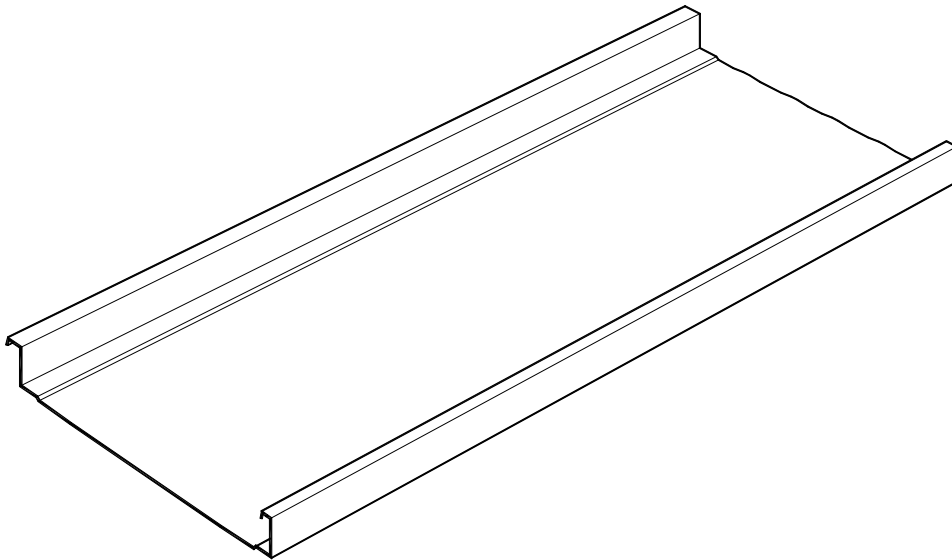




BIGBEE STEEL BUILDINGS, INC.  
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BigbeeVR  
Standing Seam Roof System  
PRODUCT APPLICATION GUIDE



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## 1.0 General

### 1.1 Purpose of the Application Guide

This guide has been prepared to help the designer understand the **BigbeeVR** Roof System, its design and performance features. It is **Bigbee Steel Buildings, Inc.**'s intent that this guide, together with the specific roof application requirements, will allow the designer to determine how to best incorporate the **BigbeeVR** Roof System into a specific project. This guide will only describe the **BigbeeVR** system and does not make any recommendations for the application of the roof on any specific project. A professional designer should be employed to determine how best to integrate this roof system, with other roof and wall products to form a complete building project.

This Application Guide will provide the following:

- Roof System Description
- Performance Capabilities
- Application Limitations
- Responsibilities for Proper Product Application and Use

The Product Application Guide is organized into the following sections:

- Product Description - Describes the roof system, its materials, weather resistance and structural performance characteristics. This description also includes confirming tests, design criteria and product warranties available from **Bigbee Steel Buildings, Inc.**
- Application Guidelines and Limitations
- Architectural Details - These are the application details used by **Bigbee Steel Buildings, Inc.** to detail a standard roof system. The details are suitable for reproduction.

### 1.2 Product Contract Type

We at **Bigbee Steel Buildings, Inc.** want to serve our customers to the best of our ability. We recognize that not all projects are the same nor require the same level of design from our personnel. Most projects will require the design and engineering to be done locally by the customer or their engineers. Other projects will require **Bigbee Steel Buildings, Inc.** to take responsibility to determine the best application of the roof system to our components. **Bigbee Steel Buildings, Inc.** will not take responsibility for the design or product application on projects for which we do not have complete information. To allow our customers to purchase our products in a way that offers them the best opportunity to enjoy a sound, well performing roof, we offer two ordering methods or contract types. Each contract type is tailored to place the design and product selection where it can best be accomplished.

A. **BigbeeVR** Standard Roof System

The Standard Roof System is designed by **Bigbee Steel Buildings, Inc.** and includes the roof materials required by the contract. The end customer will provide sufficient building information for **Bigbee Steel Buildings, Inc.** personnel to determine what materials will be required by contract. This system will include erection instructions, erection details, material and, when included in the purchase contract, material warranty.

Materials included in this roof system will be selected by **Bigbee Steel Buildings, Inc.** personnel and engineers to meet the requirements of the customer purchase contract. These materials include:

1. Roof panels
2. Clips
3. Perimeter attachment parts
4. Perimeter trim parts
5. Accessories
6. Related hardware, closures, and sealants

These materials will be selected in accordance with the standard **BigbeeVR** Application Guide and the **Bigbee Steel Buildings, Inc./Customer Contract**.

B. **BigbeeVR** Component Roof

This type of roof order is a parts order for some or all of the parts and materials manufactured by **Bigbee Steel Buildings, Inc.** that are used in the **BigbeeVR** Roof System. The component roof order will not be reviewed by **Bigbee Steel Buildings, Inc.** personnel for completeness or compatibility of the parts ordered. **Bigbee Steel Buildings, Inc.** will process the order as a parts order and ship the parts without specific installation instructions, installation details or engineering.

The end customer will be responsible for all applications design, shop drawings, installation drawings and material take-off.

No weather resistance warranty is available from **Bigbee Steel Buildings, Inc.** for a component roof. Any weather resistance warranty must be provided by the roof designer or contractor.

### 1.3 Responsibilities of the Parties

#### A. **Bigbee Steel Buildings, Inc.**

**Bigbee Steel Buildings, Inc.** will provide a roof system that will perform satisfactorily when used in accordance with this **BigbeeVR** Application Guide and Installation Instructions, as described in the purchase contract and disclaims all other responsibilities including warranties of fitness.

#### B. End Customer

The customer is responsible for ensuring:

- a. That the **BigbeeVR** Roof System is suitable for the purpose for which it is to be used and that the roof system meets all local, state, and/or federal building codes.
- b. That the roof system is installed in accordance with good engineering and construction practices and in accordance with the **BigbeeVR** Installation Instructions and shop drawings.
- c. That the owner is advised of proper maintenance of the **BigbeeVR** Roof System in accordance with good metal roof maintenance practices and the warranty terms.

#### C. Owner

The roof owner is responsible for protecting the roof from damage and performing regular maintenance such as removal of excess snow and ice, frequent clearing of drainage systems, and immediate repair of roof damage.

NOTE: Clarification or recommendations concerning **BigbeeVR** roof applications, modifications, repairs, etc must be directed to, and confirmed by, a **Bigbee Steel Buildings, Inc.** project manager. Contact **Bigbee Steel Buildings, Inc.**

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## 2.0 Product Description

### 2.1 General

The **BigbeeVR** Roof System has been designed by **Bigbee Steel Buildings, Inc.** for use in architectural or functional applications where both appearance and weather resistance of the roof are primary concerns. Many standing seam roof systems have similar appearance but have major differences in their performance. The **BigbeeVR** Roof System has many advantages over most other roof systems and, when properly installed, will offer excellent weather resistance and be practically maintenance free.

The **BigbeeVR** Roof System is adaptable for use on new construction and as a replacement roof for existing buildings where weather resistance and architectural appearance is the most important design consideration.

The following paragraphs provide a detailed description of the **BigbeeVR** Roof System, its materials, performance capabilities, confirming tests, design criteria, and the available warranties.

### 2.2 Physical Description

#### A. General

The **BigbeeVR** Roof System will consist of metal panels joined together by a unique factory-formed, interlocking seam that is easily assembled and seamed in the field. The **BigbeeVR** Roof System is secured to the roof structure with clips that are locked into the seam during the field seaming process. Associated components such as perimeter plates, perimeter trim and flashing have been designed to accommodate most types of structures.

#### B. Panel

The panel will be fabricated from steel which is coated with Galvalume and optional factory applied paint. Galvalume coated steel sheet will provide a long-lasting, weathering membrane. Galvalume coating has a proven weatherability of in excess of 20 years. The steel sheet is impervious to moisture and will resist falling objects and roof traffic better than other known roof membranes commonly used. The steel panels will be formed into a shape that will resist live load and wind uplift without the complexity and cost of additional substrate as required on most other roofing systems. The ultimate performance of a Galvalume coated steel panel is determined by effectiveness of the design of the steel panel, perimeter seals, and panel attachment methods.

1. The **BigbeeVR** Panel will be a factory precision roll-formed pan panel with side seams formed by 14 forming stations. The panel is available in the following widths and seam heights. The panel size options are:

Designation	Seam Height	Panel Width
<b>BigbeeVR-216</b>	2"	16"
<b>BigbeeVR-218</b>	2"	18"

Each panel will have a male and female vertical leg formed so the two legs can be seamed in the field by hand seaming at clip locations only or continuously with a motorized field seaming machine.

2. Maximum panel lengths will be provided to minimize the need for end splices. Maximum length will be controlled by transportation considerations (usually 45').
3. Panel lengths are cut using a one piece die that sheers the panel to length and makes factory notches in the male and female sides. By using a single die to sheer and notch, indexing of the panel ends and the notches is precisely controlled. The manufacturing process will assure that the panel lengths are within  $\pm 1/16$ " from panel to panel.
4. Approximate weight of panels is shown in the table below:

Panel	Width	24 ga. (lbs/sf)	22 ga. (lbs/sf)
<b>BigbeeVR-216</b>	16"	1.360	1.694
<b>BigbeeVR-218</b>	18"	1.317	1.642

### C. Seam

The panel seam is designed to perform three functions that are critical to the performance of the roof system. These functions are:

1. Seal the sides of the panels without through fasteners to minimize water penetration.
2. Provide attachment location for structural clips.

3. Structurally connect the sides of the panels to form a continuous membrane and resist bending loads.

Water resistance of the seam is developed by factory applied sealant. The factory applied sealant is injected into the female side of the seam during panel forming.

**BigbeeVR** Panels have a sidelap that can be formed into two types of seams:

1. **“TripleLok”**<sup>TM</sup> - The **“TripleLok”** seam is formed by continuously field seaming the adjacent panel sides over each other to interlock the two panels so they form a watertight seal that will resist separation even if the panels are severely lifted during design storm conditions. The **“TripleLok”** seam is partially formed in the factory and completed in the field with a powered seamer. The **“TripleLok”** seam will resist greater uplift forces than any known seam.
2. **“QuadLok”**<sup>TM</sup> - The **“QuadLok”** seam is formed by reforming the **“TripleLok”** seam with field seaming to further tighten and form an additional strengthening bend such that a 24 gauge roof panel will resist uplift loads greater than a 22 gauge panel. This seam is only used at some roof edge zones and/or roof corners or on extremely high roofs in high wind areas where wind uplift forces are severe.

#### D. Reinforcing Legs

Vertical legs on the panel sides will strengthen the steel membrane so it will resist the roof loads such as erection loads, live loads and wind uplift. The panel vertical legs will also provide a raised platform for the panel seam two inches (2") above the panel surface. By raising the seam above the panel flat, roof water drainage will not often flow above the seam. The base of each leg has a shallow shoulder rib. The shoulder rib will stiffen the vertical leg where it transitions from flat to vertical, thus providing greater resistance to damage from wind uplift, roof traffic and field handling. The shoulder rib has been sized so it will appear as a shadow from the ground after the roof is installed. The shoulder rib will not prevent the panel from being formed over the eave on some applications to provide a fascia effect.

#### E. Panel Flat

The flat area between corrugations will be formed with striations to minimize the effect of oil-canning in the panel sheet. The striations consist of a series of slight offsets (less than a material thickness in depth) formed in the panel flat. The effect of the striations is to break up any oil-canning in the flat to relative narrow portions of the panel. The visual effects of the striations are pleasant and architecturally driven and they fade from view when the panel is viewed from a distance. This leaves the appearance that the panel has a flat surface. Experience has shown that the striations reduce the appearance of oil canning

better than minor ribs or pencil ribs. Oil-Canning is a natural occurrence in metal panels that does not affect the finish or structural integrity of the panel and is therefore NOT a cause for rejection.

#### F. Panel Clips

Panel clips fasten the roof panels to the structure. The panel clips are available in either **fixed** or **floating**. Fixed clips will be one piece clips that will not allow the roof panel to move with expansion and contraction. Floating clips will have a tab and a base with a sliding interlock allowing the roof 1-3/4" of expansion movement and 1-3/4" of contraction movement. The floating clip tab will move in the sliding interlock of the 16 gauge galvanized steel clip base. The clip base will be protected from corrosion by galvanized coating that has similar weather resistance to that of the panel coating.

The clip tabs will have a top portion formed so they will be folded into the **"TripleLok"** seam during seaming of the sidelap. No sealant is required on the clip because the sealant location in the outer hook portion of the female leg of the panel seam will not be interrupted by the clip tab. The clip tab will have **fingers** formed in the portion that is seamed into the **"TripleLok"** seam to minimize the force required to seam the clip into the **"TripleLok"** seam.

Panel clips will be attached to the secondary structurals with two 1/4"-14 self-drilling screw. Fasteners required for other building applications will be determined by the type of secondary structurals or the substrate used on the building.

**Fixed clips** will be offered in three heights: zero clearance, low clearance and high clearance. **Zero clearance** clips will be used where **no insulation** is to be placed between the panel and the secondary structurals or where the panel run is short and a decking is used under the panel. **Low clips** should be used for blanket insulation **up to 4" thick** without foam spacer blocks. Low clips will provide a nominal 3/8" stand off between the panel flat and the structurals for compressed insulation. **High clips** should be used when: spacer blocks are required or; **6" inches or thicker** blanket insulation is required; or when a combination of spacer blocks and thicker insulation are required. High clips will provide 1-3/8" nominal clearance for the compressed insulation and a foam block. The high clearance clips have a panel support shelf that will support the panel during installation and seaming.

**Floating clips** will be offered in two heights: **low**, and **high**. Low and high floating clips will be used under the same conditions as the fixed clips. The movable tab of the floating clip is locked in the center position of its slide range by tabs that release when the clip fastener compresses the clip base during installation. This centering release design assures the clips will provide a full 1-3/4" of roof movement for expansion and a full 1-3/4" movement for contraction.

## G. Panel Endlap

Panel endlaps will be required if the panel run length is greater than the maximum length panel that can be shipped. Panel endlaps provide a continuation of the panel sidelap seal along the end of the panels where the two panels join end to end. Because the **BigbeeVR** Roof System is designed to be water resistant on low slope roof applications, the endlap seal is of a gasket design. The gasket design will resist moisture entry from water flowing over the endlap from either direction. This type of design is necessary because on low slope roofs, wind can force water up the slope and ice damming can cause water to temporarily pond along the panel flat. To achieve a gasket seal, the two light gauge roof panels have butyl tape sealant placed between them and are then tightly clamped to a relatively heavy gauge, back-up plate. This will distribute the fastener clamping force along the light gauge panel material resulting in a uniform compression of the butyl sealant placed between the panels. The back-up plate will also extrude the sealant into the fastener hole around the fastener shank and under the fastener sealing washer to seal the panels and fastener holes from moisture entry.

The panel endlap splice will not be attached to the secondary structurals so any roof movement due to differential expansion and contraction between the roof panels and the roof structurals will not be restricted.

The panel endlaps will be staggered to minimize the number of material thickness lapped together at the endlap and thus minimize the tendency of the panel width to crawl or stretch.

The **BigbeeVR** endlap:

1. The back-up plate is placed under the panel and rest on the secondary structurals. The endlap can be placed as close as 4" from the upslope edge of the secondary structural or as far as 12" from the upslope edge of the secondary structural member.
2. The panel vertical legs are factory-notched for the endlap condition. Factory-notching the panels prevents field notching errors at this critical portion of the roof, thereby improving the assurance of a weather resistant endlap and neat appearance.
3. The (optional) cinch strap is fabricated from stainless steel having weather resistance finish to match the coating used on the roof panel. This assures a long life and low maintenance roof system.

## H. Eave and Termination Perimeter Plates

1. Eave perimeter plates are installed over the eave member so the outer edge extends over the wall panel. The eave perimeter plate provides a solid, non-compressible attachment point for the eave end of the panel run. The eave end of the panel run must resist the forces of the panel movement during differential expansion and contraction between the roof panel and the roof structurals. If the panel was not tightly clamped to the eave plate, all the forces of expansion and contraction would be applied to the fastener shaft and the fastener hole, resulting in elongating of the fastener holes and eventual entry of moisture. The eave perimeter plate also provides a means of locating the eave fastener outside the building envelope so any moisture entry will have a minor effect on the building contents.
2. The termination perimeter plate is installed along the termination rake angle. The termination perimeter plate will provide a shelf to attach the panel flat of the last panel along the termination rake. The termination perimeter plate has slotted holes in the base for attachment to the rake angle with shoulder fasteners. The use of shoulder fasteners in the slotted holes will provide a means for the roof to move independent of the roof structurals during expansion and contraction of the roof panels.

#### I. Start of Panel Run

1. The start of a panel run requires a full width panel and is accomplished by installing panel clips along the rake angle. The female leg of the panel is attached to the tab of the start clip when the rake trim is fastened to the roof panel. The advantages of using a panel clip for the starting of a panel run is that the clip may be attached to the rake angle before the insulation is placed and its exact location can be marked on the rake angle leg. With the clip in place before the insulation is started, start positioning of the roof panel is a simple matter of establishing the correct eave overhang and placing the female leg over the clip tab.
2. If it is desirable to reposition the location of the roof panel side laps, the panel run may be started with a partial panel. To start the roof with a partial panel, a termination perimeter plate is used along the start rake instead of panel clips. The partial panel flat is attached to the termination perimeter plate in the same manner as the termination panel is attached at the end of a panel run.

#### J. Termination of Panel Run

1. The termination of the last panel run at the rake is accomplished in the panel flat. By terminating the panel run in the flat, it is not as critical to hold the panel on module as with other systems that terminate on the panel corrugation. Panel module does affect the fit up of the closures and the ability to properly seam the panel. This method of termination also accommodates greater variance on the squareness of the roof structure.

#### K. Ridge Flashing

1. The design of the ridge flashing accommodates roof expansion and contraction. The ridge flashing and closures will have a finish that matches the roof panel finish.

#### L. Eave Trim and Gutter

1. The roof panel is sealed to the wall panel with an eave flashing. The eave flashing provides a gasket sealing point to seal the underside of the roof panel and acts as a shingle to shed water over the outside of the wall panel. The eave trim is standard with or without gutter.
2. The eave trim is available in two types. One type consists of a one piece trim section to be used if the wall panel is installed before the roof panel. The other type is a two piece trim to be used if the roof panel is installed before the wall panel.

#### M. Fasteners

1. The **BigbeeVR** Roof System will not have exposed through fasteners that penetrate the roof membrane over the building envelope **except at panel endlaps** on roof runs that are longer than the length a panel can be shipped.
  - A. Endlap fasteners
    - a. Six (6) endlap fasteners will be required to seal the panel endlaps.
    - b. Endlap fasteners will be oversized #12 x 1 ¼" self drilling fasteners.
  - B. All exposed fasteners will be self-drilling and not require special tools other than industry standard screw guns. Fasteners will have metal backed neoprene sealing washers.

## 2.3 Material and Finish

### A. Panel and Flashing Material

1. The roof panels will be of 24 ga. or 22 ga.<sup>1</sup> steel, 50,000 psi minimum yield strength (ASTM A792, Grade 50), coated with AZ50 (minimum) aluminum/zinc alloy for painted finish or AZ55 aluminum/zinc alloy for unpainted finish.<sup>2</sup>
2. The flashing and trim will be 26 ga. steel 50,000 psi minimum yield strength (ASTM A792, Grade 50), coated with AZ50 (minimum) aluminum/zinc alloy.

### B. Sealants

1. The seam sealant will be a non-drying, non-hardening, non-oxidizing butyl rubber-based sealant specifically formulated for factory sealing standing seam roof panels.
2. Sealant for the eave, end splice, ridge flashing, and rake trim will be non-drying, non-hardening, butyl based tape sealant specifically formulated for field application at temperatures of 20° F to 120° F.
3. Service temperature of both sealants will be -60° F to 180° F.

### C. Closures

1. The end dam to be used at the ridge and high side of a single slope roof is a die-formed steel closure with factory punched holes. The end dam seals the outside of the panel at the ridge or high edge of a single slope roof panel to the ridge or high edge of roof flashing. This seal is developed using gasket techniques similar to those used at the endlap. The tape sealant is sandwiched between the roof panel which is fully supported by a rigid heavy gauge back-up plate and the flange of the end dam. The fasteners clamp the back-up plate and end dam together. The clamping force uniformly compresses the sealant between the panel and the end dam causing the sealant to be extruded with over one ton of force. The extruded sealant provides a seal that will resist wind-blown water.

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<sup>1</sup> 22 ga. available on special request with extended delivery time required.

<sup>2</sup> Other materials and finishes available on special request with extended delivery time required.

## 3.0 Standard Roof System Application Guidelines and Use Limitations

### 3.1 General

The **BigbeeVR** Roof System is a heavy-duty architectural or functional roof system intended for use where architectural appearance, water resistance, expansion/contraction and insulation efficiency are of prime importance.

**Bigbee Steel Buildings, Inc.** has designed the **BigbeeVR** Roof System to be water resistant and have a long life expectancy when properly specified by a qualified building designer who is aware of the conditions normal to industrial and commercial roof installations. The building designer should analyze the requirements of the specific building being covered with the **BigbeeVR** Roof System to determine if the features and limitations of the system will be compatible with the design requirements of the specific building.

### 3.2 Roof Configuration

#### A. Basic Application

The **BigbeeVR** roof panel is better suited for special roof details because the vertical leg design. It is an easier panel to seal and make weather tight at the ends or at slope and bevel cuts. However, the following roof configurations should be evaluated on a project to project basis.

#### B. Rectangular

The **BigbeeVR** Roof Systems are designed primarily for architecturally driven commercial roofs with steeper single or double sloped rectangular areas. **BigbeeVR** roofs can be applied to more complex configurations, but consideration must be given to the potential for increased material and labor cost and potential erection problems resulting from the complexity of the parts and their installation. **More complex roof configurations, such as those listed below, must be specifically approved by Bigbee Steel Buildings, Inc. in writing to be covered by any Bigbee Steel Buildings, Inc. guarantee.**

#### C. Beveled

Non-rectangular configurations such as beveled eaves, beveled gables, hips and valleys, are designed similar to their rectangular counterparts with the exception of the transitions which require field cutting of the panel and special factory or field-fabricated flashing parts.

#### D. Pitch Transitions

Changes in roof pitch will require a transition joint or ridge between the different

pitched roof sections. **The transition joint may require provisions for expansion and contraction of one or both roof planes.** The designer may be required to provide special secondary structurals to accommodate fixing the roof panels at locations other than the eave. Panels run “over the eave” onto a mansard will require rib clips or covers.

#### E. Arched

Arched roofs are usually on structures with roofs set to a curved plane either laterally or longitudinally. The **BigbeeVR** Roof System is not recommended for use on arched roofs without review by **Bigbee Steel Buildings, Inc.**

### 3.3 Roof Pitch

#### A. Minimum Pitch

Minimum allowable roof pitch is primarily determined by the anticipated amount of water ponding expected on the roof. Building width, roof deflection, parapets, gutter design, rainfall intensity, wind direction and snow and ice damming (geographical location) are the common factors determining water ponding.

Low pitch roofs (below 2:12) in heavy snow and ice regions should not be designed with conditions that will accumulate snow or ice such as high parapets and wall above the roof transitions.

Long roof runs (in excess of 200') in heavy rain areas such as the Gulf Coast should have a roof pitch greater than 1/4:12 to minimize water build up due to heavy wind and rainfall.

#### B. Ponding

The **BigbeeVR** Roof System utilizes gasket type joints to resist standing water on low pitch applications. These joints are designed to resist momentary flooding, such as that caused by heavy rain with wind gusts. Permanent water damming such as caused by obstructions, clogged valley gutters or long-term ice damming must be avoided.

#### C. Deflection

Lower roof slopes (less than 1:12) tend to increase the amount of ponding and consequently increases the deflection of supporting structurals which may in turn cause additional ponding.

Concentrated loads and other loads such as suspended ceilings, lighting, HVAC equipment, sprinklers, and cranes that are supported by the same structurals that support the roof panel may cause excessive roof deflection with resulting ponding.

#### D. Maximum Pitch

Maximum roof pitch is primarily determined by the effect upon the supporting structure, erection requirements and trim/flash/gutter designs. High pitch roofs, especially those used with sloped metal reroof framing systems, when subjected to gravity roof loads, may develop substantial "in plane" loads and may require special bracing and may require special roof panel attachment.

#### E. Standard Roof Pitch Limitations

The **BigbeeVR** Roof System's minimum allowable roof slope is 1/2:12 as standard. A 1/4:12 sloped roof must be approved by **Bigbee Steel Buildings, Inc.**

The **BigbeeVR** Roof System's maximum allowable roof slope is 6:12 as standard. Greater slope requires approval from **Bigbee Steel Buildings, Inc.**

The standard pitch limitations are based on general and typical roof applications. It is the customer's responsibility to assure that the specified roof slope is adequate for the building and environmental conditions of the specific project.

### 3.4 Roof Drainage

#### A. Drainage Factors

Roof drainage is an important factor in the design of a building. It is affected by building conditions such as slope, size, deflections and evenness of the roof. It is also affected by environmental conditions such as rainfall intensity, snow and ice occurrence and wind factors.

#### B. Roof Profile and Width

The roof drainage design criteria will limit the width of the building by the system's ability to carry off rain water.

On a single slope roof, the high eave is more suitable for parapet or facade treatment and the entire roof area drains to the low eave. The absence of a ridge and gutter and down spout system at one eave provides material and erection savings.

On a gabled roof, the ridge divides the roof area so each eave handles half the roof drainage. With a gutter and down spout system at each eave, a wider roof area can be drained.

For extremely wide roof areas, multi-gabled roofs will be required. The roof is divided by alternate ridges and valleys with drainage at each eave and at the

valleys. The valleys require an interior drain pipe system.

### C. Eave Drainage Options

Eave drainage is usually by exterior mounted gutter and down spouts. Where suitable for appearance and ground run-off conditions, gutters are not provided and the run-off occurs at the roof edge.

Interior eave gutters are required when the low eave is at a parapet or wall, or when icing is so severe that the gutter and drain pipes must be heated by the building's interior.

In severe snow and ice regions, the eave gutters may be omitted and the roof edge extended so run-off and icing occurs away from the wall surface.

### D. Effect of Pitch on Roof Drainage

Steep roof slopes increase the rate of run off of short duration, high intensity rainfalls. In regions where snowfall is a factor, snow slides down steep roofs could overflow and dam the gutters and down spouts.

## 3.5 Expansion and Contraction

### A. Temperature Differential

Theoretically, the temperature differential between the roof's surface and the supporting structural determines the amount of differential expansion/contraction movement the roof system must accommodate. In actual use, some of this movement is absorbed by the flexing of the supporting structure and minor oil-canning or strain in the roof. Insulated structures experience greater temperature differentials than uninsulated structures.

In setting differential temperature requirements, consideration must be given to panel color, building location, infrared heating by the sun, the cooling effect of structures, insulated buildings that are temperature sensitive, or in extreme climates, may require wider than normal temperature ranges. Differential temperatures of insulated buildings with dark roofs in mountain areas are particularly high.

Differential temperature movement may be estimated using rational analysis. When an unrestrained steel panel 100' long is subjected to a 100° F temperature change, its length changes 0.78". Temperature movement may be restricted by panel restraint, but doing this is impractical because of the large forces required.

A 24 gauge **BigbeeVR** Panel would require about 10,000 pounds force to restrain it. Many specifications require a 100° F temperature change for differential movement between the panel and its support structure. Conditions

which require differential expansion and contraction temperatures in excess of 100° F require special approval from **Bigbee Steel Buildings, Inc.** to qualify for any guarantee.

#### B. Effect on Roof Panels

1. In the direction parallel to the eaves, **BigbeeVR** Roofs absorb the differential movements by flexing of the panel profile and sidelaps. Since the panels are only 16" or 18" wide, the differential movement at each panel is insignificant and does not accumulate in the direction parallel to the panel corrugation.
2. Expansion and contraction from eave to ridge in panel runs less than 50', the differential movement is absorbed by flexing of the support structure and minor oil-canning or strain in the roof panels. In roofs with eave to ridge panel runs that are in excess of:
  - 1) 50', when secondary structurals are light gage Zee or Cee members.
  - 2) 30' when the roof is erected on more rigid structurals such as heavy zee or cee purlins, or purlins that are supported by stiff attachments, bar joists, or hot rolled beams.

The **BigbeeVR** Roofs must be erected to absorb the differential movement between the panel and its support by sliding of the 2 piece floating clips and specially designed perimeter flashing.

#### C. Standard Roof Size Limitations

1. The following size limitations apply to each separate roof section. A roof section is defined as an "in plane" section separated from other sections by perimeter transitions such as eave, gable, ridge, parapet and expansion joints. These size limitations are based on a 100° F maximum temperature differential between the roof surface and the supporting structure.
2. Roof section length (dimension parallel to building eave) is not limited.
3. Maximum standard roof section width (eave to ridge length) is limited as follows:
  - 30' -- with fixed clips attached to inflexible structurals.
  - 50' -- with fixed clips attached to flexible structurals (such as cee or zee purlins).
  - 225' - with floating clips.

Greater roof section widths require approval from **Bigbee Steel Buildings, Inc.**

#### D. Provisions for Expansion /Contraction

##### 1. Roof Fixity

Any given section of roof with floating clips must be rigidly attached by only one line of fasteners running along the eave unless a special design requires the roof to be fixed at the ridge of the building.

##### 2. Roof Section Fixed at the Eave

As standard, when using the floating clip, the **BigbeeVR** Roofs are rigidly attached to the supporting structure only at the low eave. At the high eave, ridge, rake and transitions, the edge of the roof is closed with flashing designed to absorb the differential movement between the roof and the adjacent structures.

##### 3. Rake

Along the rakes, the edge of the roof is attached to the supporting structure and closed to the adjacent structure by clips and flashing designed to allow free roof movement in the direction parallel to the rake. The rake flashing must be secured to walls or adjacent structurals with counter flashing or reglets which are designed to allow the free movement of the flashing.

##### 4. Penetrations

See penetrations in 3.8 for accommodating panel movement.

##### 5. Expansion Joints

Expansion joints tie separate roof sections together, yet allow each section to expand and contract independently. Expansion joints are required on extra wide buildings, at structural expansion joints, at the transition of different roof pitches, at maximum panel runs and at the transition of different roof types.

For expansion joints running parallel to the eave, the **BigbeeVR** Roof System utilizes a vertical step between the two roof sections. The step allows the lower roof to be closed with a flashing that absorbs the differential movement. The upper roof is rigidly attached similar to a low eave condition.

For expansion joints running parallel to the endwall, the **BigbeeVR** Roof System utilizes a small vertically raised parapet between the two roof sections.

## 6. Inside Corners

Where an inside corner caused by a change in the width of the roof creates a condition where adjacent panels have different fixed points, the accumulated expansion/ contraction movement of the roof is different along the adjacent panels on either side of the inside corner. When the distance between the panel attachment point at the low eaves is 30' or less, the roof system will absorb the differential movement. When the distance between the attachment point at the low eaves exceed 30', an expansion joint is required between the adjacent panel sidelaps to accommodate the differential movement.

Where an inside corner is located at the high eave of a roof fixed at the low eave, the accumulated expansion/contraction movement is the same on the adjacent panels on either side of the inside corner, thus there is no differential movement.

## 3.6 General Structural Considerations

### A. Roof Dead Load

The structure supporting the roof system should include the dead weight of the panel system in the design calculations. The weight of the panels is given in the section titled "product description".

### B. Lateral Stability

Because the roof panels are attached to the supporting structurals with sliding clips, the roof panels do not provide lateral bracing to the secondary structurals. Bridging or brace angles may be required to stabilize the roof secondary structurals.

### C. In-plane Deflection

Because the roof system is rigidly attached only to one structural member per roof section, usually the eave member, that member must have sufficient strength and stiffness or be braced to resist any in-plane (outward) deflection caused by the roof load. As the roof pitch increases, other factors being equal, the in-plane load increases.

### D. Panel Clip and Clip Requirements

1. One panel clip is placed at the intersection of each roof panel sidelap and roof structural, except where the panel is attached to the underlying structure with through fasteners.
2. The clips hold the roof panel either at 0.0", 3/8", or 1-3/8" above the structural.

The clips providing a stand-off are designed to provide a space for the roof insulation between the panels and structurals. The zero clearance clips are for use where no insulation is required or over rigid board insulation with bearing plates.

3. The floating clip has a sliding interlock to allow for 1-3/4" expansion and 1-3/4" contraction movement of the roof panel.

The floating clip will accommodate a roof panel movement of  $\pm 1-3/4$ ". This is equal to the thermal movement in a 225' panel run when subjected to a temperature differential of 100° F between the roof panel and its support structure.

The sliding clip base provides a 1" x 2" bearing surface with two 5/16" diameter holes for attachment of the clips to the supporting structure. The surfaces to which the clips are attached must not deviate more than  $\pm 1/4$ " from their common plane and must have sufficient strength and stiffness to resist the load imposed on it by the base of the clip and its attachment fastener.

The clip attachment fasteners will be provided by **Bigbee Steel Buildings, Inc.** as appropriate for the specified roof design requirements and the specified structural member material, size and spacing.

- a. The panel clip tab will be of 0.031" steel, 50,000 psi minimum yield strength with G90 galvanizing.
- b. The clip base will be of 0.064 steel, 50,000 psi minimum yield strength with G-90 galvanizing.

### 3.7 Insulation

#### A. Insulation Provisions

The **BigbeeVR** Roof provides a space for insulation between the roof and the supporting structurals. This is accomplished by an eave perimeter plate which supports the roof in a plane slightly above the top of the structurals. The eave perimeter plate and clips are designed to provide a positive mechanical tie between the roof and the supporting structure with minimum interruption of the insulation.

As standard, the roof clips and eave perimeter plate are designed to provide either a nominal 3/8" or 1-3/8" insulation space between the roof and supporting structurals. Insulation space greater than 1-3/8" will require special order and approval by **Bigbee Steel Buildings, Inc.**

## B. Insulating Methods

### 1. Condensation Control

With any insulation system, the proper design and installation of vapor retarders and ventilation systems are of the utmost importance to prevent condensation and the resulting problems of moisture damage, dripping and loss of insulation efficiency. **Bigbee Steel Buildings, Inc.** recommends the services of a qualified engineer to specify the appropriate vapor control system for the specific building and environmental conditions.

### 2. Blanket Insulation

Blanket insulation and clip height selection are interdependent design considerations. Blanket insulation up to 4" thick can be used with the low clips having a nominal 3/8" stand-off. For thicker insulation up to 6", the high clip and a foam spacer block are required. Insulation thicker than 6" can be used provided the insulation gives support for the panel flat when fully compressed, but does not force the panel flat to be bowed above its normal horizontal plane. Generally, each 1" thickness of fiberglass insulation will compress to about 1/8" over a 3" wide purlin. For example, a 3" thick insulation compresses to about 3/8". A 3/8" space between the purlin and panel will accommodate 3" to 4" of insulation (the clip will be raised slightly as it is sitting on compressed insulation), or a 1-3/8" space will accommodate 6" of compressed insulation.

The insulation is stretched across the supporting structurals with the **BigbeeVR** Roofs applied directly over the insulation. Between the structurals, the insulation assumes its full thickness. Over the structural, the insulation may assume the thickness of the space between the structural and the roof. This provides much greater insulation efficiency than the common systems which completely compress the insulation between the roof and the structural.

### 3. Spacer Blocks

Optional spacer blocks may be provided with the roof panels as installation aids when installing the roof with 1-3/8" stand-off clips and up to 4" of insulation. **Do not use the 3/8" standoff clip with spacer blocks.**

### 4. Other Insulation Systems

There are several insulation systems which provide a clip or bracket to support thicker insulation between the structurals. A blanket or board

insulation is then placed over the joists to insulate the space between roof and structurals.

These systems may work well with the **BigbeeVR** Roofs however, they may affect the appearance or structural performance of the **BigbeeVR** Panel Systems and may void standard warranties. To obtain approval of these systems and maintain a guarantee, check with **Bigbee Steel Buildings, Inc.**. Additional details are available from the insulation system suppliers.

#### 5. Insulation Facing

Condensation occurs when warm, moist air comes into contact with a cold surface, i.e., a cold panel surface on or below the dew point.

In most sections of the United States, condensation on the underside of a metal roof can be prevented by keeping warm, moist air away from the panel. With metal roofs, this is often accomplished by placing blanket insulation and a vapor retarder immediately below the panel. The vapor retarder should be on the warm side of the insulation. For the blanket insulation to work, the insulation must keep the vapor retarder's surface above its dew point and the vapor retarder must prevent water vapor from reaching the cold surface of the underside of the panel. In addition, it must prevent streams of warm air from passing over the surface of the cold panel. In order to achieve this, the perm rating of the vapor retarder must be very low because the perm rating of the metal roof is substantially 0.0 (zero). Metal roofs are less forgiving than some other types of roofing such as wood shingles that breathe. The body of the vapor retarder must not have pin holes or other tears and the edges of the vapor retarder must be joined in such a way they prevent both water vapor, and air penetration.

A vapor retarder having a perm rating of 0.02 is recommended and **Bigbee Steel Buildings, Inc.** warranty requires a maximum of 0.05. For further information on condensation control in metal buildings, refer to the MBMA Condensation Fact Sheet.

#### 6. Sub Framing

On roofs where there is insufficient space for the desired thickness of insulation, such as when the **BigbeeVR** Roofs are used over a liner or over an existing roof, additional insulation space may be obtained by fastening furring members or spacers to the existing structure. The roof clips are then attached to these members. The furring strips must be designed to resist the load transferred to the furring strip by the panel clips.

#### 7. Board Insulation

Board insulations, such as rigid foams, may be applied over the supporting

structure to fill the insulation space. The board size should be matched to the roof clip spacing to minimize cutting the board insulation around the clips. Where greater insulation thickness is required, the roof clips may be installed on top of the board insulation. Depending upon the compressive strength of the board insulation, **bearing plates** are normally installed under the roof clips.

### 3.8 Roof Penetrations

#### A. Critical Requirements

The proper flashing of roof penetrations is an important factor concerning the roof's water tightness and structural performance. Because the penetration cuts through the panel flat and is subjected to the full and often concentrated water run-off as well as snow and ice accumulation, the design and installation of penetrations is critical and should be performed only by those experienced in such applications. **It is necessary to cut the panel back 2" from the uphill and down hill edges of fixed object penetrating the panel surface to allow for expansion/contraction movement.**

For **BigbeeVR** Standard Roof Systems, curb material and application design must be provided by **Bigbee Steel Buildings, Inc.**

For **BigbeeVR** Custom Roof Systems, curb material and application design are subject to approval by **Bigbee Steel Buildings, Inc.**

#### B. Pipe Flashing

Penetrations for small pipes and ducts may be flashed with **Bigbee Steel Buildings, Inc.**'s standard curb flashing. The flashing consists of a flexible boot with a metal backed sealing flange. The flashing must be located in the panel flat and must be located to provide a 2" min. space between the panel rib and the flashing to prevent blockage of the roof run-off.

#### C. Curbs

Larger penetrations, which are wider than the roof panel, will require a self flashing roof curb. The **BigbeeVR** specified curb will be a metal, factory-built assembly consisting of a vertical wall at least 8" high with a continuous perimeter flange that is configured to accommodate the roof panel profile. Because the curb is interfaced and tied directly to the roof panel, the curb must float with the roof surface and be independent from any sub framing. No through fastening of the roof curb to the supporting structurals is allowed.

The **basic curb** will have an extended flange all around with a built in water diverter at the uphill side to direct the water flow around the unit. The curb will be

provided with the necessary fasteners and sealant to install the unit properly to the panel flats. The curb will be factory welded and coated at all joints to assure weather tightness and constructed from galvanized, Galvalume or all aluminum material. **Bigbee Steel Buildings, Inc.** will recommend a qualified curb supplier who is skilled at accommodating the dimensional requirements.

There are three types or load requirements of curb installations:

Level 1 – For curbs that support 2000 lbs loads (hatches, ventilators, fans, skylights) or less, use the Basic Unit with lightweight sub framing designed to allow the curb to float and support the intended loads.

Level 2 – For curbs that support 2001 lbs to 5000 lbs (medium AC units), use the same basic unit with the light weight sub framing plus a fixed Inner Curb to support the heavier load. The basic unit will act as a floating counter flash for the entire assembly. The inner curb will be flashed to the basic unit for weather tightness. Additional support framing will be required under the inner curb and be provided by **Bigbee Steel Buildings, Inc.**

Level 3 – For loads greater than 5000 lbs (large AC units and mechanical stations) will require pipe supported frames with a minimum of 18" clearance above the roof plane. The Basic Unit curb with floating sub framing is used in this application and houses the supply/return plenums. The loads are carried by the pipe column frames which bear on heavy sub-framing below the plane. Pipe flashing is used to seal to the roof and accommodate thermal movement.

#### D. Clearances

Curbs must be located at least 4" away from adjacent construction to allow for attachment to the roof panel or supporting structurals and to allow for roof run-off around the sides of the curb. It is most important that the roof panels and support structurals are at the correct elevation and in-plane to assure that the curb flange will uniformly fit to the roof panel and eliminate any ponding areas around the curb.

### 3.9 Corrosion

The **BigbeeVR** Roof Panels and Flashing are made of steel clad with an aluminum/zinc alloy. This is the strongest, most durable and maintenance free of the practical roof materials. However, to help ensure longevity, the roof must be designed, installed and maintained so as to prevent the roof's exposure to the following conditions:

1. Exposure to a corrosive atmosphere, settlements and run-off such as chemical exhausts, salt spray, etc.
2. Exposure through direct contact or run-off from corrosive materials such as uncured cement, some treated lumbars, acids, caustics, etc.

3. Consistent exposure to moisture such as caused by water or steam exhausts, continuous drainage overflow, long term ponding and moisture-holding materials such as accumulated dirt, leaves, sawdust, fibers, etc.
4. Exposure to wet insulation and wet sub-materials such as caused by roof leakage, improper condensation control or installation.
5. Exposure through direct contact or run-off from bare and rusting iron or steel objects and materials such as tools, metal scraps, fasteners, wire, staples, saw and nibbler chips, abrasive dust, etc. The rusting of these objects absorbs the protective cladding from the roof surfaces leaving the roof material's bare steel exposed to rusting.
6. Exposure through direct contact or run-off from dissimilar metals such as copper pipes or flashing.
7. Scratch and scuff damage or erosion of the roof material's protective cladding which exposes the material's bare steel.

### 3.10 Roof Appearance

Steep roofs, and sometimes low pitch roofs, may be seen and the aesthetics of such roofs may be important. In these situations, steps should be taken to construct these roofs accordingly.

Every effort is made to assure **BigbeeVR** panels reach the job site in premium condition. The panels should be stored and used in such a manner the premium appearance is preserved.

The **“TripleLok”** and **“QuadLok”** seams are formed by an electrically powered seaming machine. As the seamer forms the seam, some pressure marks and slight scuffing of the paint finish may be noticeable. These are normal with all roofs having a seamed sidelap and are rarely visible from the ground. The edge of the panel clip will read through or print the panel material at the seam and along a portion of the vertical leg. This is called “clip read through” and is normal to seamer sidelaps. Clip read-through is not visible from a distance and requires close inspection to notice.

All metal panels exhibit some oil-can or wave of the surface in certain conditions. Panels that are rigidly fixed to insulated structurals so that differential movement between the two occur may exhibit more pronounced oil-can when subjected to rising temperatures. Oil-Canning is a natural occurrence in metal panels that does not affect the finish or structural integrity of the panel and is therefore NOT a cause for rejection.

Panels over deck that are supported above the deck by fixed clips may exhibit more pronounced oil-can when subjected to rising temperatures.

Panels with excessive insulation between the panel and its support may cause the flat of the panel to "pillow" upward and some may consider this detrimental to appearance.

Panel installation may have a detrimental effect on appearance if improperly or carelessly done. When roof appearance is important, special precautions must be taken.

The roof surface must be protected from damage caused by the following roof traffic conditions:

- a. Constant erection traffic such as at roof access and material loading areas and areas subject to consistent traffic by the roof installers or other trades.
- b. Maintenance traffic such as at roof access and equipment maintenance areas.

Except during erection and for roof and equipment maintenance, no other foot traffic should be allowed on the roof.

To prevent roof damage caused by roof foot traffic conditions, **Bigbee Steel Buildings, Inc.** recommends the application of a proper roof walkway system. There are several manufactured systems available with bearing features and clamps which will secure the walkways without roof penetrations or bearing damage. These systems are available in redwood, aluminum and galvanized steel construction and are available with non-slip treads.

Temporary or permanent field constructed walkways may be utilized but consideration must be given to prevent penetration and abrasion or deformation damage to the roof panels.

### 3.11 Erection

#### A. Erection Instructions

See **BigbeeVR** Roof Erection Requirements and Recommendations included in the **BigbeeVR** Roof Installation Guide available from **Bigbee Steel Buildings, Inc.**

#### B. Erection Temperature

Roof erection temperatures are important considerations. Temperature extremes must be considered during installation of the roof because of the temperature sensitivity of the sealants and other parts such as clips. The recommended installation temperature range is 20° F to 120° F. At colder temperatures, the sealant stiffens, resulting in loss of adhesion and compressibility. At higher temperatures, the sealant becomes too soft for practical handling. Once the roof

is installed and in service, the sealant can withstand temperatures of -60° F to 180° F.

### C. Erection Accuracy

Because the **BigbeeVR** Roofs utilize factory prepared interlocking components, the proper placement of the components during erection is critical. The precise location of reference points and accurate field measurements are most important.

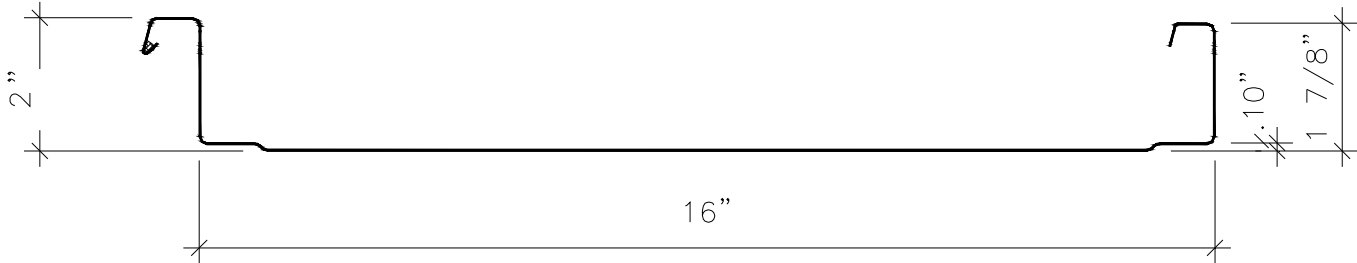
**BigbeeVR** Roofs are designed to absorb normal deviations or tolerances, but excessive out of square or dimensional variations must be identified and provided for in all details.

### 3.12 Roof Additions and Modifications

For **BigbeeVR** Standard Roof Systems, any modifications or additions to the roof must be reviewed and approved by **Bigbee Steel Buildings, Inc.** Modifications and additions may affect the structural and weather tightness performance of the roof in ways that may not be readily understood or considered by parties other than **Bigbee Steel Buildings, Inc.** Also, any modifications or additions should be reviewed for effects on the structure and code compliance.

## 4.0 Load Span Tables and Section Properties

### 4.1 *BigbeeVR-216* Panel Profile



### 4.2 *BigbeeVR-216* Section Properties

Gauge	F <sub>y</sub> (ksi)	Wt. (psf)	Thick. (inch)	Panel Top in Compression			Panel Bottom in Compression		
				I <sub>x</sub> (in <sup>4</sup> )	S <sub>x</sub> (in <sup>3</sup> )	F <sub>b</sub> (ksi)	I <sub>x</sub> (in <sup>4</sup> )	S <sub>x</sub> (in <sup>3</sup> )	F <sub>b</sub> (ksi)
24	50	1.360	0.024	0.2132	0.1229	29.9	0.1217	0.1067	29.9
22	50	1.694	0.030	0.2731	0.1593	29.9	0.1573	0.1337	29.9

NOTE: Section properties are calculated in accordance with 1986 AISI Specifications. S<sub>x</sub> and F<sub>b</sub> are for stress determination; I<sub>x</sub> is for deflection determination.

24 gauge: allowable intermediate bearing at 3" = 0.686 kip/ft  
allowable end bearing at 2" = 0.212 kip/ft

22 gauge: allowable intermediate bearing at 3" = 1.016 kip/ft  
allowable end bearing at 2" = 0.386 kip/ft

\* Oil-Canning is a natural occurrence in metal panels that does not affect the finish or structural integrity of the panel and is therefore NOT a cause for rejection.

**4.3 BigbeeVR-216 Allowable Gravity Loads - All Loads in Pounds per Square Foot**

**A. 24 Gauge Material ( $F_y = 50$  ksi)**

Span Type	Load Type	Span (In feet)							
		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Single Span	Stress	273.1	153.6	98.3	68.3	50.2	38.4	30.3	24.6
	Deflection	273.1	153.6	98.3	68.3	50.2	36.4	25.6	18.6
2 Spans	Stress	237.2	133.4	85.4	59.3	43.6	33.4	26.4	21.3
	Deflection	237.2	133.4	85.4	59.3	43.6	33.4	26.4	21.3
3 Spans or more	Stress	277.1	155.9	99.8	69.3	50.9	39.0	30.8	24.9
	Deflection	277.1	155.9	99.8	69.3	50.9	39.0	30.8	24.9

**B. 22 Gauge Material ( $F_y = 50$  ksi)**

Span Type	Load Type	Span (In feet)							
		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Single Span	Stress	354.0	199.1	127.4	88.5	65.0	49.8	39.3	31.9
	Deflection	354.0	199.1	127.4	88.5	65.0	46.6	32.7	23.9
2 Spans	Stress	297.2	167.2	107.0	74.3	54.6	41.8	33.0	26.7
	Deflection	297.2	167.2	107.0	74.3	54.6	41.8	33.0	26.7
3 Spans or more	Stress	347.2	195.3	125.0	86.8	63.8	48.8	38.6	31.2
	Deflection	347.2	195.3	125.0	86.8	63.8	48.8	38.6	31.2

- Notes:
1. Tabulated values are total allowable loads calculated in accordance with good engineering practices and maximum bending stresses as shown for physical and section properties given in Section 4.2.
  2. Deflection loads are limited by a maximum deflection ratio of  $L/180$  of span or maximum bending stress, whichever is less.
  3. These load capacities are for the panel itself. Frames, purlins, clips, fasteners, and all supports must be designed to resist all loads imposed by the panel.

**4.4 BigbeeVR-216 Allowable Wind Uplift Loads - All Loads in Pounds per Square Foot**

**A. 24 Gauge Material ( $F_y = 50$  ksi)**

***TripleLok Seam***

Span	1592 Test Ultimate Load	1592 Design Load	COE Design Load
2.0	232.3	136.4	140.8
2.5		113.2	116.9
3.0		94.3	97.3
3.5		80.9	83.5
4.0		70.8	73.1
4.5		62.9	64.9
5.0	96.5	56.6	58.5

***QuadLok Seam***

Span	1592 Test Ultimate Load	1592 Design Load	COE Design Load
2.0	332.0	194.7	201.2
2.5		157.6	163.0
3.0		131.3	135.8
3.5		112.6	116.5
4.0		98.5	101.9
4.5		87.6	90.6
5.0	134.7	78.8	81.6

- Notes:
1. The above tabulated loads are generated from certified ASTM E-1592 testing.
  2. Intermediate design loads are interpolated from ultimate test loads.
  3. Design loads contain a safety factor of calculated per AISI.
  4. COE design load contains a 1.65 safety factor per COE 07416 Specification.
  5. These load capacities are for the panel itself. Frames, purlins, clips, fasteners, and all supports must be designed to resist all loads imposed by the panel.
  6. Allowable wind uplift loads have not been increased by 33% as allowed by some codes when wind load controls.
  7. This material is subject to change with out notice. Contact Building Research Systems for most current values.

**B. 22 Gauge Material ( $F_y = 50$  ksi)**

***TripleLok Seam***

Span	1592 Test Ultimate Load	1592 Design Load	COE Design Load
2.0			
2.5	171.6	85.8	104.0
3.0		79.6	95.2
3.5		73.3	87.0
4.0		67.1	79.4
4.5		60.7	72.4
5.0	109.2	54.6	66.2

***QuadLok Seam***

Span	1592 Test Ultimate Load	1592 Design Load	COE Design Load
2.0			
2.5	192.4	96.2	116.6
3.0		90.0	108.8
3.5		83.7	100.0
4.0		77.5	92.4
4.5		71.2	85.3
5.0	130.0	65.0	78.8

- Notes:
1. The above tabulated loads are generated from certified ASTM E-1592 testing.
  2. Intermediate design loads are interpolated from ultimate test loads.
  3. Design loads contain a safety factor of 2.0 calculated per AISI.
  4. COE design load contains a 1.65 safety factor per COE 07416 Specification.
  5. These load capacities are for the panel itself. Frames, purlins, clips, fasteners, and all supports must be designed to resist all loads imposed by the panel.
  6. Allowable wind uplift loads have not been increased by 33% as allowed by some codes when wind load controls.
  7. This material is subject to change with out notice. Contact Building Research Systems for most current values.

#### 4.5 *BigbeeVR-218* Panel Profile



#### 4.6 *BigbeeVR-218* Section Properties

Gauge	F <sub>y</sub> (ksi)	Wt. (psf)	Thick. (inch)	Panel Top in Compression			Panel Bottom in Compression		
				I <sub>x</sub> <sup>4</sup> (in <sup>4</sup> )	S <sub>x</sub> <sup>3</sup> (in <sup>3</sup> )	F <sub>b</sub> (ksi)	I <sub>x</sub> <sup>4</sup> (in <sup>4</sup> )	S <sub>x</sub> <sup>3</sup> (in <sup>3</sup> )	F <sub>b</sub> (ksi)
24	50	1.317	0.024	0.1933	0.1089	29.9	0.1082	0.0949	29.9
22	50	1.642	0.03	0.2483	0.1417	29.9	0.1399	0.1189	29.9

NOTE: Section properties are calculated in accordance with 1986 AISI Specifications. S<sub>x</sub> and F<sub>b</sub> are for stress determination; I<sub>x</sub> is for deflection determination.

24 gauge: allowable intermediate bearing at 3" = 0.686 kip/ft  
allowable end bearing at 2" = 0.212 kip/ft

22 gauge: allowable intermediate bearing at 3" = 1.016 kip/ft  
allowable end bearing at 2" = 0.386 kip/ft

\* Oil-Canning is a natural occurrence in metal panels that does not affect the finish or structural integrity of the panel and is therefore NOT a cause for rejection.

**4.7 BigbeeVR-218 Allowable Gravity Loads - All Loads in Pounds per Square Foot**

**A. 24 Gauge Material ( $F_y = 50$  ksi)**

Span Type	Load Type	Span (In feet)							
		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Single Span	Stress	242.0	136.1	87.1	60.5	44.4	34.0	26.9	21.8
	Deflection	242.0	136.1	87.1	60.5	44.4	33.0	23.2	16.9
2 Spans	Stress	210.9	118.6	75.9	52.7	38.7	29.7	23.4	19.0
	Deflection	210.9	118.6	75.9	52.7	38.7	29.7	23.4	19.0
3 Spans or more	Stress	246.4	138.6	88.7	61.6	45.2	34.6	27.4	22.2
	Deflection	246.4	138.6	88.7	61.6	45.2	34.6	27.4	22.2

**B. 22 Gauge Material ( $F_y = 50$  ksi)**

Span Type	Load Type	Span (In feet)							
		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Single Span	Stress	314.9	177.1	113.4	78.7	57.8	44.3	35.0	28.3
	Deflection	314.9	177.1	113.4	78.7	57.8	42.4	29.8	21.7
2 Spans	Stress	264.3	148.6	95.1	66.1	48.5	37.2	29.4	23.8
	Deflection	264.3	148.6	95.1	66.1	48.5	37.2	29.4	23.8
3 Spans or more	Stress	308.7	173.6	111.1	77.2	56.7	43.4	34.3	27.8
	Deflection	308.7	173.6	111.1	77.2	56.7	43.4	34.3	27.8

- Notes:
1. Tabulated values are total allowable loads calculated in accordance with good engineering practices and maximum bending stresses as shown for physical and section properties given in Section 4.6.
  2. Deflection loads are limited by a maximum deflection ratio of  $L/180$  of span or maximum bending stress, whichever is less.
  3. These load capacities are for the panel itself. Frames, purlins, clips, fasteners, and all supports must be designed to resist all loads imposed by the panel.

**4.8 BigbeeVR-218 Allowable Wind Uplift Loads (cont.) - All Loads in Pounds per Square Foot**

**A. 24 Gauge Material ( $F_y = 50$  ksi)**

***TripleLok Seam***

Span	1592 Test Ultimate Load	1592 Design Load	COE Design Load
2.0			
2.542	156	78.0	94.5
3.0		61.7	74.8
3.5		52.9	64.1
4.0		46.3	56.1
4.5		41.1	49.8
5.083	72.8	36.4	44.1

***QuadLok Seam***

Span	1592 Test Ultimate Load	1592 Design Load	COE Design Load
2.0			
2.5	156.0	78.0	94.5
3.0		71.8	85.5
3.5		65.5	77.1
4.0		58.5	69.6
4.5		52.0	62.8
5.0	93.6	46.8	56.7

- Notes:
1. The above tabulated loads are generated from certified ASTM E-1592 testing.
  2. Intermediate design loads are interpolated from ultimate test loads.
  3. Design loads contain a safety factor of 2.0 calculated per AISI.
  4. COE design load contains a 1.65 safety factor per COE 07416 Specification.
  5. These load capacities are for the panel itself. Frames, purlins, clips, fasteners, and all supports must be designed to resist all loads imposed by the panel.
  6. Allowable wind uplift loads have not been increased by 33% as allowed by some codes when wind load controls.
  7. This material is subject to change with out notice. Contact Building Research Systems for most current values.

**B. 22 Gauge Material ( $F_y = 50$  ksi)**

***TripleLok Seam***

Span	1592 Test Ultimate Load	1592 Design Load	COE Design Load
2.0			
2.5	156.0	78.0	94.5
3.0		72.8	87.4
3.5		67.6	80.7
4.0		62.4	74.4
4.5		57.2	68.5
5.0	104.0	52.0	63.0

***QuadLok Seam***

Span	1592 Test Ultimate Load	1592 Design Load	COE Design Load
2.0			
2.5	183.0	91.0	110.3
3.0		83.2	98.8
3.5		74.3	88.4
4.0		65.0	78.9
4.5		57.8	70.5
5.0	104.0	52.0	63.0

- Notes:
1. The above tabulated loads are generated from certified ASTM E-1592 testing.
  2. Intermediate design loads are interpolated from ultimate test loads.
  3. Design loads contain a safety factor of 2.0 calculated per AISI.
  4. COE design load contains a 1.65 safety factor per COE 07416 Specification.
  5. These load capacities are for the panel itself. Frames, purlins, clips, fasteners, and all supports must be designed to resist all loads imposed by the panel.
  6. Allowable wind uplift loads have not been increased by 33% as allowed by some codes when wind load controls.
  7. This material is subject to change with out notice. Contact Building Research Systems for most current values.