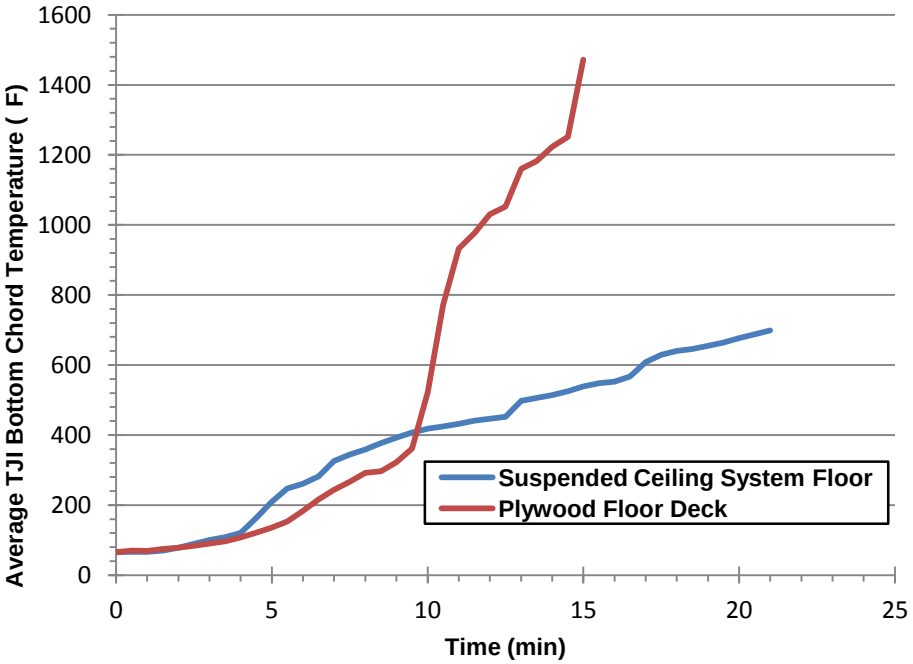


Figure 7. Average TJI bottom chord temperature for both floor assemblies

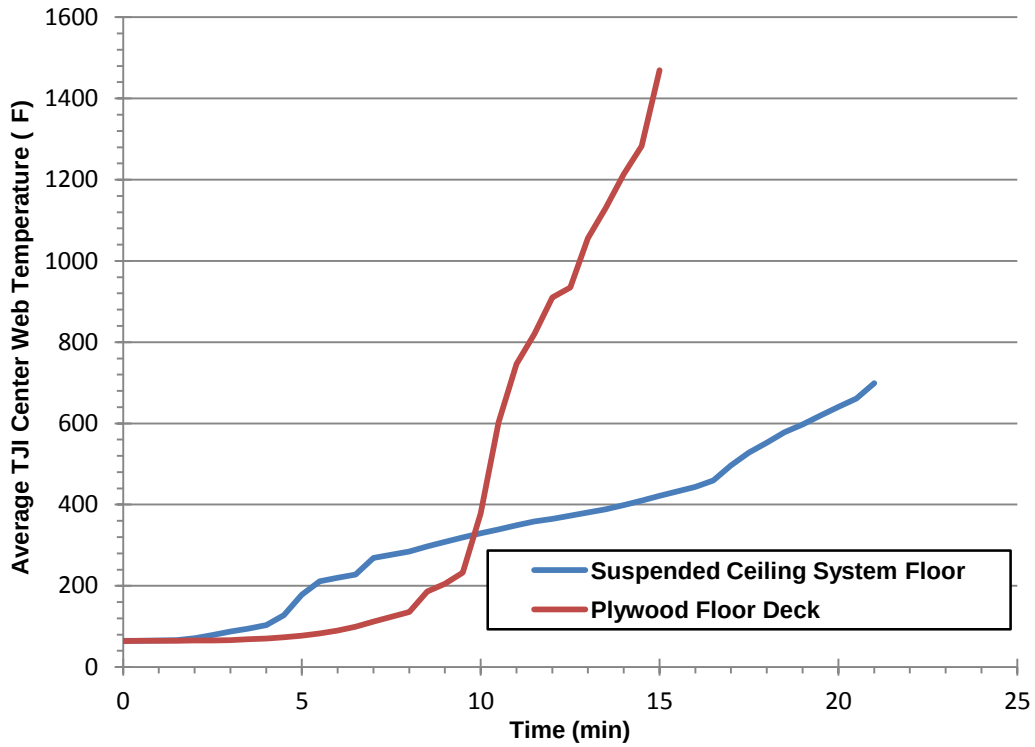


Figure 8. Average TJI center web temperature for both floor assemblies

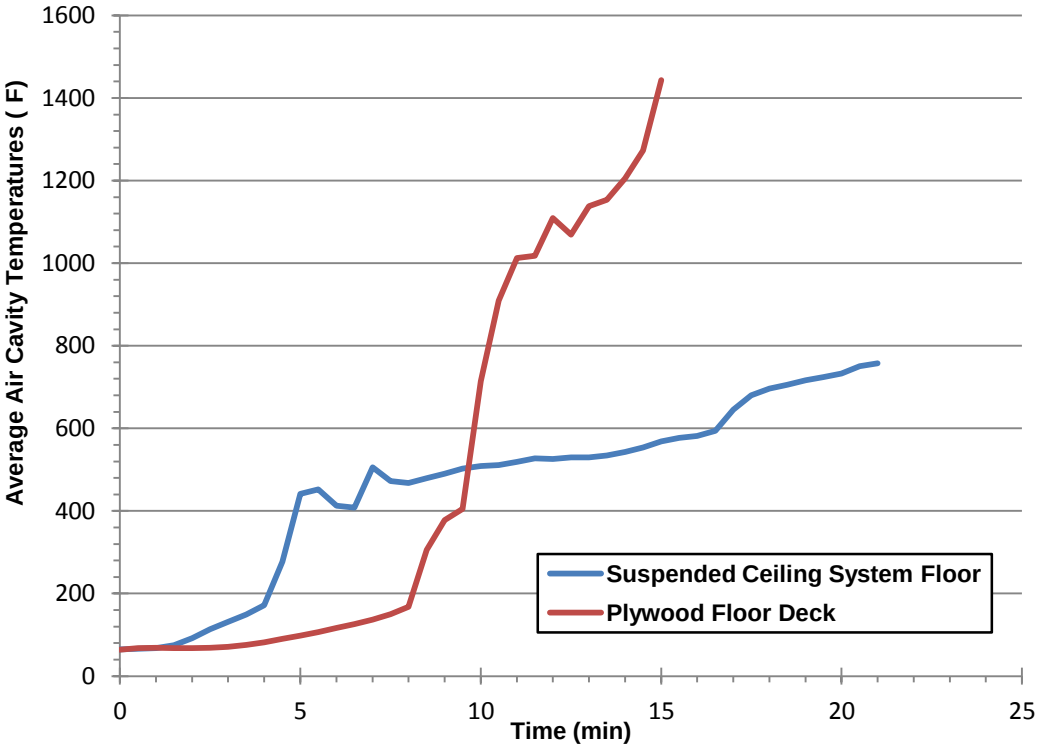


Figure 9. Average floor system air cavity temperature for both floor assemblies

As reported in the Intertek test report, the structural integrity of the wood joist floor/ceiling assembly protected with the prescriptive plywood membrane was maintained for 14 minutes 47 seconds. The comparative floor/ceiling assembly protected with the AWI ceiling tile system, installed as described in the Intertek test report, provided at a minimum 21 minutes of protection to the floor assembly. Based on the testing, it was concluded that the underside of the wood framed floor/ceiling assembly protected with the AWI ceiling tile system provided an additional 6 minutes of protection to the assembly compared to the prescriptive plywood membrane system, thus meeting the intent of the code for an "equivalent" membrane protection material.

6.0 ADDITIONAL ACCEPTABLE CEILING TILE PRODUCTS

The large-scale testing evaluated the fire performance of the 2-ft x 2-ft by ⅝-inch thick Armstrong Sahara Angled HumiGuard Plus Acoustical Material ceiling tiles (Product No. 271). Additional small-scale finish rating testing was conducted by AWI on similar ceiling tile products to potentially extrapolate the testing results to include other similar ceiling tile products and sizes of ceiling tiles. All small-scale testing to determine finish ratings for additional ceiling tile products was conducted in a similar manner as the original testing described in Section 4.0.

Small-scale tests were conducted on HumiGuard and the FireGuard ceiling tile products. The results of the follow-on small-scale testing are provided in Table 2. Included in Table 2 is the finish rating times for the tested plywood and 2-ft x 2-ft HumiGuard Plus ceiling tile product for comparison.

Table 2. Follow-on small-scale finish rating testing results

Membrane Material	Time to Exceed Temperature Limits (min)		Finish Rating (min)	Comments
	Individual	Average		
21/32" plywood	15.7	14.7	14	Sample burned through and fell into furnace at approximately 17-½ minutes
⅝-inch thick Dune HumiGuard Plus (2-ft x 4-ft panel)	9.8	9.2	9	Sample remained on furnace for approximately 45 minutes (Product No. 1773)
⅝-inch thick Fine Fissured HumiGuard Plus (2-ft x 2-ft panel)	8.0	7.1	7	Test terminated at 27.5 minutes when one board fell into furnace. Both ceiling tiles started to fall off grid system 23 to 25 minutes (Product No. 928)
FireGuard (2-ft x 4-ft panel)	9.2	8.1	8	Test terminated after 90 minutes with no noticeable deflection of test sample. (Product No. 915)

The large-scale fire test incorporated the 2-ft x 2-ft Sahara HumiGuard Plus panels (Product No. 271) which are the same formulation as the Fine Fissured HumiGuard panels (Product No. 928). Per the data in Table 2, the 2-ft x 2-ft Fine Fissured HumiGuard Plus panel has a slightly lower finish rating that the 2-ft x 4-ft Dune™ HumiGuard Plus panel. This comparison in finish rating times indicates that the 2-ft x 4-ft HumiGuard Plus panels would be expected to provide similar fire performance. The large-scale testing also supported the use of either the 2-ft x 2-ft or the 2-ft x 4-ft HumiGuard Plus panels as the use of larger panel would result in less ceiling panel joints and seams, decreasing pathways for heat to migrate into the open floor interstitial space.

During the small-scale testing, the 2-ft x 2-ft panels fell out of the grid approximately 23 to 25 minutes into the test, which is comparable to what likely occurred during the large-scale test. The larger 2-ft x 4-ft HumiGuard panel remained in the grid system during the small-scale finish rating testing for approximately 75 minutes, indicating that the longer 4-ft panel dimension would not compromise the fire performance of the fire performance.

The FireGuard panel (Product No. 915) is a commercial grade ceiling panel used in many AWI fire-resistance rated ceiling assemblies. The finish rating of the FireGuard panel is comparable to the two HumiGuard brand panels and can be substituted into the ceiling grid membrane system protecting a residential floor/ceiling assembly without adversely impacting the fire-resistance rating of the assembly.

7.0 CONCLUSIONS

New code requirements in the 2012 IRC require certain residential, non-rated floor/ceiling assemblies be protected with a membrane system to provide additional fire protection to the floor joists, specifically floor assemblies incorporating lightweight construction. The code requires the underside of the floor framing be covered by a single layer of ½-inch thick gypsum wallboard, ⅝-inch thick plywood, or an equivalent system. AWI has proposed using a residential grade fire-rated ceiling grid system incorporating main runners with fire relief notches and a non-rated ceiling panel product to provide equivalent protection for a floor assembly required by Section R501.3 of the 2012 IRC to be provided with membrane protection.

A large-scale comparative test was conducted to compare the fire performance of two identical floor assemblies constructed using TJI floor joists. One floor assembly was protected with a single layer of ⅝-inch thick (actual 21/32-inch thick) plywood and a second floor assembly was protected with the AWI ceiling panel system incorporating 2-ft x 2-ft by ⅝-inch thick Sahara HumiGuard ceiling panels.

Both floor assemblies were loaded to approximately 40 psf and subjected to the fire exposure conditions specified in ASTM E119 until collapse and/or burn through of the assembly occurred. The results of this testing showed that the plywood protected floor assembly collapsed after almost 15 minutes of fire exposure. The floor assembly protected with the AWI ceiling grid system provided an additional 6 minutes of protection over the plywood protected floor assembly. Based on the results of this testing, it was concluded that the protection afforded by the AWI suspended ceiling system incorporating the 2-ft x 2-ft by ⅝-inch thick Sahara HumiGuard ceiling panels provided an equivalent level of protection compared to the floor assembly protected with a code prescribed membrane material.

Subsequent small-scale testing indicated that a suspended ceiling grid system incorporating either 2-ft x 2-ft or 2-ft x 4-ft HumiGuard ceiling panels would provide the required level of protection. The FireGuard ceiling panels, which are more commonly used in fire-resistance rated suspended ceiling grid systems, can also be in the suspended ceiling system to meet the requirements specified in Section R501.3 of the 2012 IRC.

Based on the testing and analysis described above, it was concluded that the following ceiling tile panels meet the intent of Section R5013 of the 2012 IRC for providing protection to a non fire-resistance rated residential floor/ceiling assembly:

- ⅝-inch thick HumiGuard Plus ceiling panels:
    - 2-ft x 2-ft Fine Fissured (Product No. 928)

- 2-ft x 2-ft Fine Fissured (Product 932)
- 2-ft x 2-ft Supertuff (Product 241)
- 2-ft x 2-ft Sahara (Product No. 273)
- 2-ft x 2-ft Sand Pebble (Product No. 269A)
- 2-ft x 2-ft Sahara (Product No. 271)
- 2-ft x 4-ft Dune (Product No. 1773)

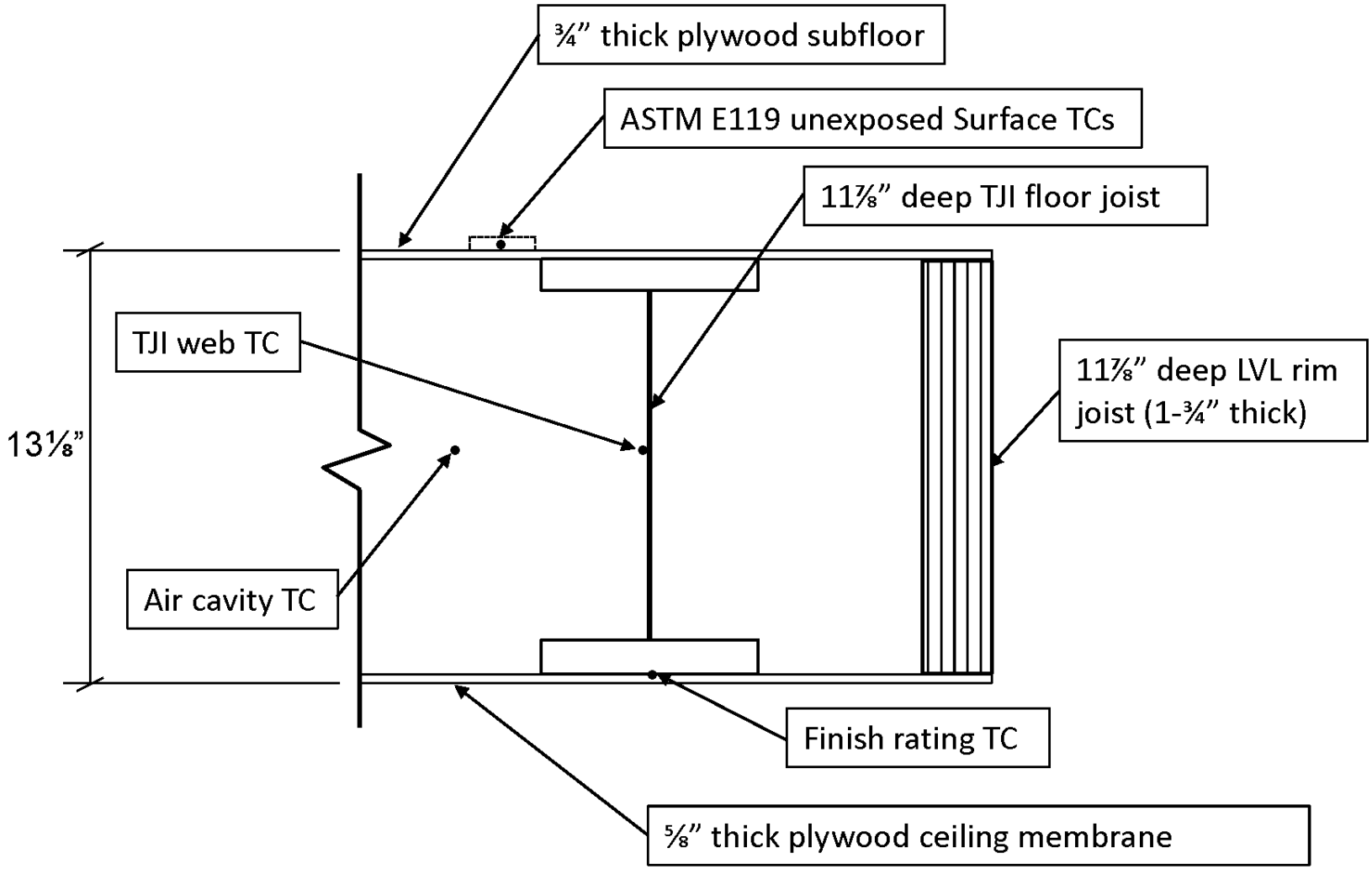
- ⅝-inch thick FireGuard ceiling panels:
  - 2-ft x 2-ft Fine Fissured Black (Product No. 1728ABL)
  - 2-ft x 2-ft Classic Fine Fissure (Product No. 954)
  - 2-ft x 4-ft Textured Fire Guard (Product No. 915)
  - 2-ft x 4-ft Fine Fissured (Product No. 922)

Any of the ceiling panel products listed above, shall be installed in a residential-grade fire-rated ceiling grid system, incorporating main runners with fire-relief notches (Product No. 8300RWH and 7400RWH), 4-ft cross tee (Product No. XL7348RWH), 2-ft cross tee (Product No. XL7328RWH), wall molding (Product No. 7800RWH), and installed a minimum of 4-inches below the bottom of the wood floor joists, as shown in the construction drawings shown in Appendix A.

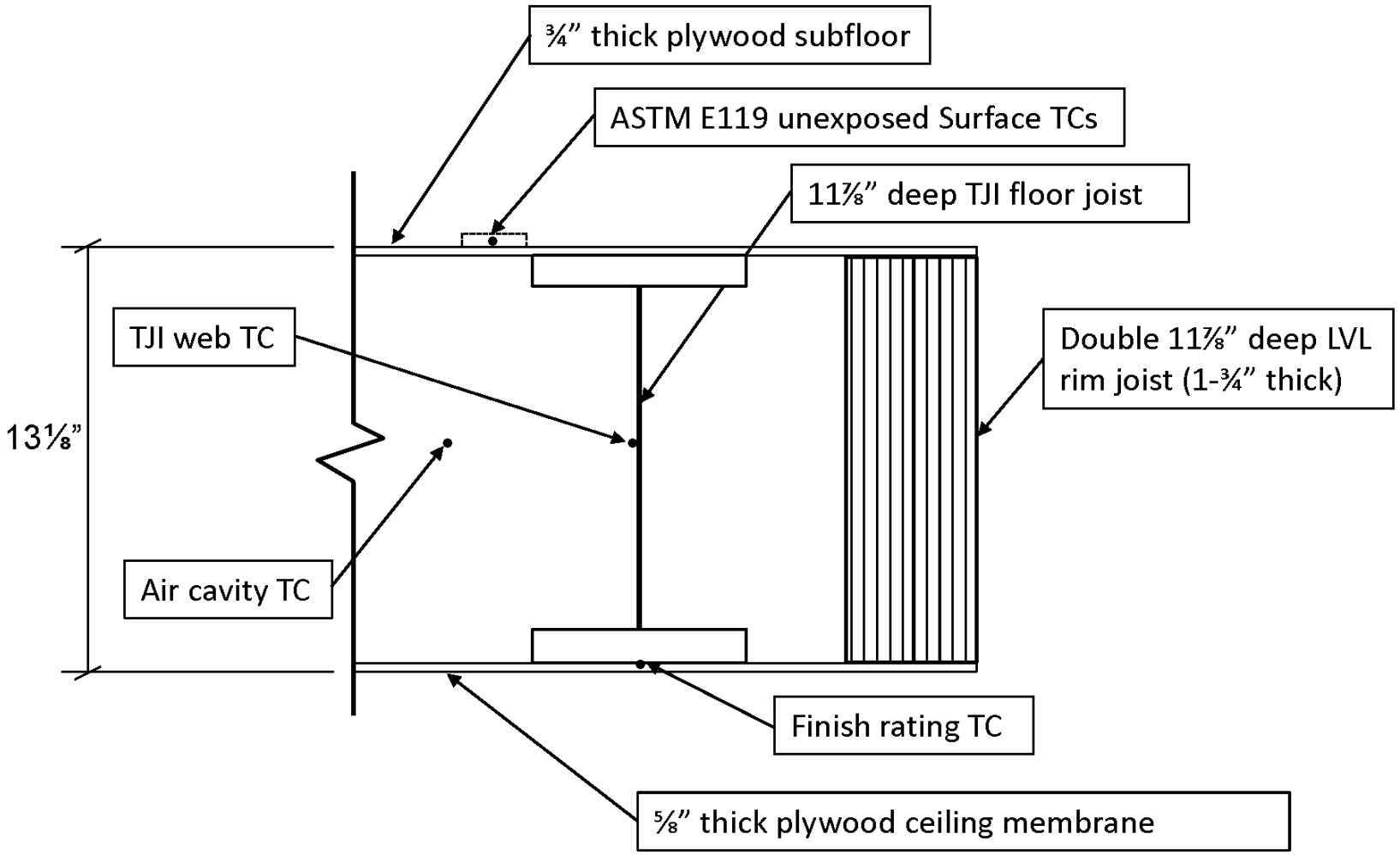
8.0 REFERENCES

1. Kodur, V.K.R. and Harmathy, T.Z., “Properties of Building Materials,” The Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 3rd Edition, National Fire Protection Association, Quincy, MA, pp. 1-155 to 1-181, 2002.
2. Forest Products Laboratory, General Technical Report FPL-GTR-113, “Wood Handbook – Wood as An Engineering Material,” Madison, WI, U.S. Department of Agriculture, pp17-6.

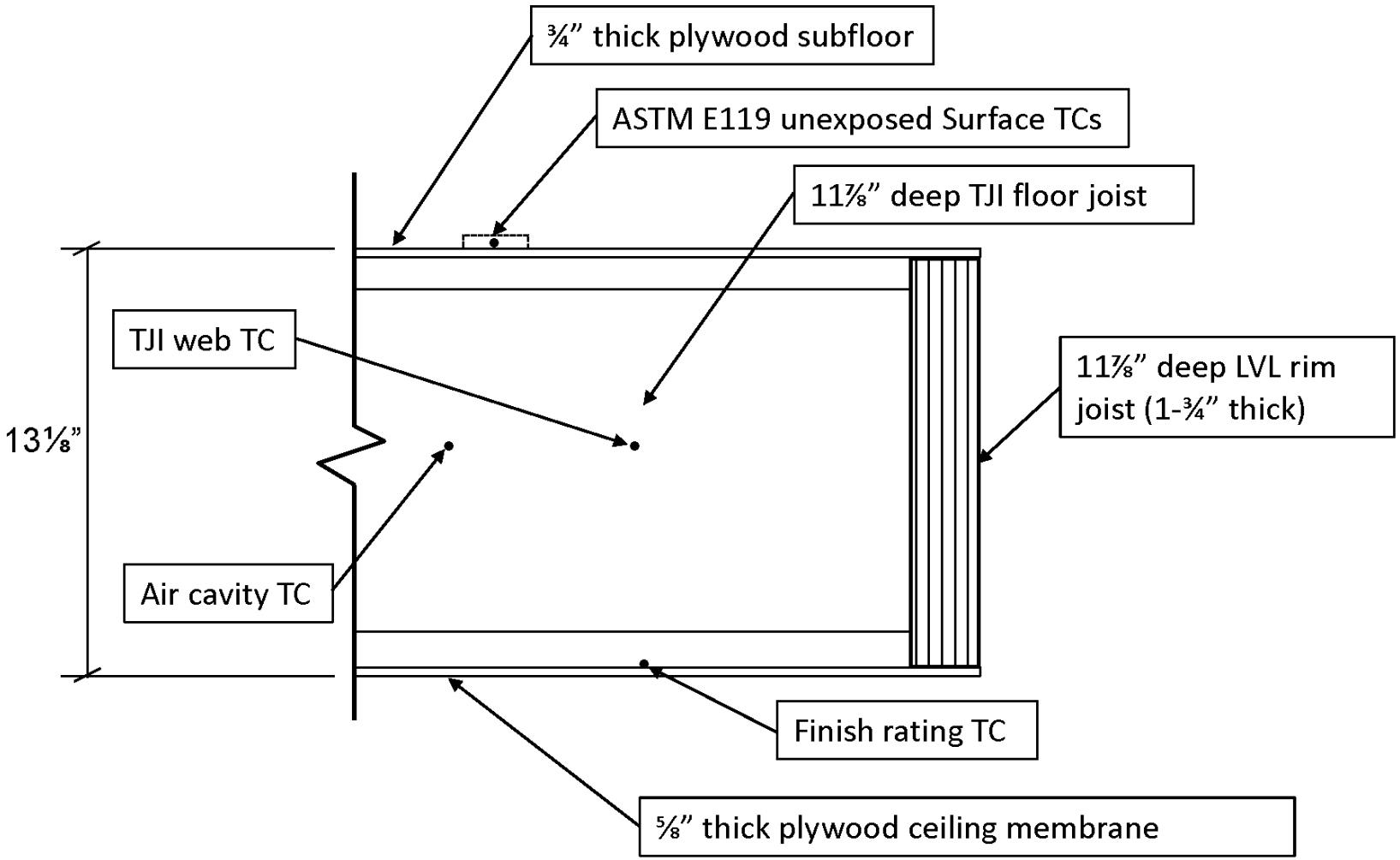
APPENDIX A – CONSTRUCTION DRAWINGS



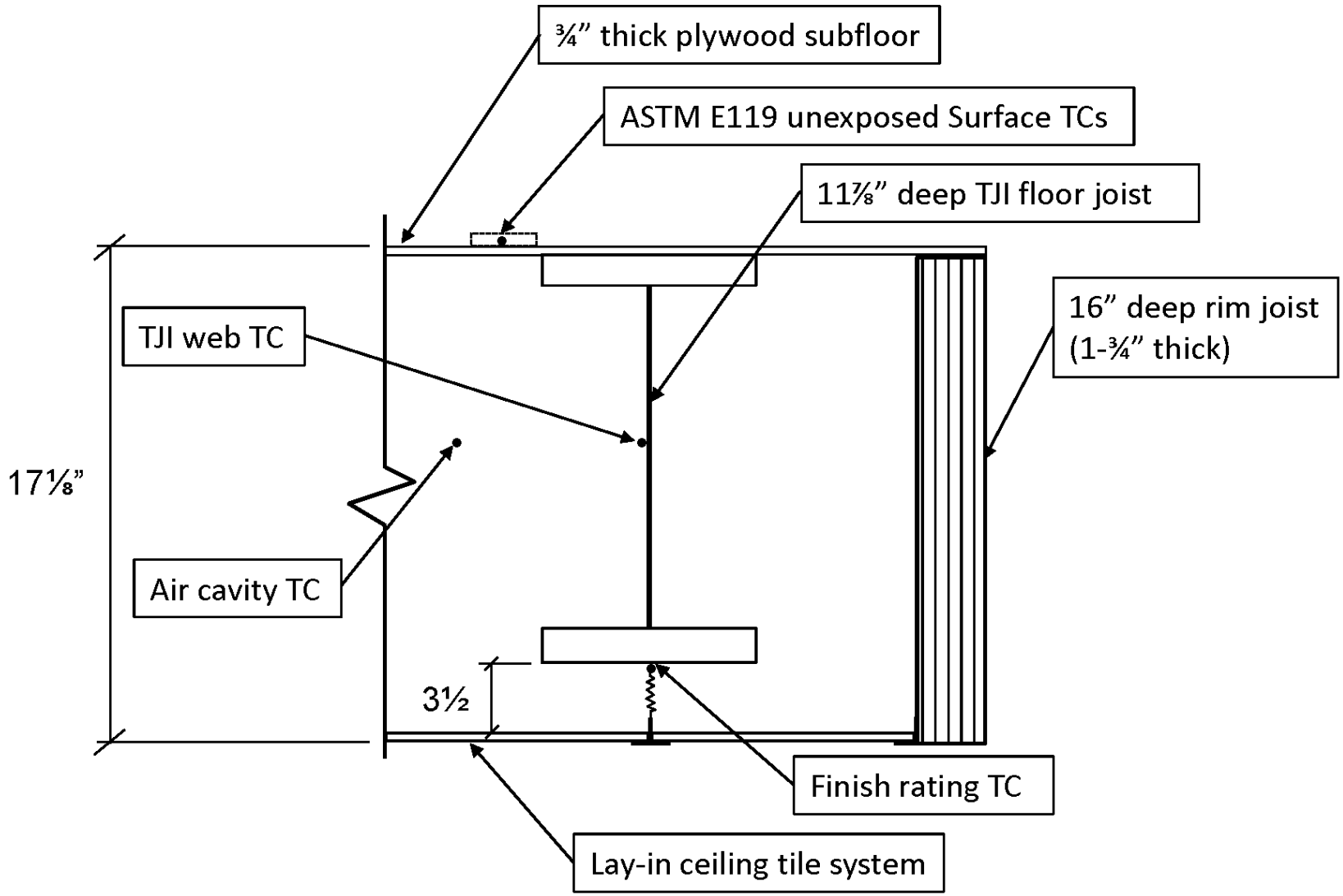
Prescriptive code ceiling membrane protection assembly



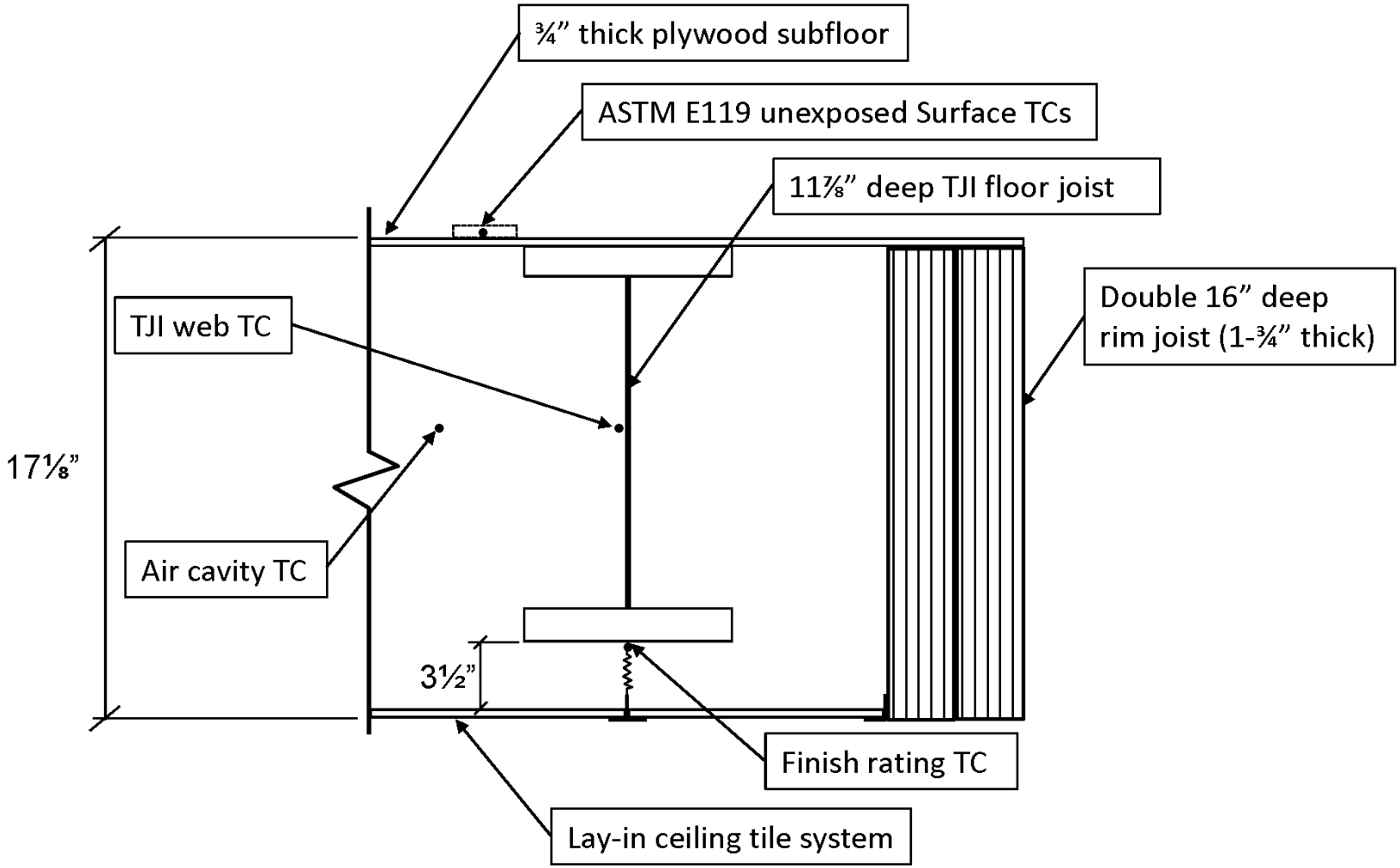
Section A-A Prescriptive code ceiling membrane protection assembly Connection at center of furnace with double rim joist header



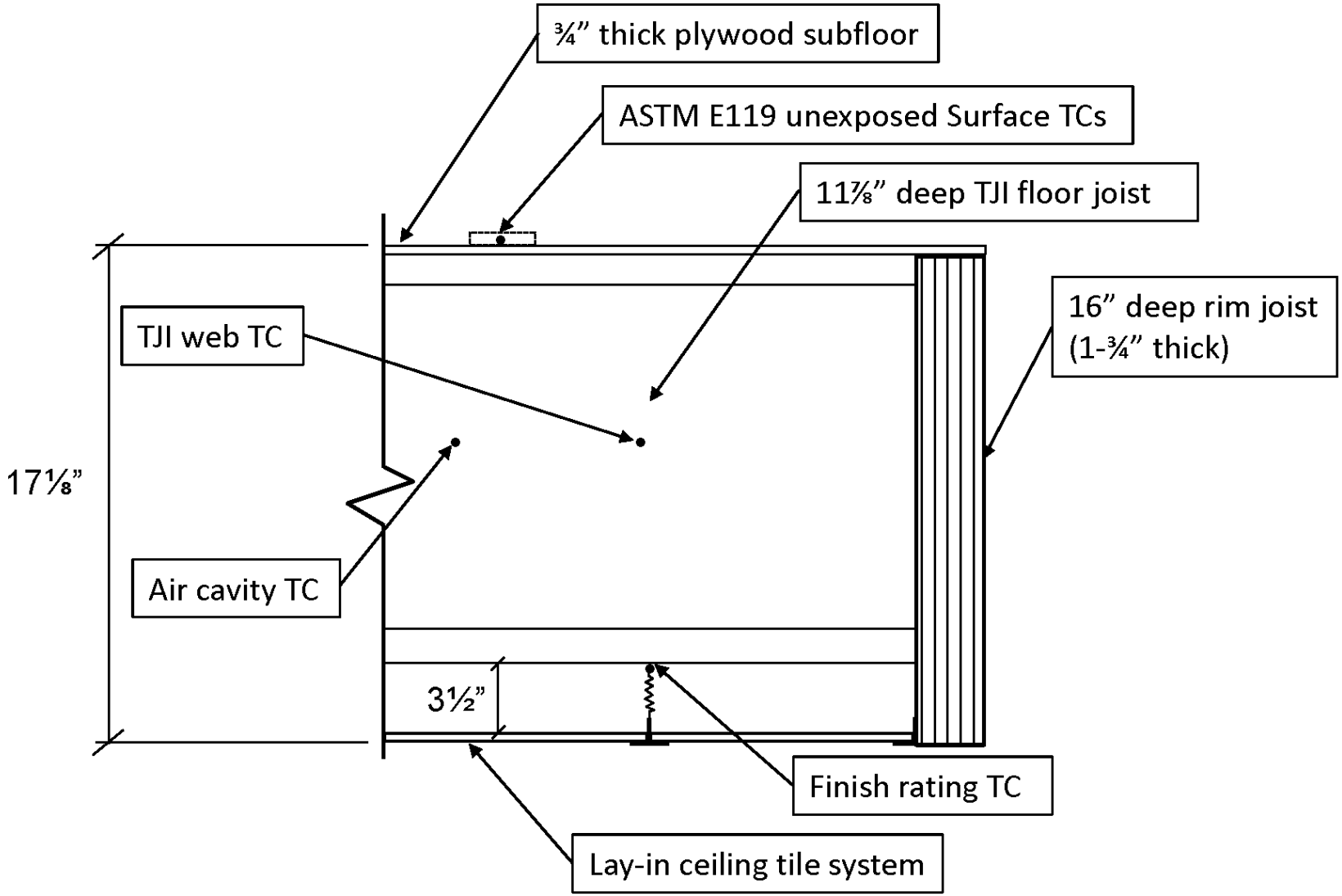
Section B-B Prescriptive code ceiling membrane protection assembly TJI connection at rim joist (TYP)



Lay-in ceiling tile membrane protection assembly



Section C-C Lay-in ceiling tile membrane protection assembly Connection at center of furnace with double rim joist header



Section D-D Lay-in ceiling tile membrane protection assembly TJI connection at rim joist (TYP)