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Clearance Checks for Bundled Wires in PLS-CADD

Version 21 of PLS-CADD includes an updated method for checking clearances to Bundled Wires. This Tech Note will provide more information on the two methods so that users can make informed decisions on which method to use.

In the software, the bundle clearance method to use can be selected from the Feature Code Data Edit table. Navigate to **Terrain/ Feature Code Data/ Edit…** to see the two (2) methods on the right, above the feature codes as shown in Figure 1. The bundle clearance method selected does not configure how a clearance check is done, but rather how the bundled wire is treated for the clearance calculations.

The first option, "*Use **Radial** Bundle Clearance Method for All Calculations*", is the legacy method that will match clearance checks done in older versions. In this method, a circle is drawn that circumscribes the wires and the distance from the center of the bundle is evaluated with the radial bundle considered.

The second option, "*Use **Rectangular** Bundle Clearance Method for Vertical and Horizontal Calculations*", is the new method. A rectangle is drawn about the effective bundle diameter of the wire and both the horizontal and vertical edges are considered for clearances. This rectangle is only used when the rectangular survey point clearance option is selected. When a radial survey point clearance check is done, the bundle assumption will automatically use the radial bundle method.

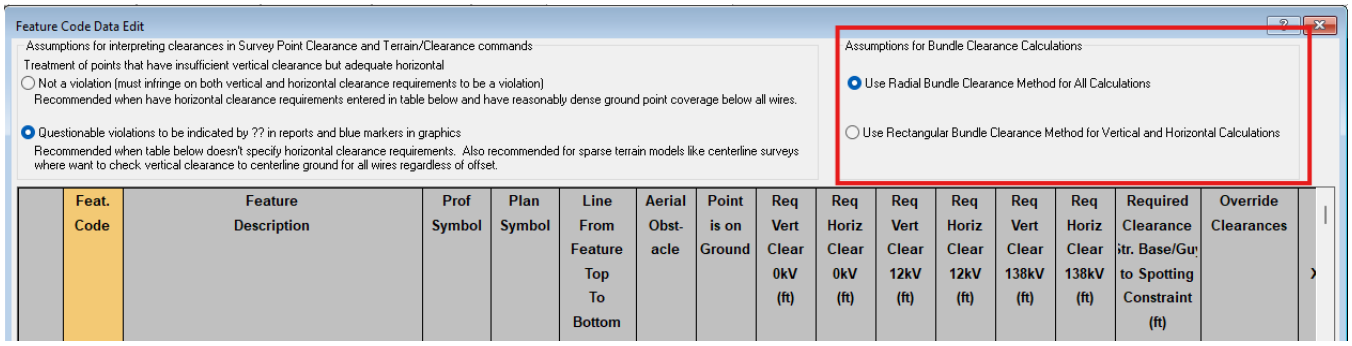


Figure 1

In this Tech Note, we'll look at the two different bundle assumptions and consider the rectangular survey point clearance checks for each bundle assumption. The radial survey point clearance check will not be included in this tech note as it will automatically use the legacy bundle method assumption.

You can follow along by using the **.bak* file attached to this document which has a line edit for a Vertical 2-Wire Bundle and a line edit for a Horizontal 2-Wire Bundle.

Note: Version 21 or newer will be required to follow along. *Using the Rectangular Bundle Clearance Method will break backward compatibility for versions older than Version 21.*

Appendix A has been added to show additional information on the effective diameters for the various wire configurations available in PLS-CADD. Please remember that PLS-CADD does not model each sub-conductor in the bundle, it is simply displaying them. And, since we have low confidence in the exact location of the individual wires, clearance calculations are performed using the effective bundle radius that circumscribes all wires in the bundle and is centered about them.

Under certain conditions, when checking clearances using a rectangular clearance check, it is possible to have clearance measurement results that are perhaps not what a user might be expecting. This Tech Note tries to better showcase how PLS-CADD calculates clearances when bundled conductors are used and point out when it might be appropriate to use this new "Rectangular Bundle Clearance Method" – please use your engineering judgment to determine which is appropriate for use on your projects.

Radial Bundle Clearance Method

For this part of the Tech Note, the **Terrain/Feature Code Data/ Edit…** Bundle Clearance Calculations Assumption must be set to "*Radial Bundle Clearance Method*" as shown in Figure 1.

In the model, left click on the "Obstacle" survey point and choose the option for "Wire Clearance to Survey Point". Make sure to choose the Rectangular Clearance option as the "Type of clearance requirement" as shown in Figure 2.

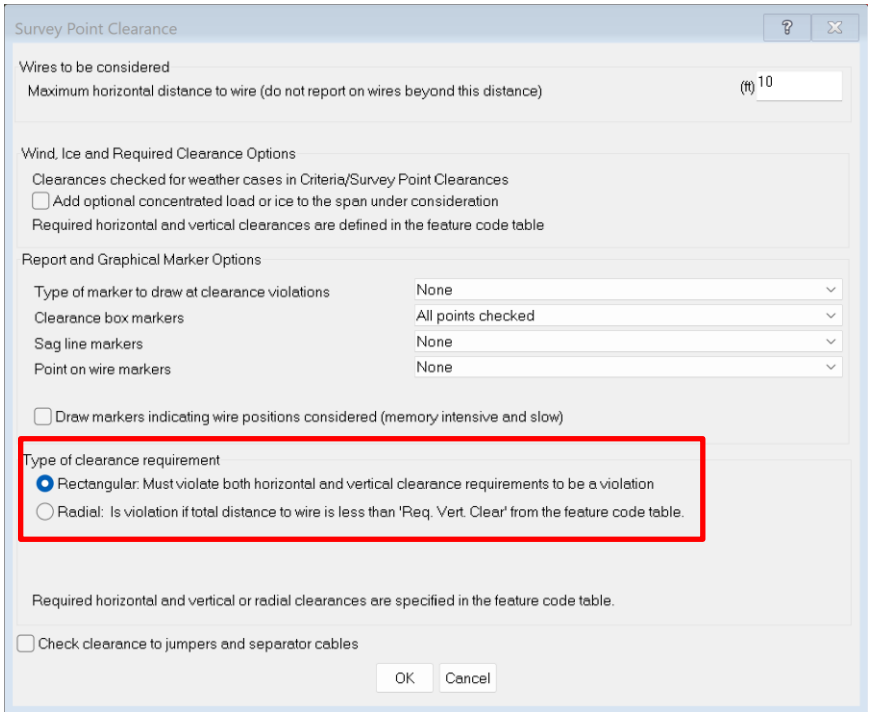


Figure 2

Click OK and left click (again) on the "Obstacle" survey point. Figure 3 shows the Cross Section View tab with some added dimension lines. You can turn on the display of the dimension lines by navigating to **Lines/ Edit..** clicking on the "Annotations Only (Rectangular)" project line and clicking the "Show" button.

Pressing the "C" key on the keyboard while your mouse is hovering over the "Obstacle" survey point, will allow you to view a Cross Section of the survey point, the clearance envelope, and the wires. You can view the cross

section “Relative to clicked upon XYZ point”, with a 90-degree orientation angle, and a 10’ depth of field to match the figures below.

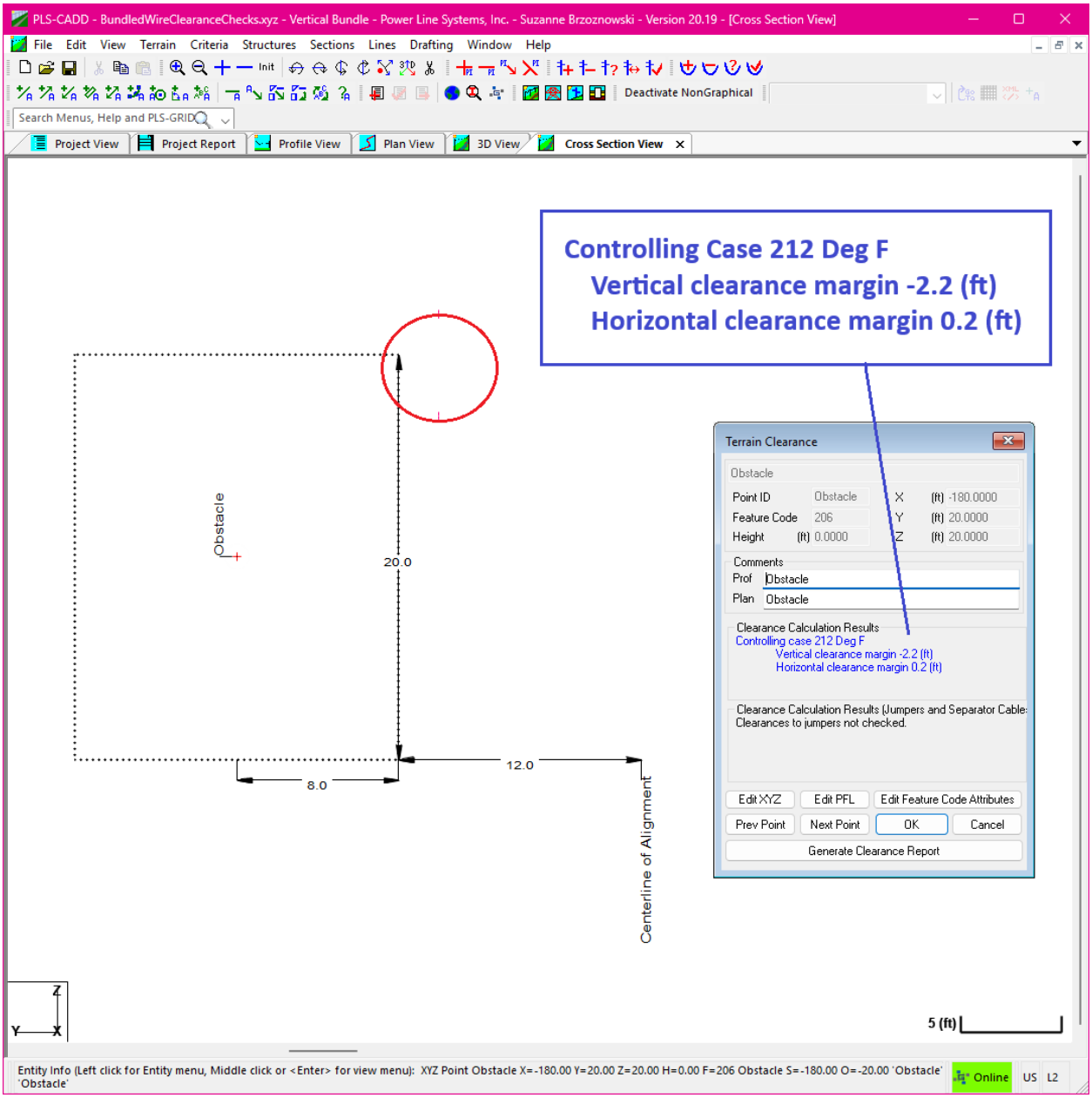


Figure 3

As mentioned previously, when using the radial bundle assumption, a circle is drawn around the bundle that circumscribes all the wires. This circle represents the effective bundle diameter of the cable. For a double bundle, the effective diameter of the bundle is the same regardless of whether the bundle is vertical or horizontal.

See Appendix A for more information on the effective diameters for the various wire configurations available in PLS-CADD.

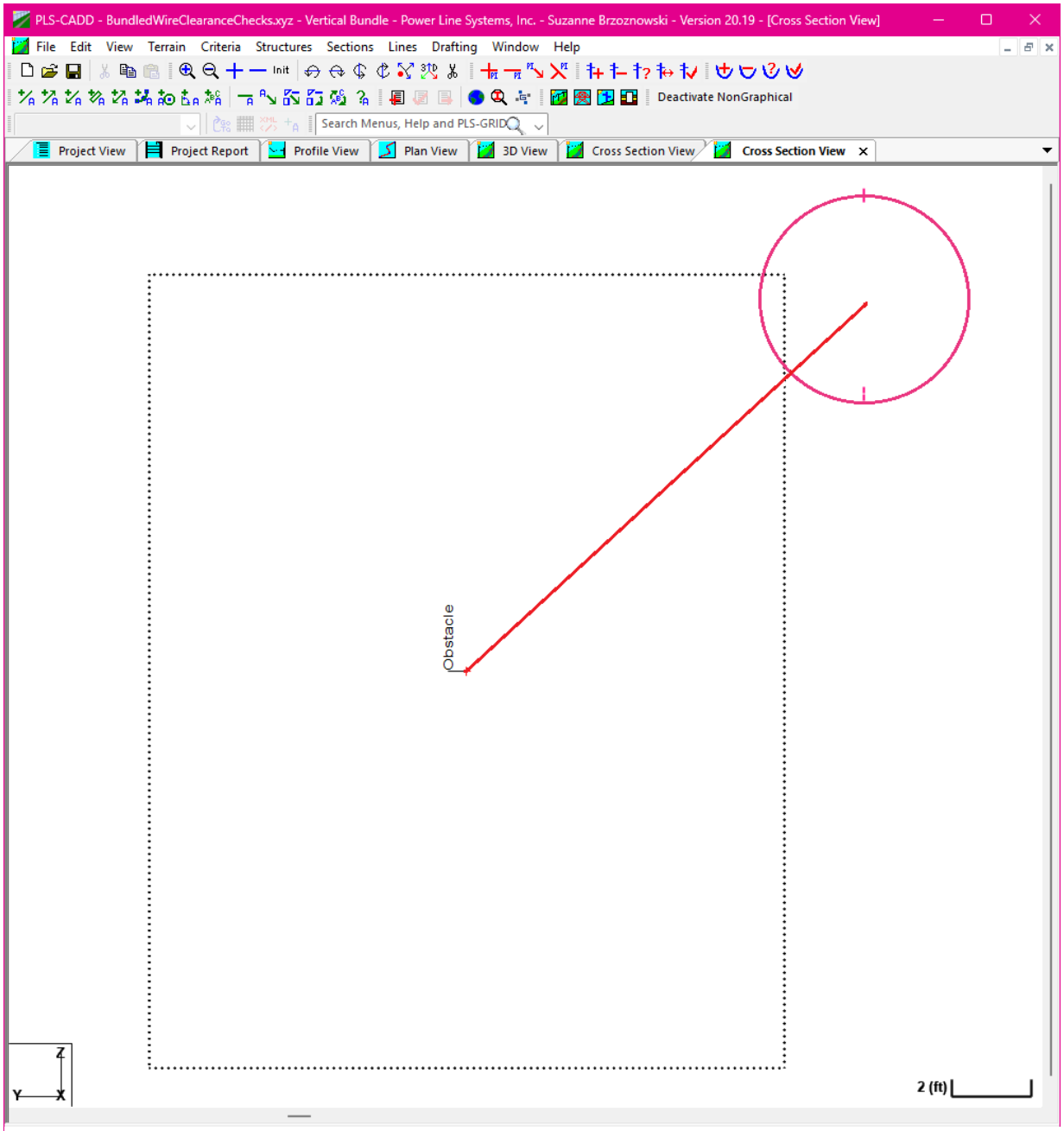


Figure 4

Next, a line is drawn from the survey point to the center of the bundled wire. Then the line is traced back down toward the survey point by the length of the effective bundle radius. This is the point where the circle and the line intersect. The intersection of the circle and the line is where the clearance measurement is determined. This is shown in Figures 4 and 5.

In the model, you'll see that you can move between the Vertical Bundle and Horizontal Bundle line edits. You can do this using the **Lines/ Edit…** menu command. Click on the Project Line you'd like to activate and click the "Select and hide other lines" button. In either project line you'll get the same survey point clearance results.

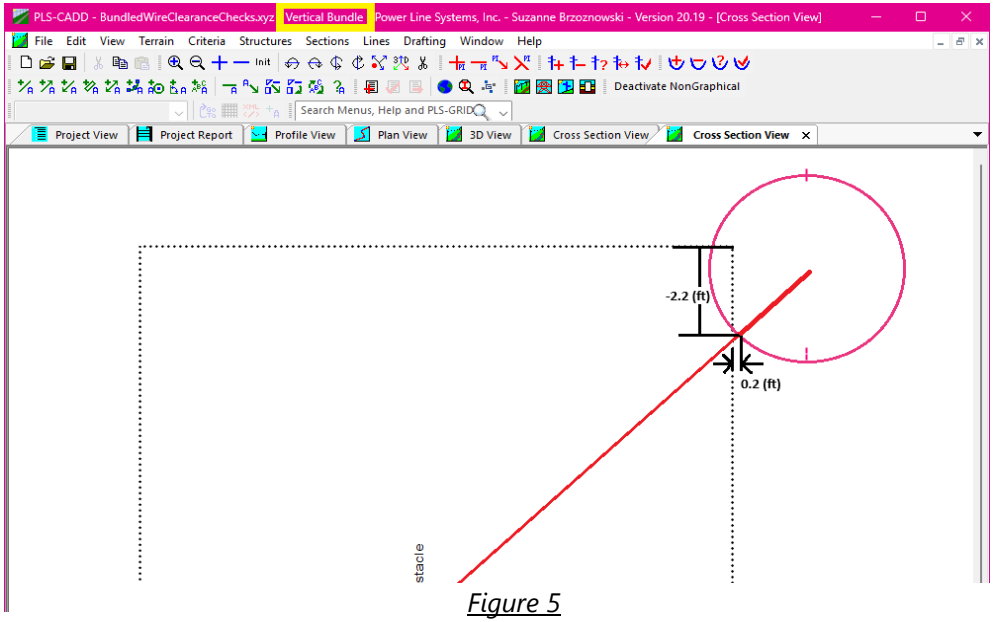


Figure 5

In the Vertical Bundle project line, the results are slightly more conservative than the vertical positions of the wire. *The results may not be conservative, however, when considering bundle tilt. Engineering judgment will be needed to determine if this is acceptable.*

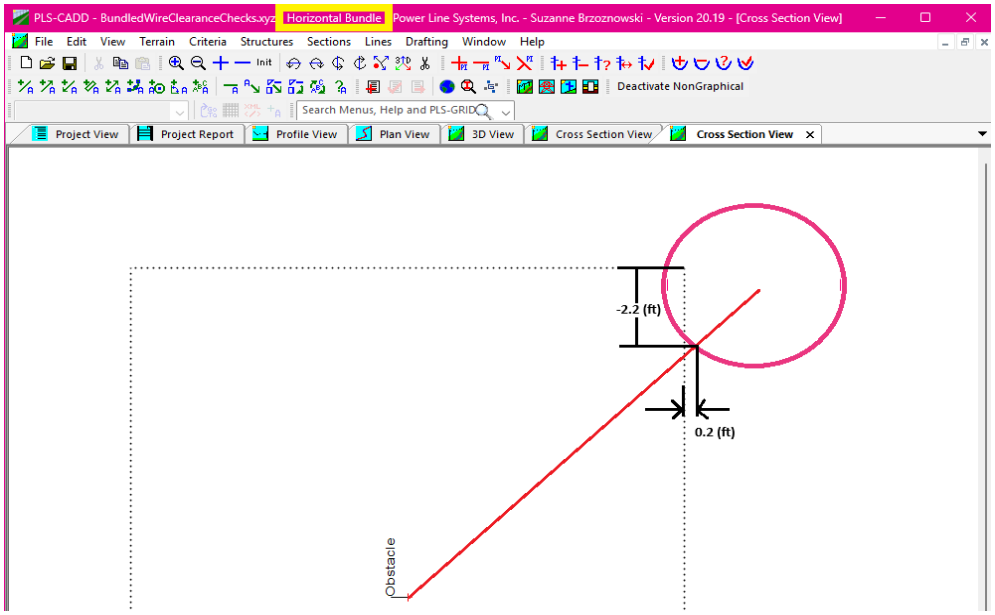


Figure 6

When the bundle is horizontal, the wire clearly falls inside the Obstacle clearance envelope, as shown in Figure 6, **but it is not flagged as a violation**. This is correct, however, based on the bundle assumption selected. The effective bundle diameter is the same for a vertical and horizontal double bundle, and the same path from the survey point to the center of the wire exists. *Engineering judgment will again be needed to determine if the radial assumption is appropriate for your model.*

Rectangular Bundle Clearance Method

For this part of the Tech Note, the **Terrain/ Feature Code Data/ Edit…** Bundle Clearance Calculations Assumption should be set to “Rectangular Bundle Clearance Method” as shown in Figure 7.

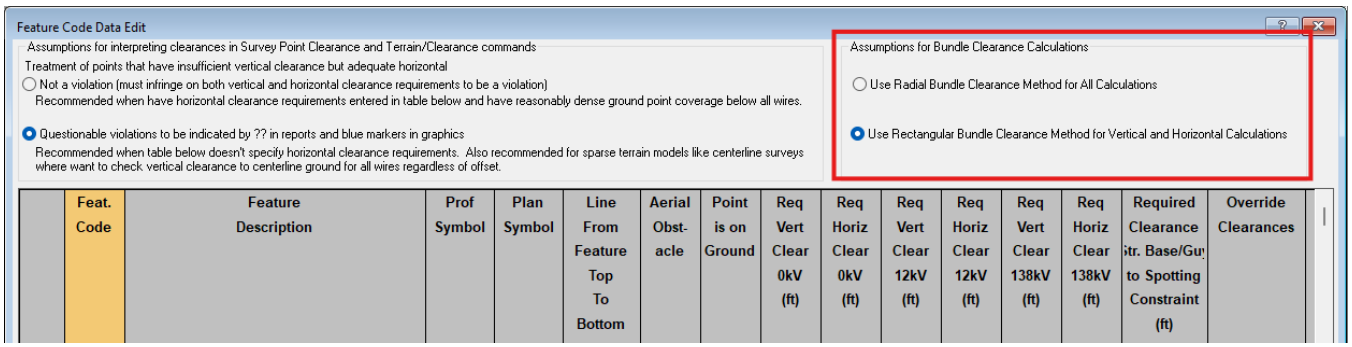


Figure 7

Now that the Bundle Clearance Method is set to rectangular, run a Wire Clearance check on the “Obstacle” survey point” again. In the model, left click on the “Obstacle” survey point and choose the option for “Wire Clearance to Survey Point”. Make sure to choose the Rectangular Clearance option as the “Type of clearance requirement” as shown in Figure 8.

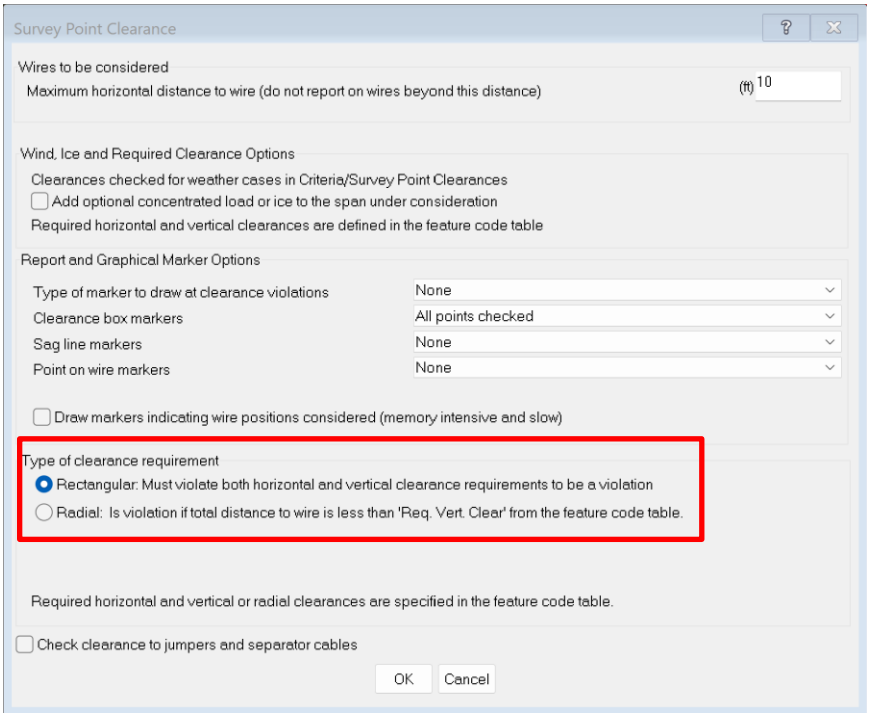


Figure 8

Click OK and left click (again) on the “Obstacle” survey point. Figure 9 shows the Cross Section View tab with some added dimension lines. You can turn on the display of the dimension lines by navigating to **Lines/ Edit..** clicking on the “Annotations Only (Rectangular)” project line and clicking the “Show” button.

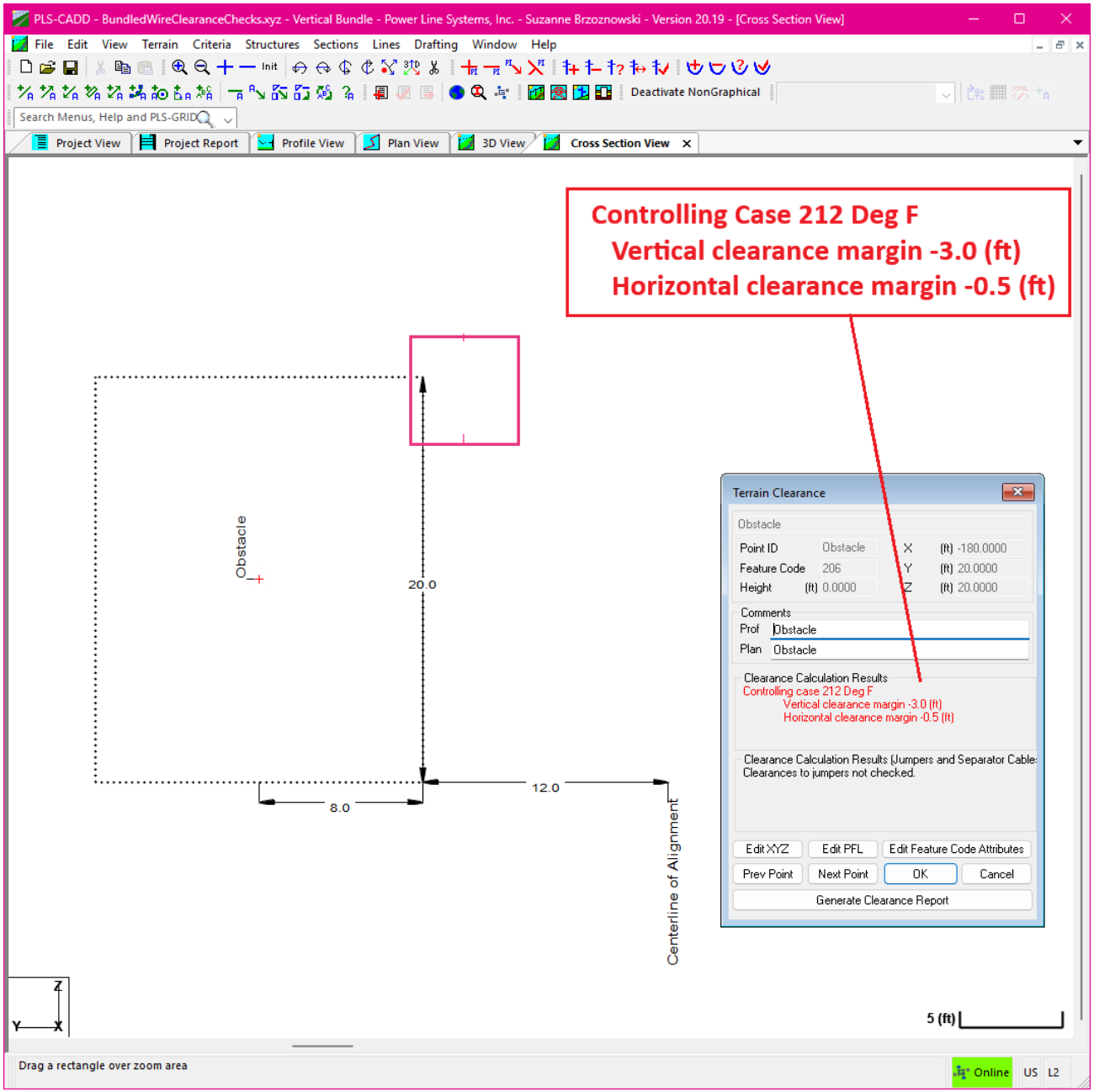


Figure 9

With the rectangular Bundle Method selected, a rectangle is drawn around the bundle to encompass the wires. The length and width of the rectangle match the bundle diameter defined in the **Sections/ Modify…** dialog. The location of the measurement for the clearance margins is the place where the line intersects the rectangle. It is the same concept as shown with the radial bundle method, but in this case the shape is the rectangle instead of a circle.

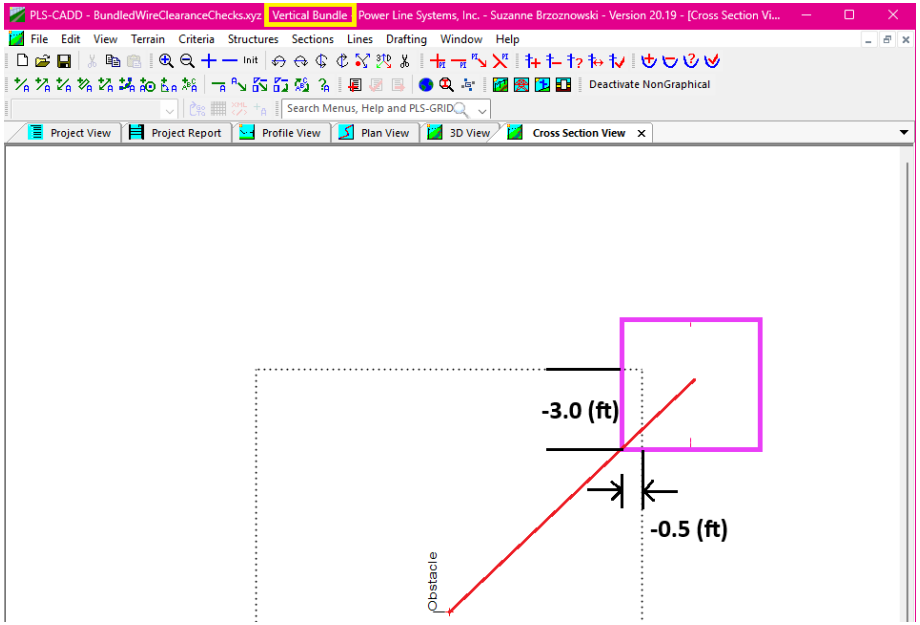


Figure 10

When the bundle is vertical, both of the wires clearly fall outside the Obstacle clearance envelope, **but this time it is flagged as a violation**. *Considering bundle tilt, this clearance violation may not be "too" conservative, but this determination requires Engineering judgment.*

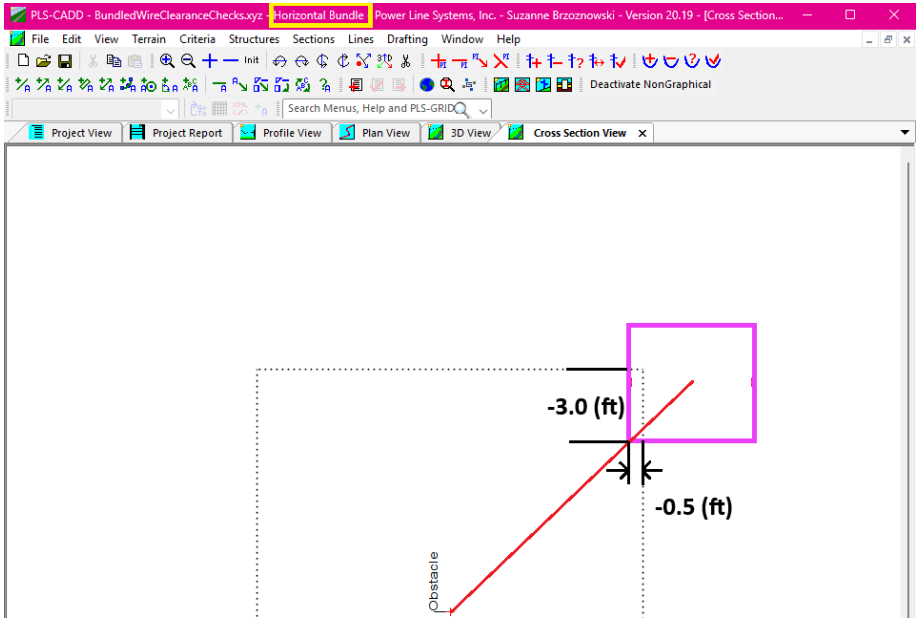


Figure 11

When the bundle is horizontal, the leftmost wire clearly falls inside the Obstacle clearance envelope, though the vertical clearance margin is a more conservative value looking to the bottom of the rectangle. *In this example, you do get the violation shown but with a slightly conservative vertical margin.*

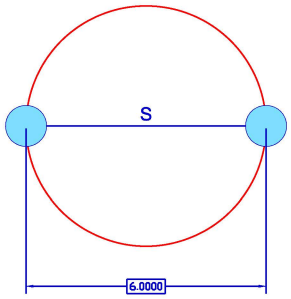
APPENDIX A

CABLE BUNDLE GEOMETRY

$$D = \frac{S}{SIN\left(\frac{\pi}{N}\right)}$$

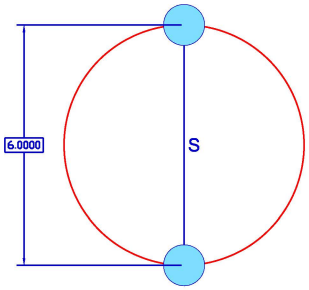
D = Bundle Diameter, diameter of the circle circumscribing all conductors at a specified Bundle Spacing
S = Bundle Spacing, center to center distance between adjacent conductors
N = Number of conductors in the Bundle

2-BUNDLE HORIZONTAL

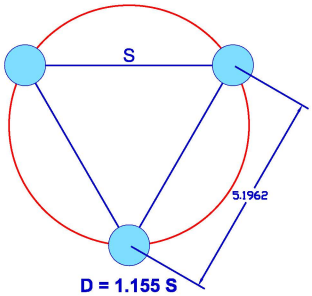


D = S

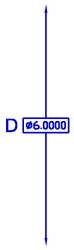
2-BUNDLE VERTICAL



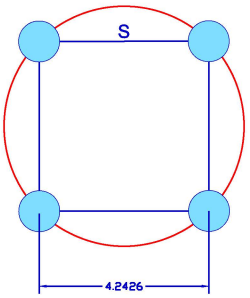
TRIANGULAR BUNDLE

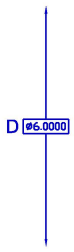


D = 1.155 S



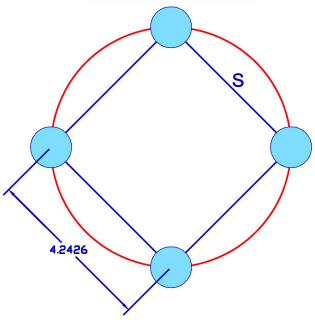
SQUARE BUNDLE



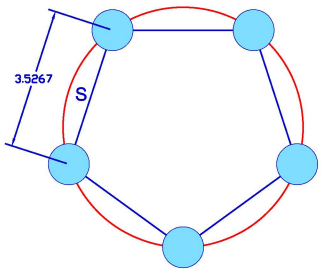


D = 1.414 S

DIAMOND BUNDLE

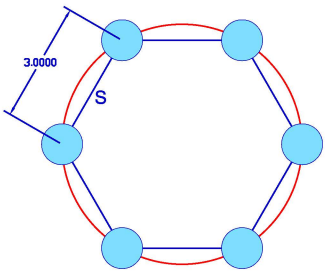


PENTAGONAL BUNDLE



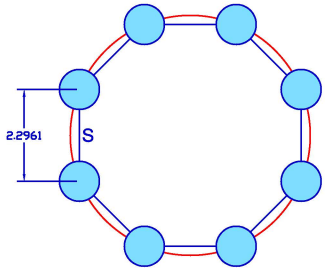
D = 1.701 S

HEXAGONAL BUNDLE



D = 2 S

OCTAGONAL BUNDLE



D = 2.613 S