Effective Coverage Area Rule Specification

Contents

Description

Rule ID	240
Rule Name	Effective Coverage Area Rule
Rule Description	This rule checks the coverage of an effect onto a specified area and optionally the ratio between the property values of the source components and checked component.

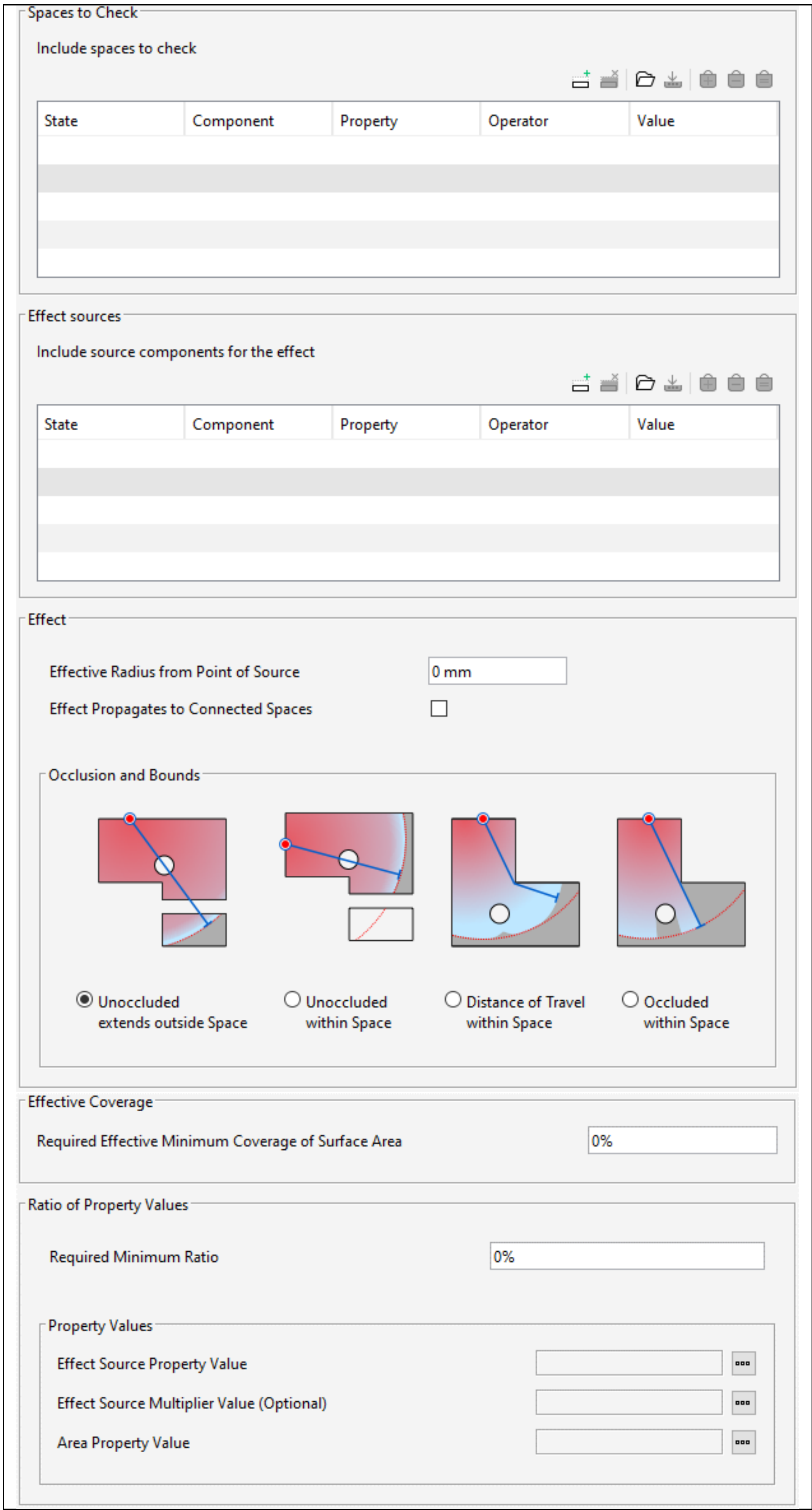
Possible Use Cases

- Checking the coverage of a source component onto the specified area(s)
- Checking the natural ventilation for BCA
- Checking the coverage of sources such as:
    - Day lighting (window)
    - Sprinkler
    - Wireless Network
    - Surveillance cameras (not fully possible)
    - Fire hose
    - Ventilation -
    - Speakers - 2nd case
    - Exit lights

Parameters

Spaces to Check [Filter Parameter] The spaces to check requirements for the effective coverage of source components
Effect Sources [Filter Parameter] The components that function as sources of an effect that generate a coverage area on the spaces to check
Effective Radius from Source [Length Parameter] The distance the effect propagates out from the source component
Effect Propagates to Connected Spaces [Checkbox Parameter] Allows the effect to extend to those spaces that connect to the spaces to check
Occlusion and Bounds Coverage Method [Radio Button Option Parameters] • **Unoccluded extends outside Space**: This option allows the coverage effect to propagate unobstructed by any object and allows the coverage effect to propagate to spaces connected to the checked space area. Example: A Wireless network or Radio Frequencies travelling through obstacles and walls **Unoccluded within Space**: This option allows the coverage effect to propagate unobstructed by any object and limits its propagation to only within the checked space area. Example: A Wireless network or Radio Frequencies that travel through obstacles but the room has wall • **Distance of Travel within Space**: This allows the coverage effect to cover any point that can be reached from the effect source, given that the distance travelled is at most "Effective Radius from Point of Source". Example: The distance of a fire hose is able to reach as it is pulled around obstacles. • **Occluded within Space**: This option enables the coverage effect to be occluded by objects and limits its propagation to only within the checked space area. Example: The field of vision a security camera or a nurse is able to view from a nurses station as the view is blocked by obstaclte.
Required Effective Minimum Coverage of Surface Area [Percentage Parameter] The minimum required percentage of coverage area on the space to check from the effect source. In other words, Effect Source Coverage Area / Area of Space to Check * 100.
Required Minimum Ratio [Percentage Parameter]: This defines the minimum required ratio that "Property Values" must satisfy. This is a property check, rather than geometry. • **Effect Source Property Value [Property Reference Parameter]**: This defines the numerator property value by specifying a property from the effect sources. The sum of this property value from all effect sources is the numerator property value. • **Effect Source Multiplier (optional) [Property Reference Parameter]:** This effect source property value is multiplied by this multiplier value. • **Area Property Value [Property Reference Parameter]**: This defines the denominator property value by specifying a property from the space area.

UI Design



UI is Static.

For Occlusion and Bounds, a method is always required to be selected so one radio button will be marked at all times.

Figure 1. Rule Parameter UI

Results

This rule creates following results:

Main check:

- Spaces to Check do not exist
  - Display a dash in the Checking view to denote insufficient information.
- Effect sources don't exist or too small effective coverage area
  - **Name**: Coverage Area Violation
  - **Description**: The coverage of {COMPONENT_NAME} by effect sources by effect sources is not sufficient: Was {ACTUAL PERCENT} %, while {REQUIRED_PERCENT} % required.
  - **Components**: Space(s) and the effect sources

Optional Ratio of Property Value Check:

- Too small ratio between effect source(s) and area
  - **Name**: Ratio of property values – Too small ratio
  - **Description**: The property value coverage of {SPACE COMPONENT_NAME} by effect sources {LIST OF EFFECT SOURCE COMPOENT NAMES AND PERCENTAGE} is not sufficient: Was {TOTAL EFFECT SOURCE PERCENTAGE}%, while {REQUIRED PERCENTAGE}% required.
  - **Components**: Space(s) and the effect sources
- Effect sources do not exist
  - **Name**: Ratio of property values – Unable to calculate the ratio – No effect source was found
  - **Description**: Unable to calculate the ratio of property values. No effect source was found.
- Effect sources property doesn't exist
  - **Name**: Ratio of property values - Unable to calculate the ratio - Property values are missing for all effect sources
  - **Description**: Unable to calculate the ratio of property values. Property values are missing for all effect sources.
  - **Components**: Space(s) and the effect sources
- Area property value doesn't exist
  - **Name**: Ratio of property values - Unable to calculate the ratio - Area property value is missing
  - **Description**: Unable to calculate the ratio of property values. Area property value is missing. Space: {SPACE COMPONENT NAME}
  - **Components**: Space(s) and the effect sources

Visualization

Visualize the spaces to check

- Use green color 50% transparency

Visualize the effect source components.

- Use red color

Visualize the calculated effective coverage area just above the checked area.

- Use red color for covered (50% transparency)
- Use green color for noncovered (50% transparency)

Checking Algorithm

Merged connected spaces are handled as one area. The value of the effect radius cannot be exceeded.

Algorithm ideas for computing the effect coverage for different cases (figure 2).

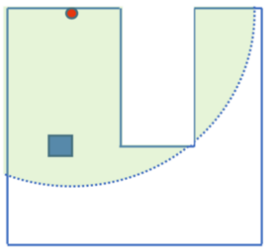
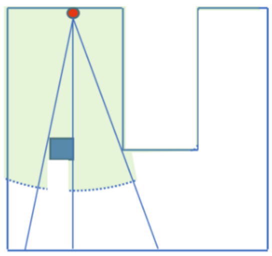
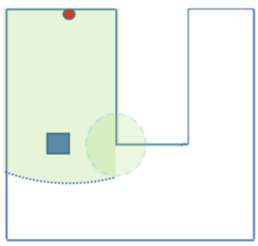
Case 1. Checking when effect is not blocked by walls or obstacles: • Create a circle that is centered on the effect source and has radius that is the effect radius. • The area covered by the effect is the intersection of the circle and the space footprint.	
Case 2. Checking when effect is blocked by obstacles: • Compute the area that is in the line of sight of the source. • Compute the circle as in case 1. • The area covered by the effect is the intersection of the circle and the area that is in the line of sight of the source.	
Case 3. Checking when effect bends around corners: • Begin as if computing the area in the line of sight of the source. • Identify the corners that block the line of sight. • Create a smaller circle on the corner with radius that is the effect radius with the distance from source to the corner subtracted. • The area covered by the effect is the intersection of the space footprint with the union of the area in the line of sight and the small circles.	

Figure 2. Checking Algorithm

Optional check:

- Check the given minimum ratio (%) (Ratio = (∑B)/A) between given effect source property (B) and checked area property (A). There can be multiple sources, so the properties are summed together.

check()

- Merged connected spaces to be handled as one area if "Effect Propagates to Connected Spaces" is marked
- Check the effective coverage of the source inside the area(s).
    - Create results
- Check Optional Ratio of Property Values
    - Create results

Testing

Integration tests using a several test models.

- Test nothing to check; No spaces to check exist (Irrelevant state)
- Test with effect source and space area
- Test with effect source and space area and obstruction components (components that cut out portions of the space to check)
- Test with effect source and merged space areas
- Test with effect source and slab area
- Test with multiple effect sources and merged space areas
- Test the optional ratio of property value check with missing and too small ratio property values.

Scope Restrictions

- Checking is restricted to 2D. The rule is not checking in 3D, e.g., how the radius goes up/down in a stairwell.
- Rule does not consider components that are obstructions unless they cut out the volume of the space to check.

Requirements

- We need to check the percentage of effect coverage of an area modelled as a space (and possibly connecting spaces) using a radius distance of an effect component.

- The rule will allow for 4 different occlusion and bounds methods of coverage:
    - **Unoccluded extends outside Space**: This option allows the coverage effect to propagate unobstructed by any object and allows the coverage effect to propagate to spaces connected to the checked space area (Figure 3).

The example below represents 3 Wi-Fi routers that can provide Wi-Fi at a certain distance across offices.

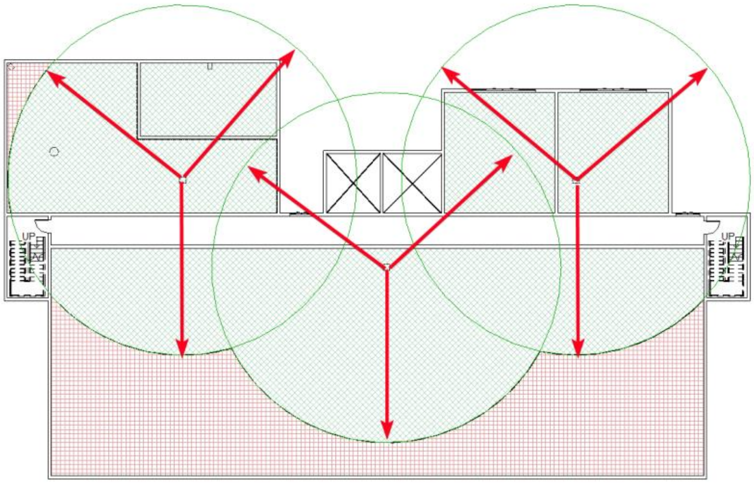


Figure 3. Unoccluded extends outside Space

- **Unoccluded within Space**: This option allows the coverage effect to propagate unobstructed by any object and limits its propagation to only within the checked space area (Figure 4).

  The example below represents 3 Bluetooth devices that can provide access to components that are within a certain distance, but only if the components reside in that computer lab.

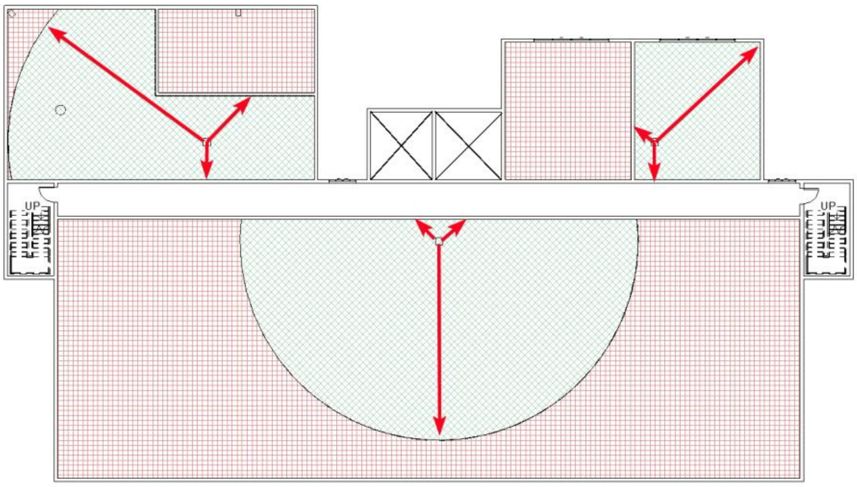


Figure 4. Unoccluded within Space

- **Distance of Travel within Space**: This allows the coverage effect to cover any point that can be reached from the effect source, given that the distance travelled is at most "Effective Radius from Point of Source" (Figure 5).

  The example below represents windows that provide ventilation within rooms at a specific travel distance.

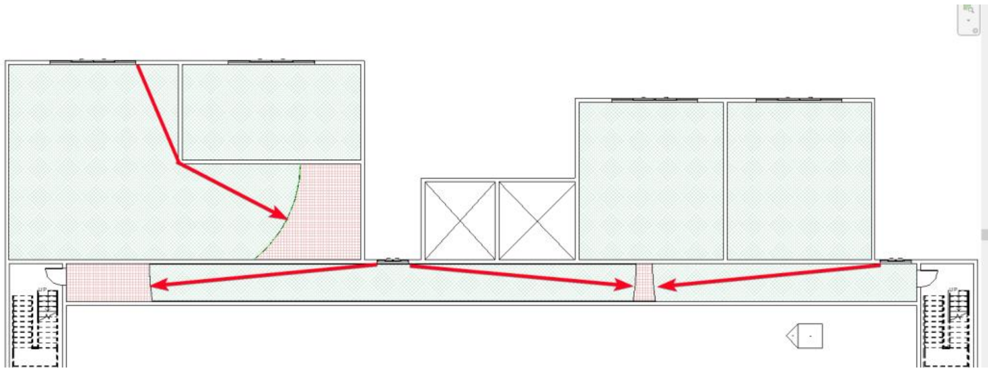


Figure 5. Distance of Travel within Space

- **Occluded within Space**: This option enables the coverage effect to be occluded by objects and limits its propagation to only within the checked space area (figure 6).

  The example below represents surveillance cameras that are able to monitor rooms within a certain distance and line of sight.

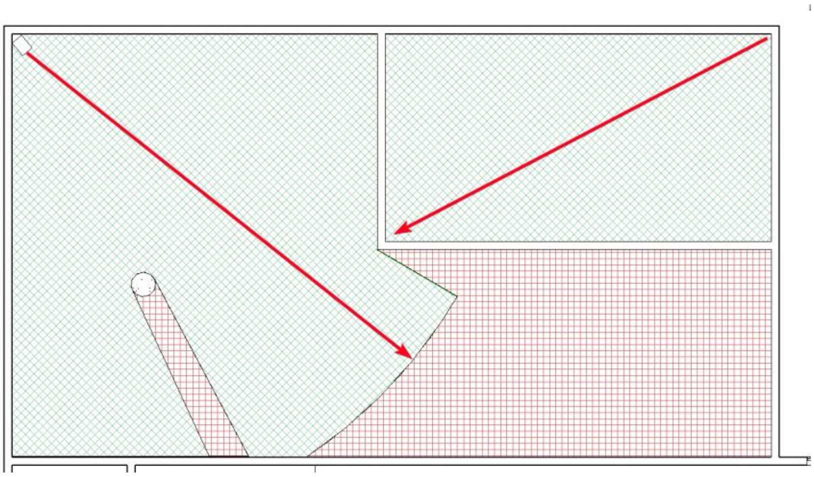


Figure 6. Occluded within Space

- According to the requirements, no portion of a room or space that is designed for natural ventilation shall be more than 12m from any window or opening ventilating the space.

  In such a case, the minimum effective coverage would be 100% of the space such that Effective

Radius of 12m from ventilation sources is able to cover the entire surface of the room using a "Distance of travel within a Space" (Figure 7).

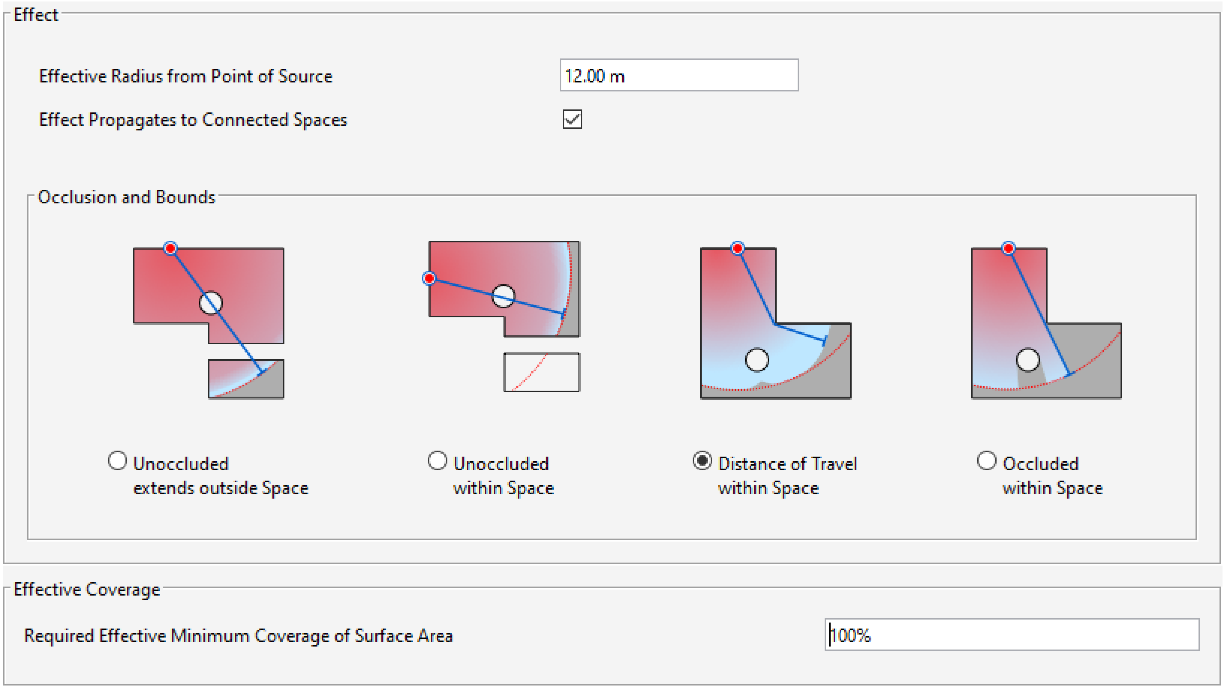


Figure 7. Distance of Travel within Space

- Additionally, the rule needs to check a required ratio of the sum of a property of the effect sources to the property of the spaces. A multiplier value is optional for the effect source Property Value.
- According to the requirement, not less than 5% of a floor area of a room or space is required to be naturally ventilated (figure 8).

  In such a case, the effect source property would be the area quantity of the ventilation components and the area property value would be the area of the space the ventilation resides. The required minimum ratio of the sum of the areas of ventilation to the area of the space is 5%. The effect source multiplier would be set to a decimal value representing the percent of the effective opening area based on the type of ventilation. For example, fixed louvers have a .5 effective opening area, whereas slinging windows fully opened would be 1.

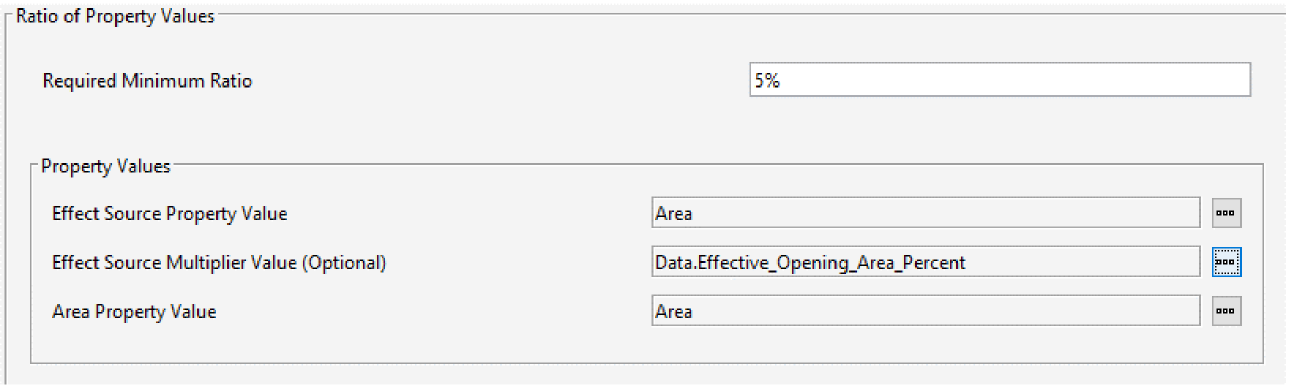


Figure 8. Ratio of Property Values

- The rule can also be used for other cases, not only for natural ventilations.