NCLOSE

# TECHNICAL RECOMMENDATION

DATE 02/16/24
SUBJECT Insulated Metal Panel (IMP) vs Aluminum Composite Material (ACM)

## RECOMMENDATION

Custom-fit IMP could be considered if air tightness QC, drainage, and ventilation can be addressed to leverage less layers (furring and exterior insulation). This is in comparison to an "ACM with an exterior insulation / furring" assembly. Custom-fit IMPs CAN offer higher R-value per inch, allowing more usable space. IMPs CAN offer a faster construction schedule due to a lower number of layers, lower fire hazard, and higher recycling potential. The ASSEMBLY Design should be leveraged, if IMP advantages are to be fully realized. See Figures 3.0, 3.1, 3.2 for assemblies. See Figure 4.0 Assembly Comparison Matrix. This document focusses upon Custom Fit IMP, since Plank IMP does not provide as much design flexibility.

## ISSUE DESCRIPTION

Definitions

An IMP (Insulated Metal Panel) is an 0.040" coil coated aluminum sheet on the outside, 1" or 2" polyisocyanurate insulation or polyurethane insulation, and 0.040" primer coated aluminum liner sheet (or more commonly 22 ga galvanized) on the inside and exterior. Joints can be dry or with sealant, with either PLANK or CUSTOM FIT options. See Figures 1.0 through 1.4.

**IMP PLANK** is flat, with maximum panel sizes around 53 feet long and 42 inches wide and are field modified to meet field conditions. PLANK are only available in specific lengths, heights, depths. PLANK cannot integrate angles or curves in the panel. PLANK is available with various repeating profiles to create shade/shadow textures, and utilize a spray-polyurethane / polyisocyanurate blend insulation.

**IMP CUSTOM FIT** can be flat or faceted, with maximum panel sizes around 192 inches long and 54 inches wide, and are manufactured to meet field conditions. CUSTOM FIT can be varied lengths, heights, depths and integrate faceted panels see Figure 1.2. CUSTOM FIT utilizes polyisocyanurate board insulation laminated to metal skins.

Figure 1.0 - IMP Plank installed (2” and 1”)

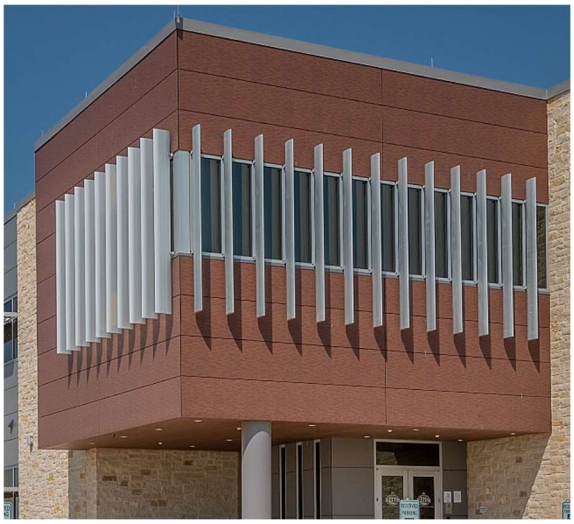

Figure 1.1 - IMP Custom Fit installed

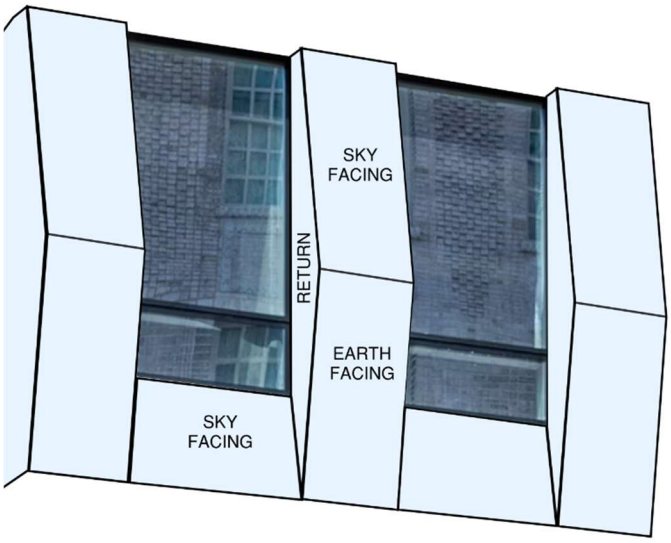


Figure 1.2 – IMP Faceted

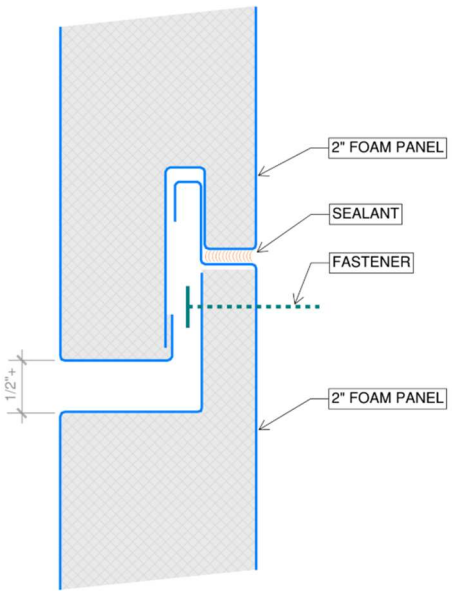


Figure 1.3 – IMP Plank Horizontal joint detail

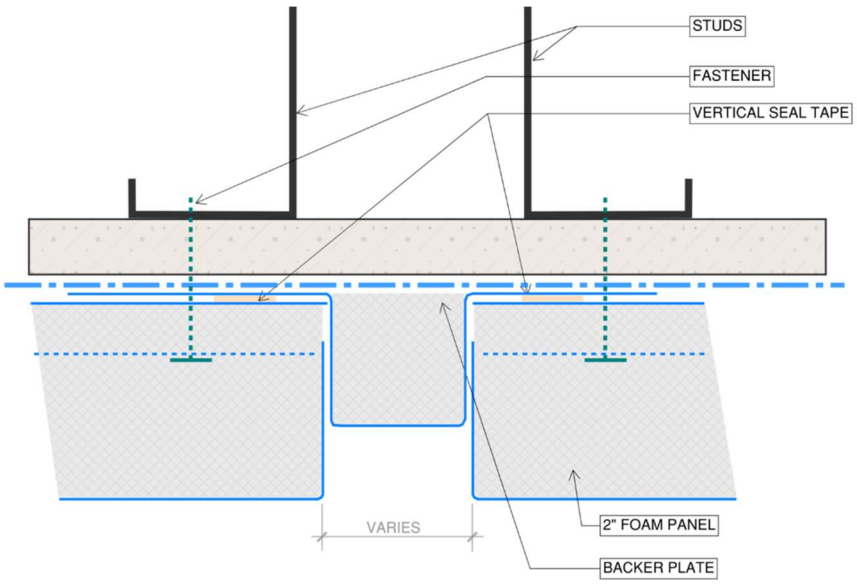


Figure 1.4 – IMP Plank Vertical joint detail

An **ACM** (Aluminum Composite Material) is also known as MCM in the codes. It is an 0.020" coil coated aluminum sheet on the outside with a plastic based core and a 0.020" coil coated aluminum sheet on the inside, or sometimes a galvanized sheet. These can be flat or faceted. When faceted they may need reinforcement at concave bends to avoid metal fatigue from wind deflection. Maximum panel sizes are about 194 inches long and 60 inches wide. There are many ways to treat the joints (angles, gaskets, exposed extrusions, sealant, dry). See Figures 2.0 + 2.1.

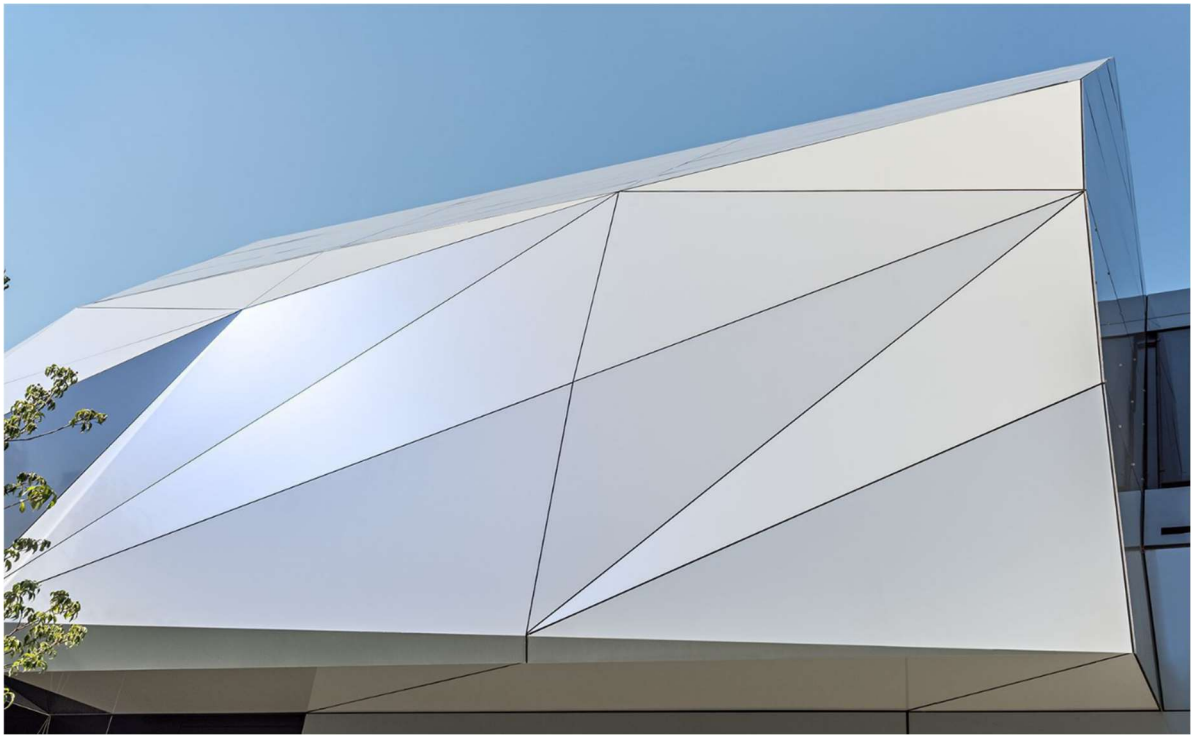

**Figure 2.0 – ACM installed**

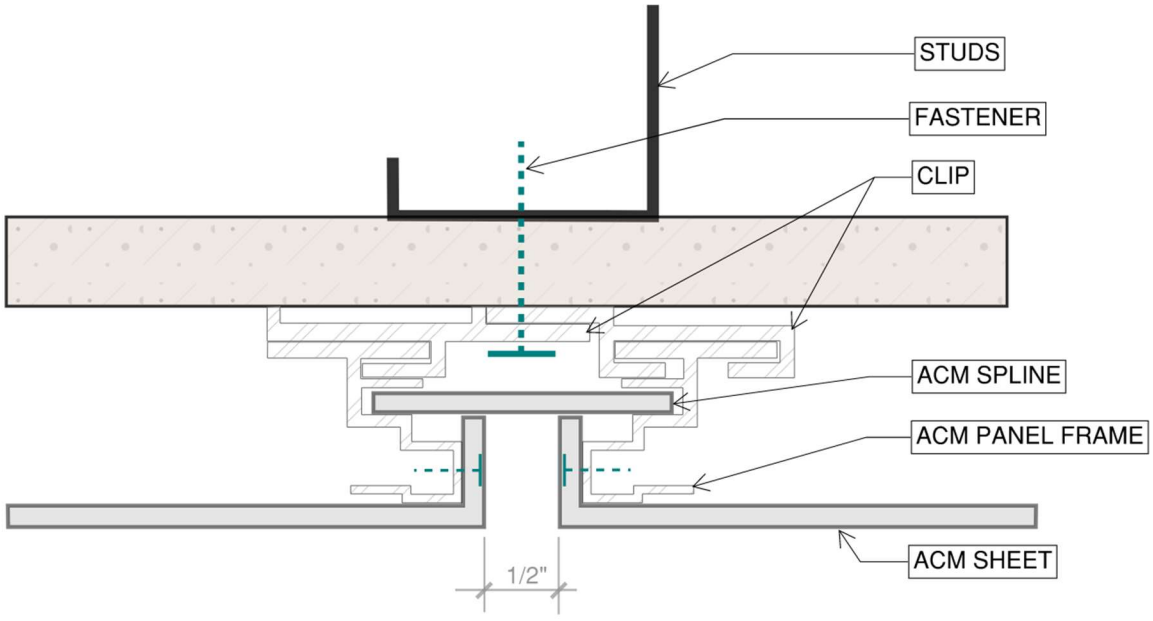


**Figure 2.1 – ACM vertical or horizontal joint**

Assemblies

IMP

An Custom Fit IMP assembly is shown below, with a drainage / ventilation gap behind the cladding, continuous membrane, and exterior insulation. See Figure 3.0.

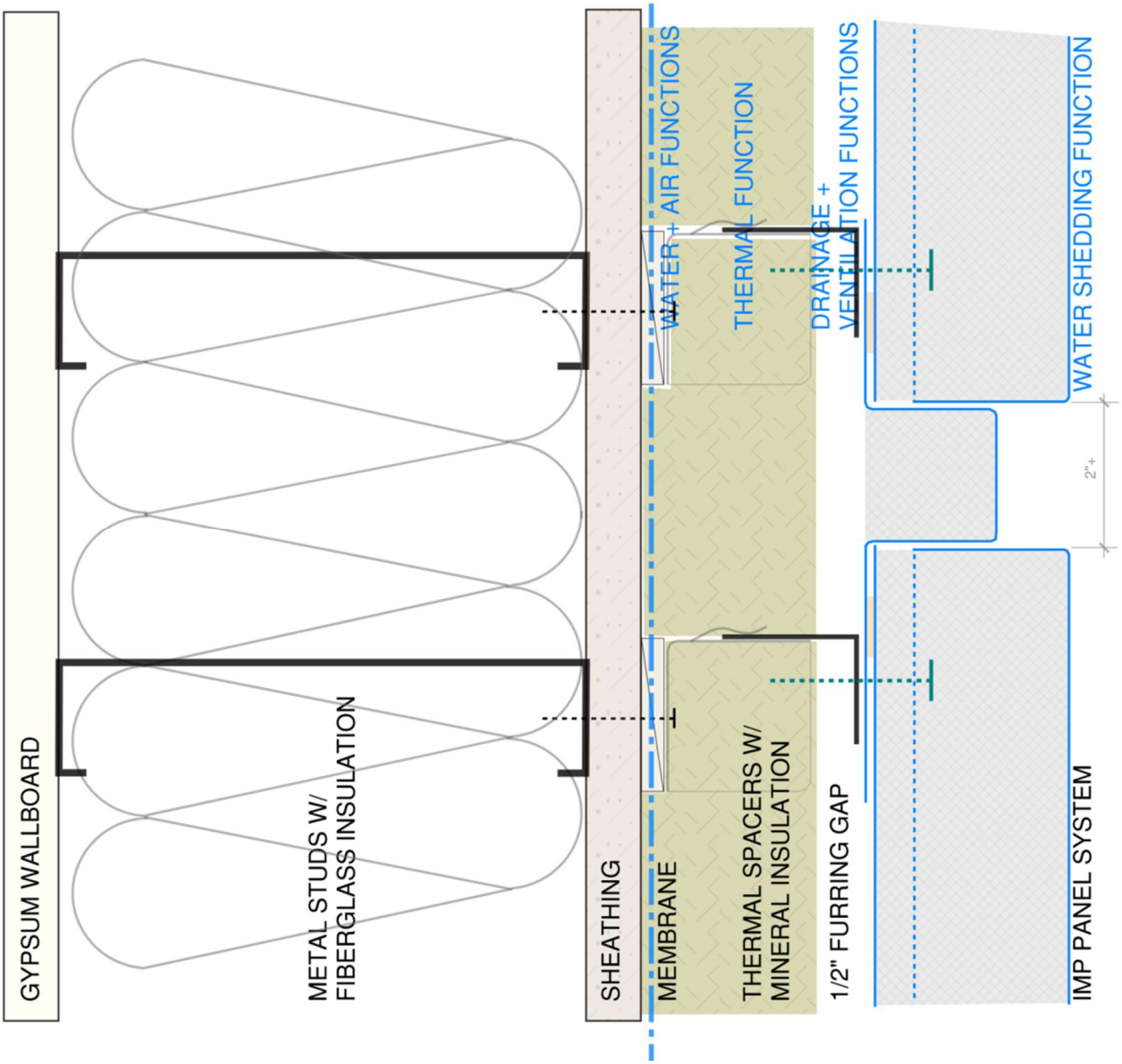


**Figure 3.0 – Assembly A – IMP Custom Fit, furring, membrane / sheathing**

An Custom Fit IMP assembly is shown below, **with a smaller drainage / ventilation gap** behind the cladding, **without** a continuous membrane, as the IMP is used for the exterior insulation, water control, and air tightness. See Figure 3.1. Batt insulation may be removed depending on energy modeling, energy goals, all project specific studies to be completed.

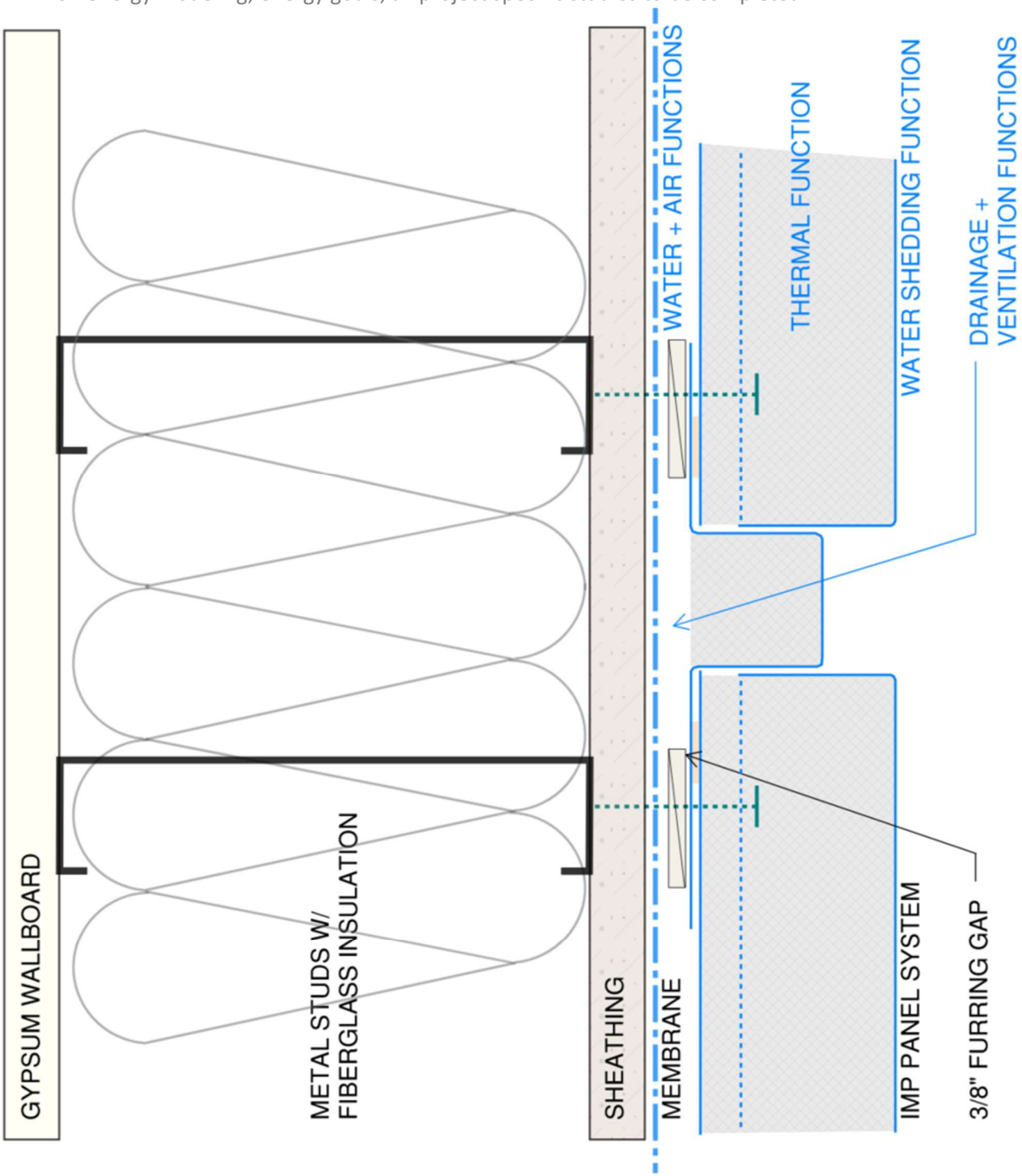


**Figure 3.1 – Assembly B – IMP Custom Fit, gap, membrane / sheathing**

ACM

An ACM assembly is shown below, with a drainage / ventilation gap behind the cladding, continuous membrane, and exterior insulation. See Figure 3.2.

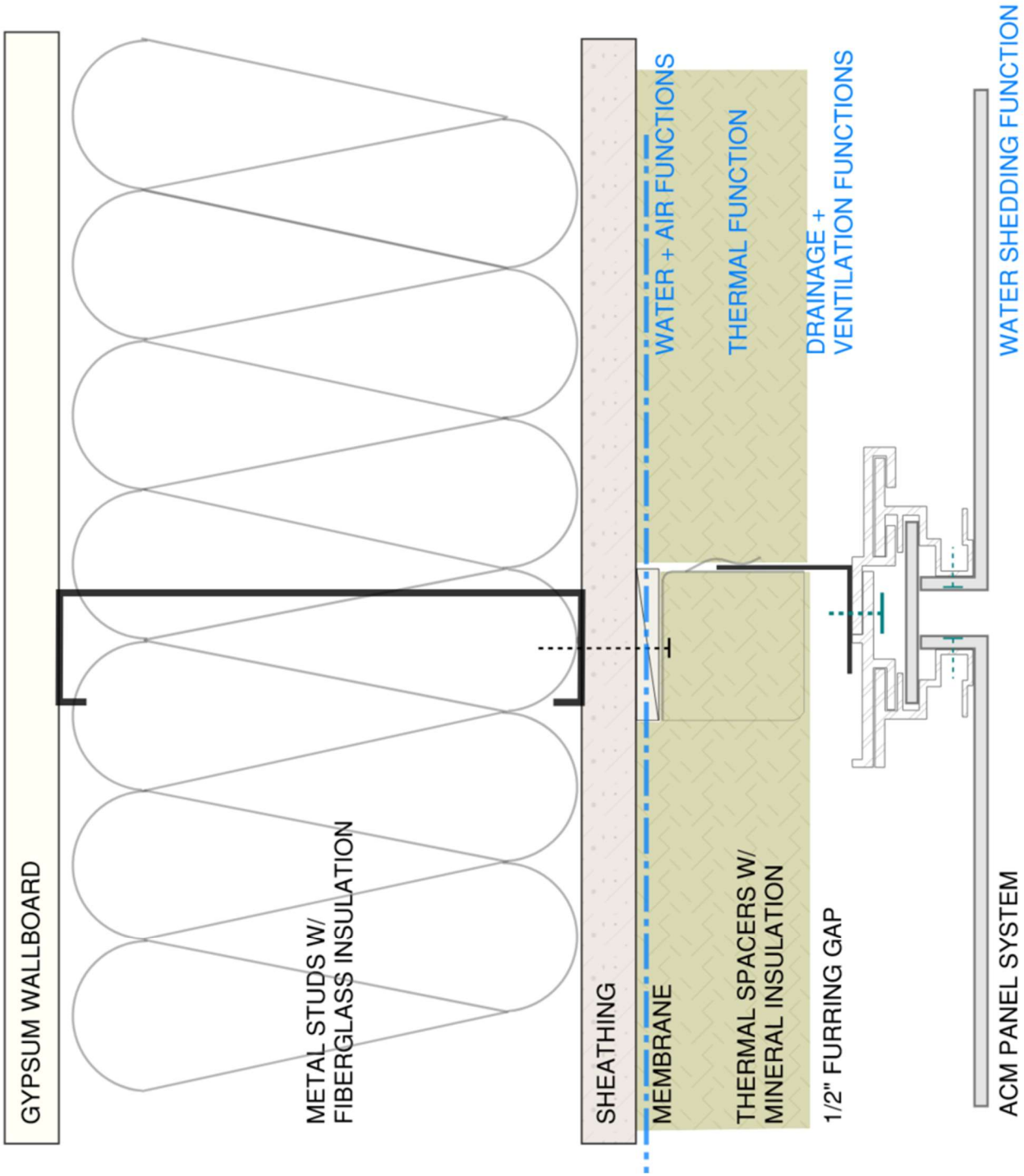


**Figure 3.2 – Assembly C – ACM, furring, membrane, sheathing**

### Cost Considerations

The biggest difference in cost between these assemblies is Assembly B not containing a clip and rail furring system with insulation. If the system is on the schedule's critical path, perhaps fewer layers can also impact overall construction schedule thus General Conditions duration. Assembly A (Custom Fit IMP over insulated furring) is more expensive than Assembly C (ACM over insulated furring), which is more expensive than Assembly B (Custom Fit IMP over shims). See Figure 4.0.

### Constructability Considerations

Assembly B has less layers of construction, thus should be simpler to install. The IMP assemblies need double studs at vertical panel edges for fastener connections, which is likely to not be at every stud (could be 16'). There is more adjustment potential with Assembly A or C in that they allow furring / clip adjustments that Assembly B does not have. Assembly B can be adjusted with additional shims.

### Building Science General Considerations

Please see each assembly above for the application of the five main control layers listed below to see which material serves which "function."

| | |
|---|---|
| **WRB - Water Resistive Barrier** | Control bulk water ingress. |
| **AB – Air Barrier** | Control air from flowing between exterior and interior. |
| **WSS – Water Shedding Surface** | Shed most of the bulk water from the exterior of assembly (first line of defense). Does not have to be stop all water. |
| **VR – Vapor Retarder** | Control vapor from entering an assembly to condense. It slows vapor and does not stop it like a "Vapor Barrier". |
| **TB – Thermal Barrier** | Reduce the amount of heat flow through an assembly. |

### Assembly Considerations

Comparing IMP vs. ACM assemblies via building science only, Assembly A and C both have a continuous membrane and gap to allow drainage and ventilation. With the continuous membrane, air tightness Quality Control (QC) concerns are also addressed. However, Assembly B, but does have a 3/8" gap for drainage and ventilation. This 3/8" gap improves the assembly's ability to drain and ventilate (drying potential) if properly ventilated (top and bottom) and drained to exterior via through wall flashing at a maximum of every 2 floors maximum spacing. The 3/8" gap circumvents the exterior insulation plane making the insulation less effective. 3/8" has been shown effective to break surface tension of water between two parallel surfaces. The size of the gap is informed by climate and / or interior vapor load. The gap (and the membrane) is recommended as a starting point to be tuned to project values. It is NOT advised to remove the gap or membrane. The 3/8" gap decision prioritizes water over thermal for the assembly design; like EIFS systems that typically include a back drained low-rise foam gap, and/or vertically grooved insulation.

It is not advised to remove this gap from a water / vapor / ventilation / drying potential perspective, unless the core of the wall can manage water ingress or the building is in a hot humid environment like Florida – See Vapor Considerations below.

Shimming behind panels is the typical approved installation method to adjust for imperfect substrate plumb / alignment as a default, therefore shims are not out of the normal system component list.

The service temperature of the membrane should be coordinated if shims are removed as the metal panel may be in direct solar heat gain and directly against the membrane when imperfect substrates require no shimming in places.

**Water Considerations**

All three assemblies provide a continuous Water Resistive Barrier Concept or Function with the continuous membrane on the sheathing. All three assemblies provide a drainage gap that doubles as a ventilation gap to varying degrees. Assemblies A and C provide a larger air gap thus better ventilation potential when compared to Assembly B, but Assembly B is acceptable. ACM directs bulk water to exterior in a more direct and layered manner. However IMPs shed water as more of a "Perfect Barrier" approach, meaning the Polyisocyanurate blend is hydrophilic.

**Air Considerations**

All 3 assemblies have a continuous membrane, therefore it's quite simple to construct an air tight assembly with any of the assemblies shown.

In Assembly B, it is possible to remove the sheathing and membrane if one of three variables exist, noted in "Assembly Considerations" above. However, without this membrane, the air tightness of the horizontal sealant and vertical seal tape in Figure 1.3 and 1.4 respectively can be a concern for Quality Control of the Air Barrier Concept for continuity. Interfaces to openings and other assemblies (top of wall, bottom of wall as well) can have the same Air Barrier Concept continuity verification challenges during construction.

**Vapor Considerations**

For buildings in ASHRAE Climate Zones where the vapor retarder is best placed on the exterior of the wall (Florida), IMPs have an advantage if they are mounted directly on a vapor closed membrane (avoid 3/8" shim). For Climate zones 3 and above (mixed or colder climates) the 3/8" shim space allows vapor from interior to go through a vapor open exterior membrane on sheathing and ventilate out around the IMP system. The furred assemblies have even more air flow to encourage more drying potential.

## Thermal Considerations

There are five R-value Definitions listed below. "Clear Wall" is recommended as the basis of comparison since that definition is what most energy codes utilize (Washington State, California, and now Oregon's 2024 Energy Code), and is the most common when comparing assemblies.

The list of R-value definitions below starts at the top as the simplest to measure but least reflective of actual installed effectiveness. The list proceeds toward the bottom of the list, becoming more complex to measure but more realistically reflecting how the wall assemblies will perform.

## R-value Definitions [1]

| | |
|---|---|
| **Product** | Value on package. |
| **Center of Cavity** | Sum of all R-values of assembly materials between studs only. |
| **Clear Wall** | Elevation area-weighted average of "Center of Cavity" and similar "Center of Stud" sum of R-values of materials. |
| **Whole Wall** | Same as "Clear Wall" + account for windows, corners, columns, details. |
| **True** | "Whole Wall" + account for air leakage wind washing, convective loops, radiation, thermal + hygric mass, installation defects. |

While Polyisocyanurate (ISO) has a higher R-value per inch than mineral board, the IMP systems have varying degrees of metal wraps on all edges and gaps of the ISO insulation, thus various thermal de-rates. The "Clear Wall" R-value definition does not consider air current around the insulation. If we did account for air circumventing insulation, assembly B would be de-rated further. Most energy code measures do not account for air flow but some take thermal breaks into account outboard of the core wall. Some energy codes require insulation on substrate but don't define what that can be. For example, EIFS has a gap behind exterior foam insulation that provides drainage, and some ventilation which meets "insulation on substrate" requirements, like Assembly B.

## Recyclable Considerations

The ability to recycle the panels (facers, liners, cores) is dependent on the facilities and machines available to support the needed process to separate the material components of each panel.

The accessibility of facilities and machinery is highest for ISO insulation, then Mineral insulation, then ACM in that order. All three are available, so adjacencies to project location could be verified on each project.

Verified by metal scrap companies, ACM has been found to be too expensive to recycle typically.

Some IMP systems are more recyclable than others. Verify with your manufacturer if the edges are not crimped to allow separating metal from insulation more easily accomplished.

**Lifespan Considerations**

Lifespan can be measured recording how many years a system has been installed in which climates. Lifespan can be approximated by ASTM tests. Lifespan can be discussed with various types of warranties offered by the manufacturer. With these three "lenses" of how to discuss "lifespan", it depends on which "lens" is used, which system (IMP vs ACM) has a longer "lifespan".

Historic

IMPs have been installed since 1952 [8]

ACMs have been installed since 1969 [9]

Testing

Lifespan test methods and is not found.

One aspect of long-term performance would be limiting wind deflection to L/175 to reduce the wind deflection, thus metal fatigue of exterior face of 0.020" on ACM. With IMP, the insulation is laminated across the entire surface, significantly reducing wind deflection / metal fatigue.

Warranties

IMPs and ACM both have finish warranties available up to 20 years for finish and equitable for other types of warranties.

**Fire Considerations**

ACMs have cores that are labeled as "fire-resistant", but can be more flammable than IMP cores of ISO insulation in some cases. Some IMP systems have a flame spread index of 5 with smoke development index of 5 per ASTM E84. Most ACM panels have a flame spread index of 25 and smoke spread index of 450 per ASTM E84. Verify on each project for each panel selected. This means, panel to panel only, IMP performs better in a fire. This may be due to ISO being more fire resistant than presumed, and the ISO is encased in metal once installed.

NFPA 285 testing exists for both systems. It is recommended to get a fire engineer equivalency letter from a fire engineer licensed in the state of the project when NFPA 285 is triggered, to provide evidence and due diligence that the built system is just as safe as the tested system. The reason is the installed details will vary from what was tested. See Attachment B and C for IMP + ACM NFPA 285 tests, respectively.

There are numerous tests available to compare IMP vs ACM for fire resistance including ASTM E84 for material only, FM 4411 for cavity walls, FM 4880 for panel systems, and NFPA 285 that includes material, assembly, product, and details. NFPA 285 is the most realistic and code required.

The size of the drainage gap should be 1/4" minimum for drainage. [10] Ventilation is better if it's 3/8" to 3/4". Larger gaps do not add drainage or ventilation capacity, but do add more air / fuel for fire and a larger space for fire to travel vertically. [11]

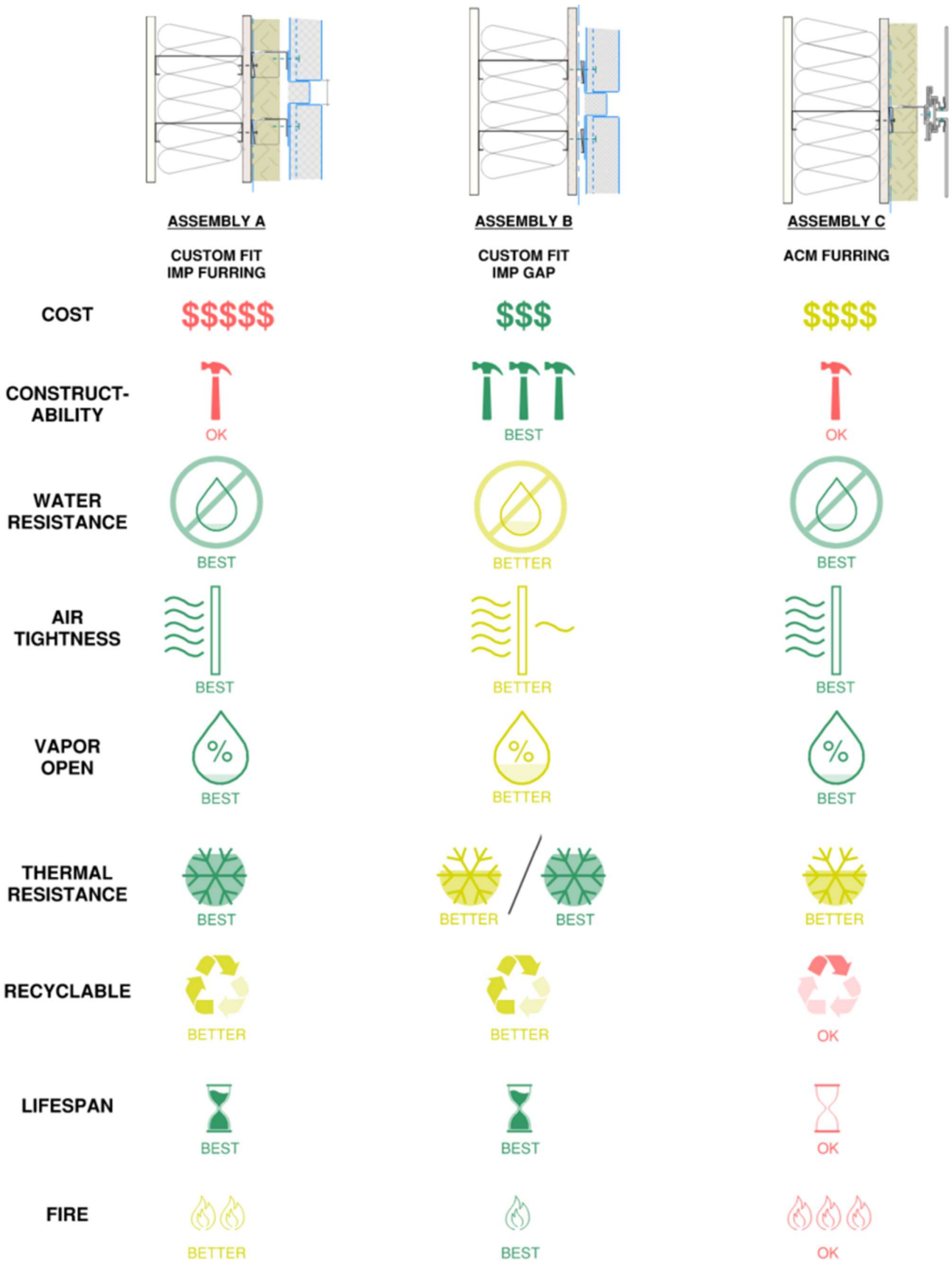


**Figure 4.0 –** Assembly Matrix

## MATRIX RATIONALE

### Pros / Cons of "Assembly A - Custom Fit IMP Furred" vs "Assembly C - ACM Furred".

**Pros**

- **COST** – The only difference between the assemblies is the panel system outside of the furring. Custom Fit IMPs are typically more expensive than ACM. IMPs require double studs at panel ends and panel maximum length is 16'. IMPs are more costly at openings for plank but not custom Fit IMP. Therefore, Plank IMPs are typically used on buildings without a lot of openings because IMPs use aluminum extrusions and sealant vs sheet metal flashing. Aluminum extrusions can be avoided by due to the planar nature of IMP, the panels themselves do not form returns to windows / doors. See Attachment A.
- **WATER** – Since the assemblies are the same from interior to back of cladding, they perform identically for bulk water management behind the cladding. Within the cladding plane, the ACM system has a more direct route for water to be weeped to the exterior from back of cladding, whereas the IMP horizontal and vertical typical joints (Figure 1.3 and 1.4) show that water is not routed to the exterior as directly.
- **AIR / VAPOR / THERMAL** – Since the assemblies are the same from interior to back of cladding, they perform identically for air, vapor, thermal aspects. The only exception to this is the number of studs bridging the batt insulation if applicable to climate, and the number of fasteners at vertical edges of panels increases for IMP vs ACM. This means more water intrusion potential if not gasketed. This means installers need to be sure to seal fastener penetrations that have fasteners withdrawn. With all fasteners on all cladding attachments, it is recommended to use at least self-adhered sheet membranes or fluid membranes to gasket fasteners.
- **RECYCABLE** - The water and electricity and number of steps to recycle ACM is more intense than IMP recycling. Both requiring separating aluminum from other products. Both are possible. [(2)] [(3)] The recycling locations of Polyisocyanurate (ISO) are more readily available in the United Sates than the recycling locations for the various types of ACM core materials and has been around for decades. [(4)] [(5)]
- **LIFESPAN** – ACM Delamination Drum Peel test of ASTM D1781 that measures resistance to panel delamination for adhesive failure between core and skin or cohesive failure of the core itself. A standard ASTM criterion would be 100 N-mm/mm (22.5 inch-lb/inch) as most manufacturers can meet this criterion. Delamination may be more susceptible on ACM at radiused corners.

**Cons**

- **CONSTRUCTABILITY** – Custom Fit IMP (not Plank IMP) is less common than ACM.
- Plank IMP may have more cost at openings due to sealant and aluminum extrusion system for flashing, vs ACM that can use route and return panels or prefinished flashing. Custom fit does not have this issue.

**Project Specific Comparisons**

- **THERMAL** - There are furring systems that are economical, easily installed / adjusted, cost effective and range in thermal efficiency widely. Most commonly 82% effective clip and rail systems like Foriea Clips or Iso Clips used here as a comparison. 82% effective means 2" of mineral board with a Product R-value of R-4.2 LTTR x 2 = R-8.4. 82% of 8.4 = R-6.9 within the 2" mineral board and clip / rail system.
  **Just the Mineral, Clip and Rail plane in Assembly C = R-6.9** Insulation and furring effective (derated) R-value. IMP in assembly A has a larger gap creating more circumventing of insulation value of IMP. This gap can be sized to balance drainage and thermal balance of values on the project.

- **FIRE** - Both IMP and ACM can meet FM 4880 Class 1 requirements. [14] [15]
  Both IMP and ACM can meet NFPA 285, see Attachment B and C.
  Both IMP and ACM have varied flame spread index and smoke development index, so verify with your panel manufacturer.
  Therefore, the fire performance of each cladding material (IMP vs ACM) as a system, depends on the type of IMP, type of ACM, designed assembly vs NFPA 285 tested assembly, and lastly the detailing at panel-to-panel joints, edges of openings, and floor to exterior wall details. Each assembly and set of products / details should be reviewed with a fire engineer licensed in the state of the project location to compare specific design decisions.

**<u>Pros / Cons of "Assembly B - Custom Fit IMP Shimmed" vs "Assembly C - ACM Furred".</u>**

**Pros**

- **COST** – See comparison above. In addition, Assembly B removes the furring and exterior insulation vs Assembly C, replacing with shims adhered or fastened to back side of IMPs. This would allow a cost savings compared to Assembly C.
- **AIR** – With a continuous membrane on both assemblies B and C the air tightness QC concerns are well addressed, however with Assembly B, it is harder to QC the fastener penetrations are filled with sealant when studs are missed and fasteners are removed.
- **RECYCABLE** - The water and electricity and number of steps to recycle ACM is more intense than IMP recycling. Both requiring separating aluminum from other products. Both are possible. [2] [3] The recycling locations of Polyisocyanurate (ISO) is more readily available in the United Sates than the recycling locations for the various types of ACM core materials and has been around for decades. [4] [5] It is typically more difficult to separate the component materials of ACM than IMP. [2] [3]
- **LIFESPAN** – See prior comparison for Lifespan comparison.
- **FIRE** – See prior comparison for Fire comparison. In addition, a smaller gap of Assembly B is a positive for less air / fuel for fire compared to Assembly C.

**Cons**

- **CONSTRUCTABILITY** – See prior comparison for Constructability comparison.
- **VAPOR** – There isn't as large of a gap for ventilation (thus drying potential) compared to Assembly C, but there is an acceptable amount in Assembly B. This is a minor difference.

**Neutral**

- **WATER** – The gap of 3/8" minimum is sufficient for drainage in Assembly B.
- **THERMAL** – See prior assembly comparison for Thermal information. In addition, the IMP insulation is now serving as the exterior insulation on Assembly B. Thermal bridging de-rate of each IMP system on each project should be verified.
  A 2" IMP R-value is a well-debated topic because the core is Polyisocyanurate. A Custom Fit IMP utilizing the hot box testing in Attachment D shows (as an example) R-14 per ASTM C1363. This is not LTTR but initial R-value.
  IMP thermal effectiveness ranges from 97% to 30% of product R-value, see Figure 4.1. The largest factor is how much the metal wraps through the insulation plane at the joints. [6] Each IMP system should be calculated and/or tested to establish it's "Clear Wall R-value" with thermal bridging. Thermal modeling (or even better) hot box testing per ASTM C1363 can be used.
  **The Custom Fit IMP plane in Assembly B (IMP shimmed) = R-14** per Hot Box Test Attachment D. This test does not include optional insulated hat channel that would improve it's performance.

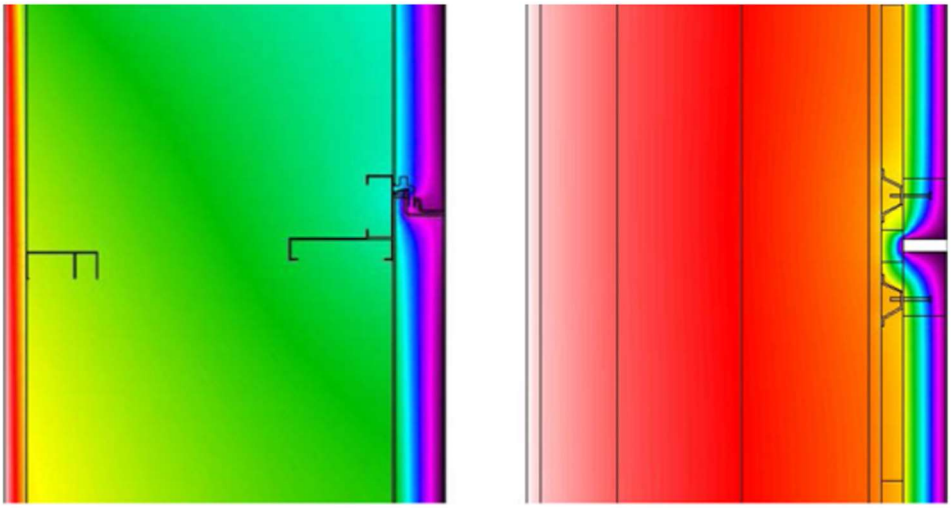

**Figure 4.1 – Left: IMP w/ Uninsulated Joints. Right: IMP w/ Insulated Joints** [6]

<u>Global Warming Gasses</u>

- Plank IMP utilizes spray polyisocyanurate insulation which has significant Global Warming Potential. The amount should be verified with each panel manufacturer. One prolific example has a GWP of 9,950. [16]
- Custom Fit IMP utilizes Polyisocyanurate so the GWP is almost zero. [13]

**ADDITIONAL RESOURCES / FOOTNOTES**


(1) R-VALUE DEFINITIONS. ORNL – Christtian + Kosny 1995

(2) ACM RECYCLING. Fairview Architectural AU – "How to Recycle Aluminum Composite Panel (ACP) Materials 09.23.2022. https://fv.com.au/news/how-to-recycle-aluminium-composite-panel

(3) ACM RECYCLING. Alumtech CA – "How to Recycle Aluminum Composite Panels" 12.14.2021. https://alumtech.ca/how-to-recycle-aluminum-composite-panels/

(4) IMP RECYCLING. DART Foam Recycling Centers US – "Map showing locations" 01.23.2024.

(5) ACM RECYCLING. SPE Inspiring Plastics Professionals – Recycling of Polyurethane and Polyisocyanurate Foam – Henri Ulrich, Odinak Tucker, AA Sayigh 08.1978. https://permatherm.net/eco-friendly-wall-panels/

(6) IMP THERMAL BRIDGING. Thermal Bridging Research: Metal Panel Wall Systems – Matthew Fickett 03.21.2015. https://www.payette.com/research-innovation/thermal-bridging-research-metal-panel-wall-systems/

(7) MINERAL WOOL RECYCLING. "Rockwool Rockcyle is ROCKWOOL's Recycling Program" https://www.rockwool.com/group/about-us/sustainability/environment/rockcycle/

(8) IMP FIRST INSTALL. "Fleming Steel Erectors" https://fse-ok.com/insulated_metal_panels/

(9) ACM FIRST INSTALL. "History of ACM Panel Development" https://alumtech.ca/history-of-acm-panels-development/

(10) DRAINAGE GAP SIZE. "BSD-013: Rain Control in Buildings" John Straub 08.22.2011. https://buildingscience.com/documents/digests/bsd-013-rain-control-in-buildings

(11)DRAINAGE GAP SIZE + FIRE. "BSI-098: Great Fire of London" Joseph Lstiburek 08.10.2017. https://buildingscience.com/documents/building-science-insights-newsletters/bsi-098-great-fire-london

(12) PLANK IMP - POLYURETHANE GWP. "JM Polyurethane Corabond III"

(13) CUSTOM FIT IMP - POLYISOCYANURATE GWP. "Polyiso Insulation's Low-GWP Blowing Agent Solution" https://www.polyiso.org/page/Low-GWPBlowingAgentSolution

(14) ACM MEETS FM 4880 CLASS I: FM Global Research Technical Report – Evaluation of the Fire Performance of ACM Assemblies using ANSI/FM4880 12.01.2017, Figure 6-10 HRR vs Heights on Building. FM 4880 is an exception in IBC, NFPA 285 is the rule.

(15) IMP MEETS FM 4880 CLASSI: Kingspan Optimo Quadcore Data Sheet. https://www.kingspan.com/us/en/products/insulated-panel-systems/wall-panel-systems/quadcore-optimo/?s=d

(16) IMP PLANK GWP 9,950: Kingspan Optimo Quadcore Enivornmenttal Declarations Sheet CA. https://www.kingspan.com/us/en/products/insulated-panel-systems/wall-panel-systems/quadcore-optimo/


**ATTACHMENTS**

**Attachment A** – Cost Estimate

**Attachment B** – IMP NFPA 285 Test Results (Available upon request)

**Attachment C** – ACM NFPA 285 Test Results (Available upon request)

**Attachment D** – IMP Hot Box Thermal Testing (Available upon request)

**ATTACHMENT A - COST ESTIMATE**
**ACM ASSEMBLY v IMP ASSEMBLY**

2/2/2024

- Average costs for a 5,000 Square Foot (SF) wall assembly from exterior sheathing through metal panel, with 10% Window To Wall Ratio (WWR).

- Average panel size of 24 SF. ACM panel installation rate of 1.5 panels per hour. IMP installation rate of 1.75 panels per hour. Reduced rate for ACM based upon non-gasketed spline installation.

- Subcontractor material mark-up of 10%. Labor rate of $85/hour.

| | | $ / SF | UNIT COSTS |
|---|---|---|---|
| **ACM FURRING ASSEMBLY** | | | |
| **Materials** | | | |
| | ACM Panels | $ 20.00 | $ 100,000 |
| | Mineral Board Insulation | $ 3.00 | $ 15,000 |
| | Thermal Spacers + Girts | $ 11.25 | $ 56,250 |
| | Membrane | $ 4.50 | $ 22,500 |
| **Labor** | | | |
| | ACM Panels | $ 17.00 | $ 85,000 |
| | Mineral Board Insulation | $ 3.00 | $ 15,000 |
| | Thermal Spacers + Girts | $ 1.00 | $ 5,000 |
| | Membrane | $ 4.50 | $ 22,500 |
| **Total** | | **$ 64.25** | **$ 321,250** |
| **CUSTOM FIT IMP FURRING ASSEMBLY** | | | |
| **Materials** | | | |
| | IMP Panels | $ 24.00 | $ 120,000 |
| | Mineral Board Insulation | $ 3.00 | $ 15,000 |
| | Thermal Spacers + Girts | $ 11.25 | $ 56,250 |
| | Membrane | $ 4.50 | $ 22,500 |
| **Labor** | | | |
| | IMP Panels | $ 12.00 | $ 60,000 |
| | Mineral Board Insulation | $ 3.00 | $ 15,000 |
| | Thermal Spacers + Girts | $ 1.00 | $ 5,000 |
| | Membrane | $ 4.50 | $ 22,500 |
| **Total** | | **$ 63.25** | **$ 316,250** |
| **CUSTOM FIT IMP SHIMMED ASSEMBLY** | | | |
| **Materials** | | | |
| | IMP Panels | $ 24.00 | $ 120,000 |
| | Mineral Board Insulation | $ - | $ - |
| | Thermal Spacers + Girts | $ - | $ - |
| | Membrane | $ 4.50 | $ 22,500 |
| **Labor** | | | |
| | IMP Panels | $ 12.00 | $ 60,000 |
| | Mineral Board Insulation | $ - | $ - |
| | Thermal Spacers + Girts | $ - | $ - |
| | Membrane | $ 4.50 | $ 22,500 |
| **Total** | | **$ 45.00** | **$ 225,000** |