

**American Railway Engineering and Maintenance of Way Association
Letter Ballot**

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Railway Track Equipment Operator Sightlines & Visibility Guideline for New On-Track Machinery

AREMA presents this design guideline on railway track equipment operator sightlines and visibility for manufacturers and designers to consider in their production of equipment. This guideline presents one direction for the design of sightlines and visibility for new on-track machinery with the knowledge that there are many acceptable design recommendations for sightlines and visibility. This guideline is a starting point for designing machinery and may be altered as necessary.

Sightlines and visibility are the operator's fields of view of the surrounding area from their position of control for both forward and reverse travel. The operator's position of control of railway track equipment include both "Travel" mode and "Work" mode. The operator's sightlines and visibility in this design guideline are only a function of the equipment under the operator's control.

Definitions

Obstruction – A partial or complete obscuring of the operator's sightlines and visibility of the surrounding area. Only those obstructions caused by the railway track equipment that is under the operator's control apply in this design guideline.

Acceptable Obstruction – An obstruction that does not prevent clear sightlines and visibility if the operator can use minor movements of the head, neck, and/or upper body or use of real-time video imaging.

Acceptable Sightlines & Visibility – The field of view presented to an operator when controlling equipment that allows for viewing of the surrounding area with or without Acceptable Obstructions.

"Travel" Mode – Operation of railway track equipment for the purpose of moving the equipment on track and with the operator situated in normal position designated for this type of control of the equipment.

Visible Light Transmission (VLT) - The amount of visible light that is allowed to pass through a glazing system. The higher the VLT number, the more visible light is allowed to transmit through the glazing system.

"Work" Mode – Operation of railway track equipment for the purpose of using the equipment to work on the maintenance of the railroad right of way and with the operator situated in the operator position designated for this type of equipment. "Work" Mode sightlines and visibility guidelines include the guidelines of "Travel" Mode to accommodate movement of equipment.

Window Definitions

- Acrylic is a composite material is known by many specific trade names including Plexiglas®, Lucite®, Acrylite®, and Perspex® to name a few. Acrylic is a plastic that is not safety rated and when broken it creates large sharp and jagged pieces.
- FRA certified material – Not a requirement for roadway equipment but is commonly used for transit - FRA Type I glass is for front facing glass and FRA Type II glass is for side facing glass. Both types require a ballistics test and a large object impact test. The ballistics test included shooting the glass with a lead bullet reaching a minimum velocity of 960 feet per second. The Impact test for FRA Type I glass included dropping a 24-pound concrete masonry unit on the glass from a distance of 30 feet to obtain a velocity of 44 feet per second. The passing criteria for FRA Type I and FRA Type II glass are that no glass particles can penetrate a thin aluminum witness plate behind the glass. (49CFR223)
- Laminated glass – a safety material - Product consisting of two or more sheets of glass separated by a polyvinyl butyl (PVB) or ethylene-vinyl acetate (EVA) interlayer. Laminated Glass is broken into three main safety ratings per the automotive industry.
 - AS1 glass is laminated glass that is rated for used in the front wind shield of an automobile. This glass has a minimum 0.030mm thick interlayer that has been tested to withstand significant impact.
 - AS2 glass is laminated glass that is rated to be used anywhere in an automobile other than the windshield. This glass has a minimum 0.015mm thick interlayer.
 - AS3 glass is laminated glass that is rated to be used anywhere in an automobile behind the driver. This glass can either be laminated or tempered.
- Low E Coating – Low Emissivity coating is a thin transparent film applied to glass so as to reduce the amount of ultraviolet and infrared light that passes through the glass.
- Polycarbonate – a safety material - Is a transparent material that is used where high impact strength and visibility is required. Polycarbonate is a composite material commonly referred to as Lexan® and may include Makrolon®, Excel®, Merlon® to name a few.
- Safety material – Any transparent product designed to prevent injury in the event of breakage. For example, laminated and polycarbonate materials are considered a safety glass.
- Tempered glass – a safety glass - A monolithic glass that has been heat treated to put the outer surfaces into compression and the inner into tension. This process results in strengthened glass that breaks into small granular pieces which are less likely to cause injury.

Sightlines

1. Figures 1 and 2 show graphic representations and dimensions related to Acceptable Sightline & Visibility for an example crane. Visibility requirements may differ among types of machines. By way of example, a track crane, an acceptable sightline and visibility area forward of the operator is drawn between 15 feet (4.6 Meters) forward of the leading surface of track equipment in a line forward of the operator and 27 inches (0.68 Meters) above the top of the rail and the horizontal sightline parallel to the rail. At the same point forward of the machinery, an acceptable sightline and visibility width is

drawn across the track for a measurement of 10' 8" (3.2 Meters) (AAR Plate C). This example provides good operator visibility of the work area in front of the crane.

2. Sightline and visibility from the operator to the sides of the vehicle should have as few obstructions as possible to allow visibility of the right-of-way.
3. Sightline and visibility from operator for rearward visibility should be possible considering acceptable obstructions and the use of mirrors. The use of cameras may be an optional requirement based on sightline obstructions.

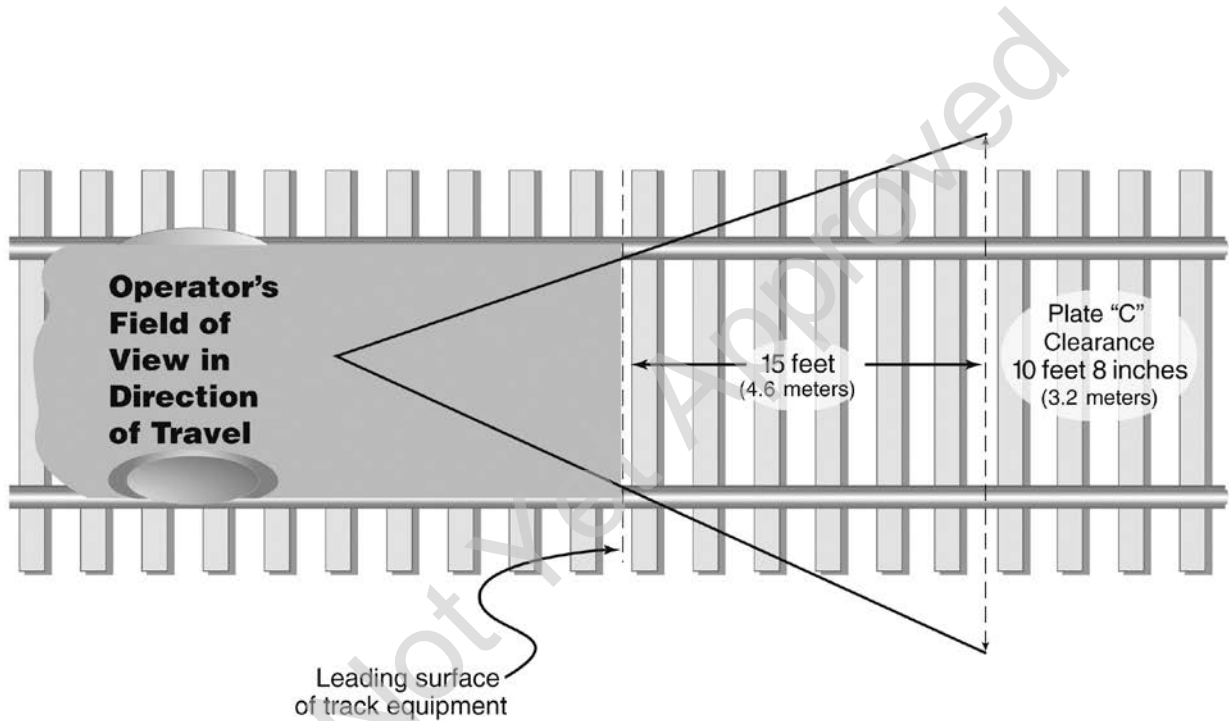


Figure 1 – Top view of sightlines and visibility for a crane operator (example)

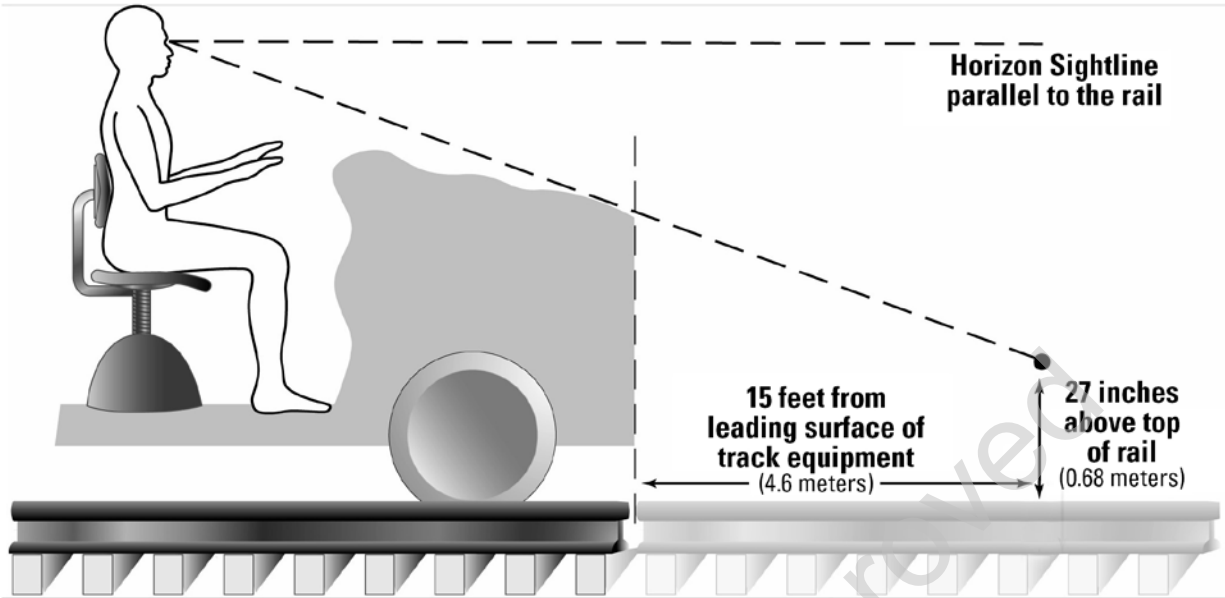


Figure 2 – Side view sightlines and visibility for a crane operator (example)

Mirrors and Cameras

1. Mirrors may improve operator visibility. The preferred application would be mirrors of a “west coast” style approximately 7” x 16” in size and incorporating a parabolic/convex mirror in the lower section to expand the area of visibility around the machine.
2. Mirrors and cameras can be used to aid visibility but should not be used as the primary or only means of providing visibility for track travel mode.
3. Machine configuration may need to be supplemented with a camera system to accommodate forward and/or rear visibility.

Visibility

1. Roadway Equipment *clear* glass should have a Minimum Visible Light Transmission percentage (VLT%) no less than 70%
2. Roadway Equipment *shaded* glass should have a Minimum Visible Light Transmission percentage (VLT%) no less than 50%
3. If a window is exposed to rain, a wiper may be used to keep the window clear.

Window Applications

1. Only safety window material should be used in machinery.
2. Laminated glass is best used in areas where the glass is proximity of items that can cause damage. Laminated glass can be found in multiple locations on a machine however, the front windshield is almost always laminated. Laminated glass is not preferred where holes through the glass are required for hardware.
3. Tempered glass is best used in areas where the weight of laminated glass is problematic. It is also needed where holes must be drilled into the glass for the addition of hardware. In many cases tempered glass is proprietary due to the curvature and fit to the machine.
4. Polycarbonate is considered a safety material and is best used where a window is in extreme danger of damage. The main drawback to using polycarbonate is that it scratches easily.
5. Emergency windows can be made of a breakable material such as a tempered glass and outfitted with a hammer for escape or the window can be unbreakable, such as polycarbonate, and allow the sash to open by way of window releases, or levers used to hold the window sash in place during normal operations.

Window Guards

1. Window guards can be used to cover a window as long as it doesn't negatively affect sightlines and visibility.
2. If a window guard is used, access to the window should be engineered to make glazing replacement easy to perform.

Gasket Recommendations

There are three main types of gaskets that can be used to glaze material into an opening of a machine. In some instances, a work head or obstruction may restrict the available space available for the gasket and the gasket may then be installed reversed or inside to outside.

1. One-piece, self-locking straight universal weather strip is shown in Figure 3. This gasket is the most common and is considered the easiest to apply. It is preferred for window openings in almost all applications.

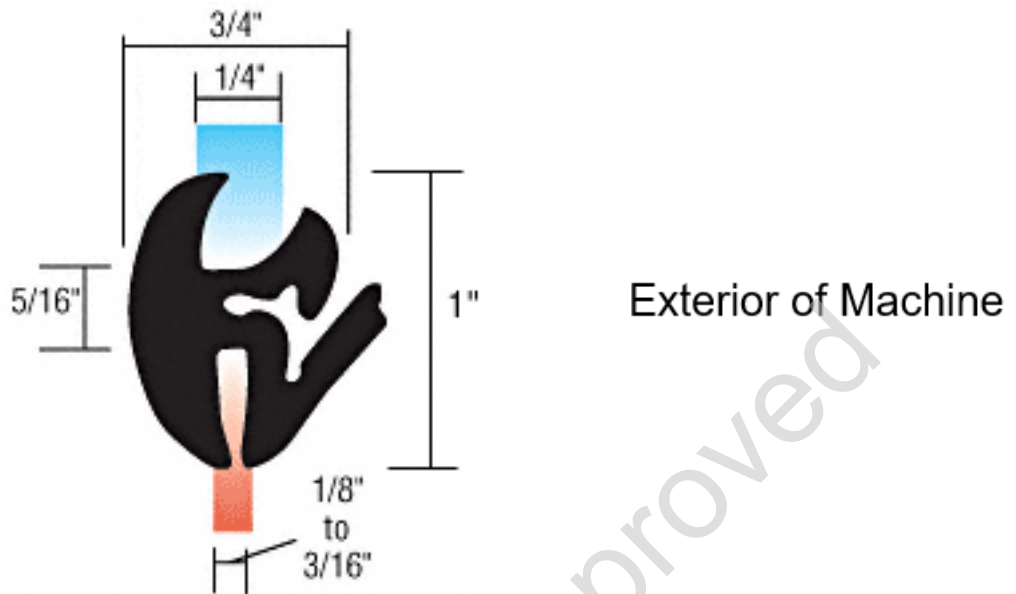


Figure 3. Preferred window gasket where glass is in line with steel frame

2. One-piece self-locking S type universal weather strip is shown in Figure 4. This gasket is used in applications where it is beneficial for the glass to be outside the line of the pinchweld. This application is similar to straight weather strip in its ease of installation. This is not a recommended gasket to use if there are close clearances that would create the need to reverse the gasket, inside to outside.

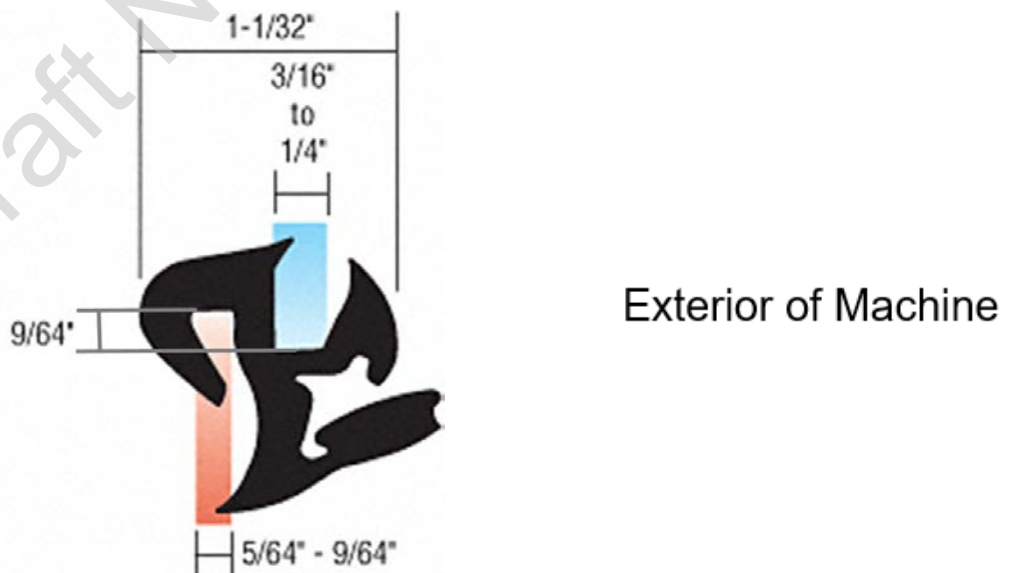


Figure 4. Preferred window gasket where glass is offset with steel frame

- Two piece locking straight universal weather strip is shown in Figure 5. This gasket is used in many applications and performs similarly to one-piece self-locking weather strip.

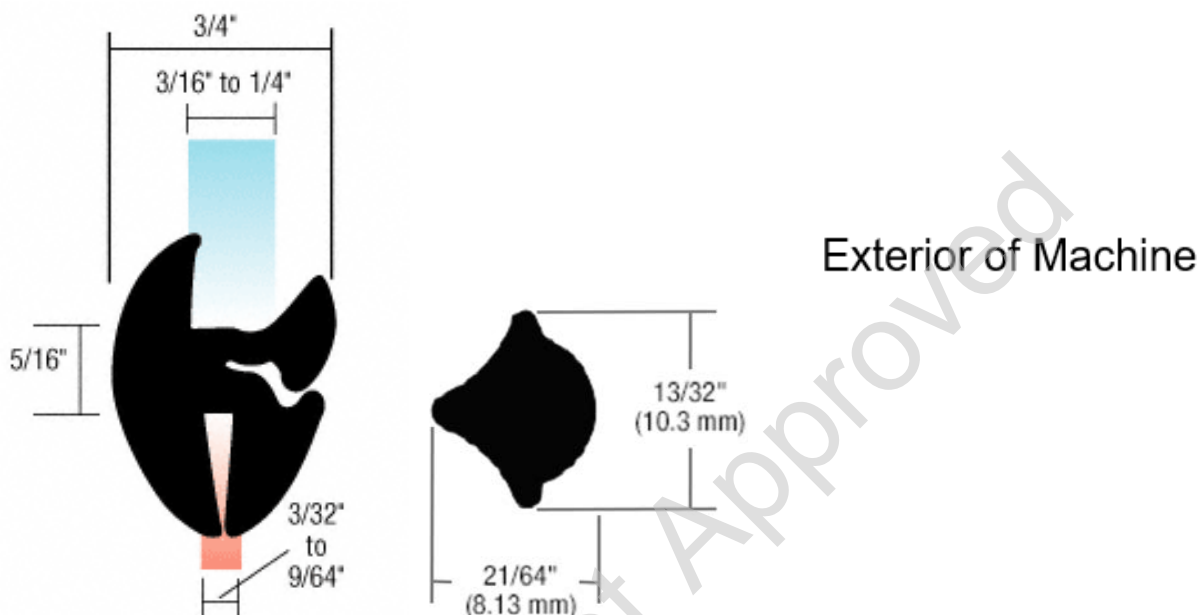


Figure 5. Preferred two piece locking straight universal weather strip

Window Size and Shape

The most common standard sheet sizes for safety laminated glass available to the US glass industry are as follows: 36" x 60", 36" x 84", 48" x 60", 48" x 84", 48" x 96". The first priority for selecting glass size is visibility for the user. Planning window sizes will minimize time taken to fit replacement windows during field repairs and minimize waste. Also, using standard sizes or stock cut from standard sizes makes it more efficient for the manufacturer to maintain stock of glass, and gaskets as well as maintaining stock for mobile crews that maintain on-track machinery. Creating multiple windows of the same dimension on the same machine will allow more consistently accurate replacement and can allow that glass part to be used in multiple areas, reducing overall inventory.

Examples of Window Design

- Windows located on the side of a cab primarily used for sunlight is proposed to have a window that is 37" x 20". Instead the window was designed 36" x 18" leaving more usable glass from the 36" x 60" standard stock sheet of glass.
- A window opening that provides for visual requirements out the front of the cab to view track, work area and crossings is proposed to be 84" wide by 52" tall. Traditionally the cab has two windows that are different sizes - one may be 42" x 49" and the other is 37" x 49". These dimensions require the use of two sheets of 48" x 60" which leaves a large amount of

scrap window material. If the window dimensions were both 40"x 47" then one 48"x 84" sheet would accommodate both windows with less scrap to complete the task.

3. The preferred window shape is flat. A curved window can be used if there is an improvement in sightlines to the user that flat glass cannot accomplish. If a curved window is used, the window should be kept available in stock as replacements are required.

Radius

1. Recommended corner radius of the window should be approximately 3".
2. Recommended corner radius minimum of windows should be relative to the minimum radius allowed by the type of rubber gasket used. Gasket where the glass is sitting in line with the steel frame (Figure 3) will have a minimum radius of 1.5" (this is the most commonly used gasket). Gasket where the glass is offset to the outside of the steel frame (Figure 4) will have a minimum radius of 2".