

# Industry 4.0 Curriculum

## THE SAFETY SCANNER

Name	Class/Period	Date

### 1. Overview

In this lab activity, you will create safety zones for your robot cart using the safety scanner and its configuration software. You will also transfer the configuration to the scanner and test the output.

This lab activity assumes that you already know how to program a basic motion job in the robot controller, or that there already is a loaded job that you can run.

### 2. Performance Objectives

After completing this lab activity, you will be able to:

- Create warning and protection zones using the safety scanner's configuration software.
- Transfer the configuration file to the safety scanner.
- Adjust the safety zones to accommodate the setup in your laboratory.

### 3. Required Materials

You need the following materials to complete the lab activity:

- Robotic cell with a Motoman robotic arm, YRC1000micro controller, and Keyence Safety Scanner
- USB-USB cable
- Personal computer with Keyence Safety Device Configurator software installed.

### 4. Inventory and Safety

Before beginning the lab activity, review this checklist and mark off each item as you complete it.

- All hardware components are available for this lab activity.
- Keyence Safety Device Configurator software is installed on your workstation.
- Loose hair, clothing, and jewelry are secured.
- The work area is clean and devoid of food or drink.
- Review the safety guidelines.
- Read through the entirety of this lab activity to familiarize yourself with the requirements.

## 5. Background

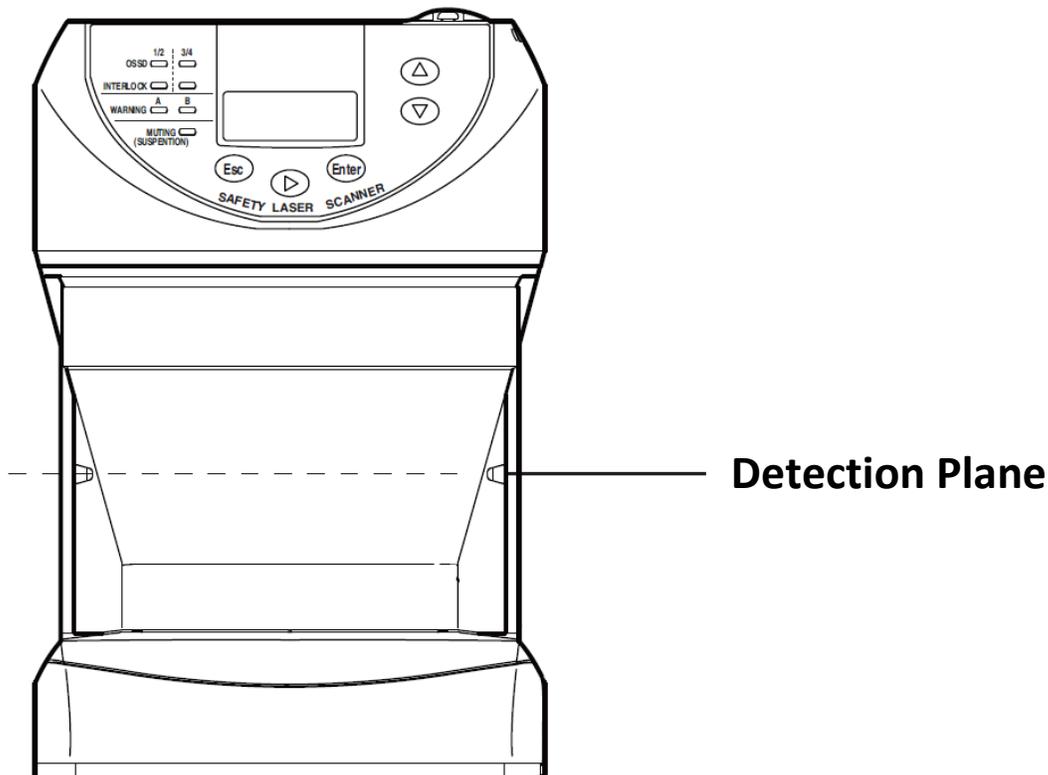
### 5.1. The Safety Scanner

Your safety scanner allows for the configuration of two safety zones:

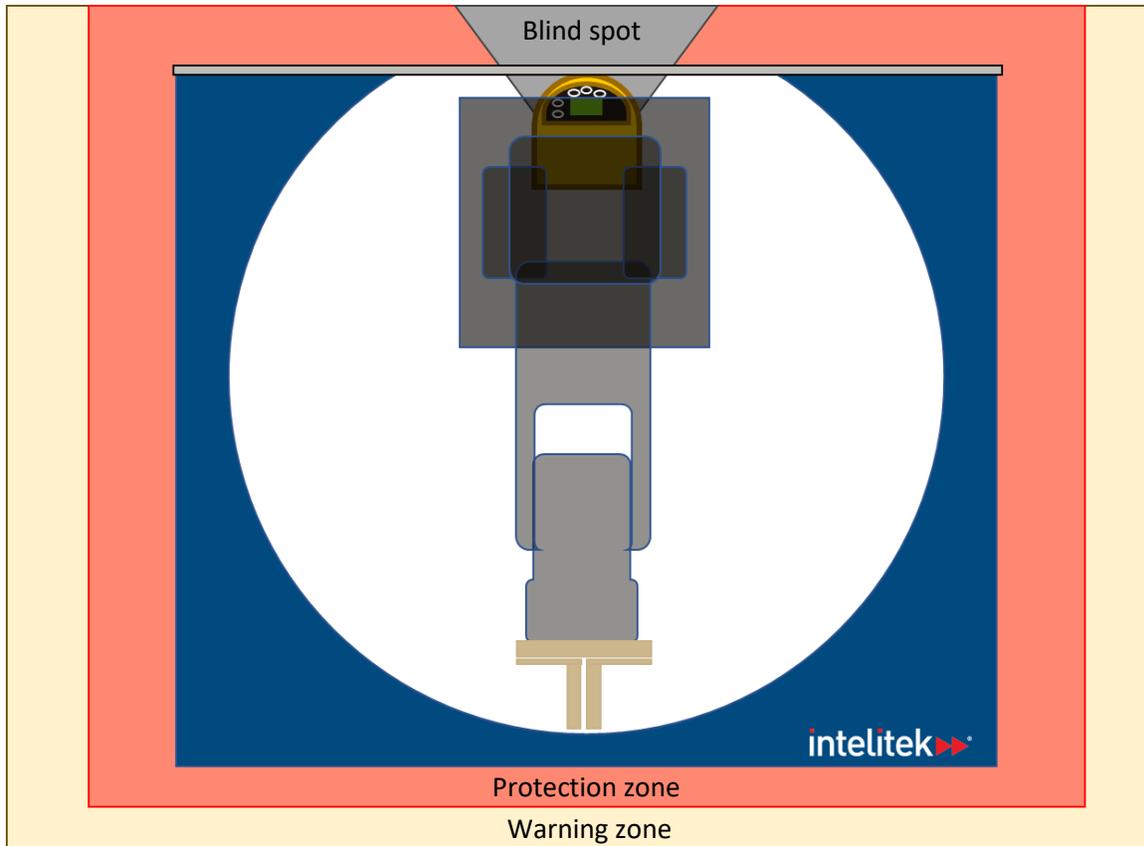
- **Protection zone:** This is the innermost zone – the zone that is closest to the robot. If a person or object enters this zone, the robot stops operating (if it is currently playing back a job).
- **Warning zone:** This is the outermost safety zone, and it acts as a buffer area. If a person or object enters this zone, the robot slows down. The speed of the robot will be as defined by the Intelitek System Integrator (typically about 20 mm per second).

### 5.2. The Scanner and the Robot Cell

The safety scanner scanning area is a 2-dimensional plane (the “detection plane”). Therefore, the scanner will only detect objects that are located at the same height as the mounted safety scanner.



On your robot cart or cell, the scanner is located underneath the table where the robot is mounted. The distance from the scanner to the front of the table is approximately 0.9 meters (about 36 inches). The protection zone will include this (under the) table area, plus an additional area around the table (about 0.5 meters or 20 inches). The warning zone will be composed of an additional perimeter of about 0.5 meters (20 inches). The safety scanner also has a blind spot behind itself where it cannot scan objects.



Schematic representation of the protection zone, warning zone, and blind spot on an Intelitek Robotic Cart

The table/cart may have legs or include other objects (such as I/O boxes) in front of the safety scanner. These legs or objects need to be excluded from the safety zones.

## 6. Key Terms

The following are useful terms.

- **Output Signal Switching Device (OSSD):** A component in safety systems that manages the signals sent out by safety.
- **Edge Detection Mode (EDM):** A feature used in safety scanners to identify and detect the edges or boundaries of a specific area. It helps the scanner recognize where one space ends and another begins.

## 7. Lab Activity

### 7.1. Zone Configuration

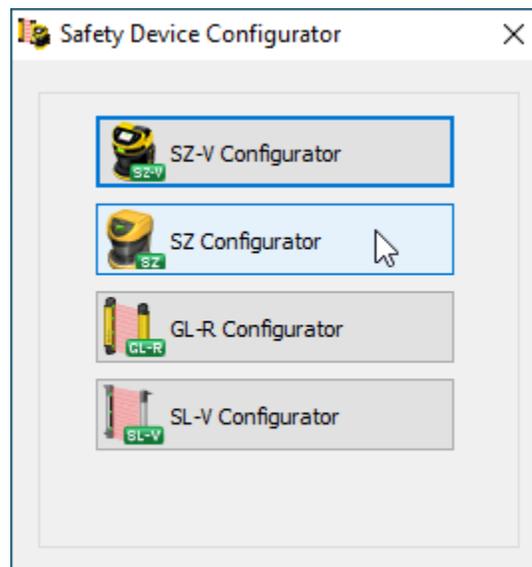
In this section, you will create a new safety sensor configuration file and define the protection and warning zones.

Perform these steps.

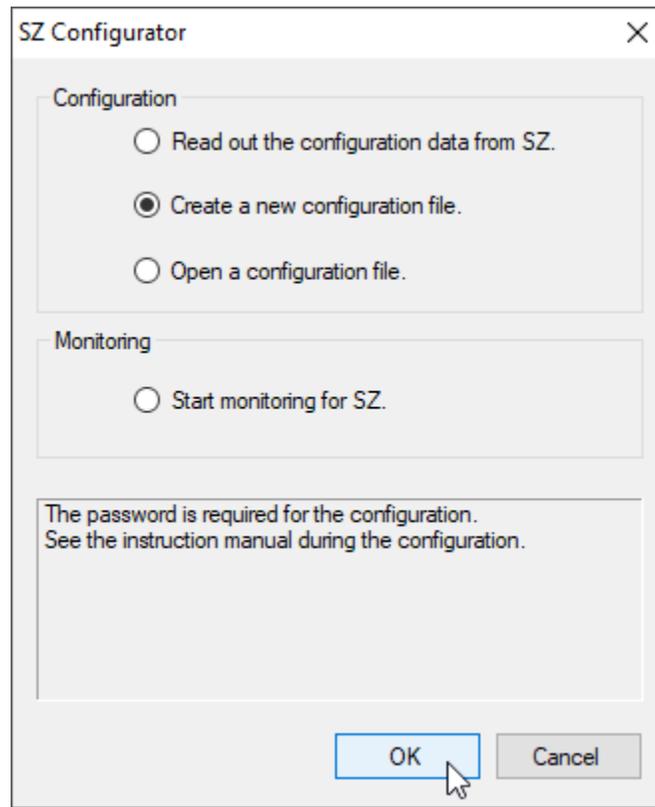
1. Run the **KEYENCE Safety Device Configurator** software.



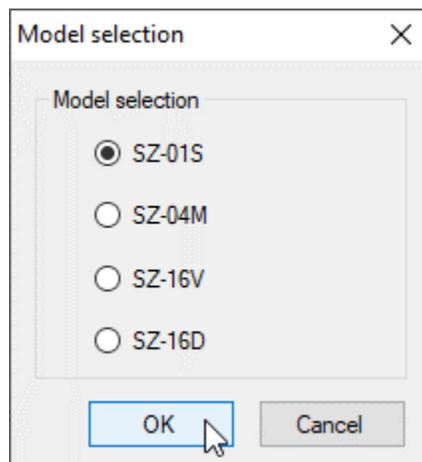
2. If prompted, select the configurator for your scanner.



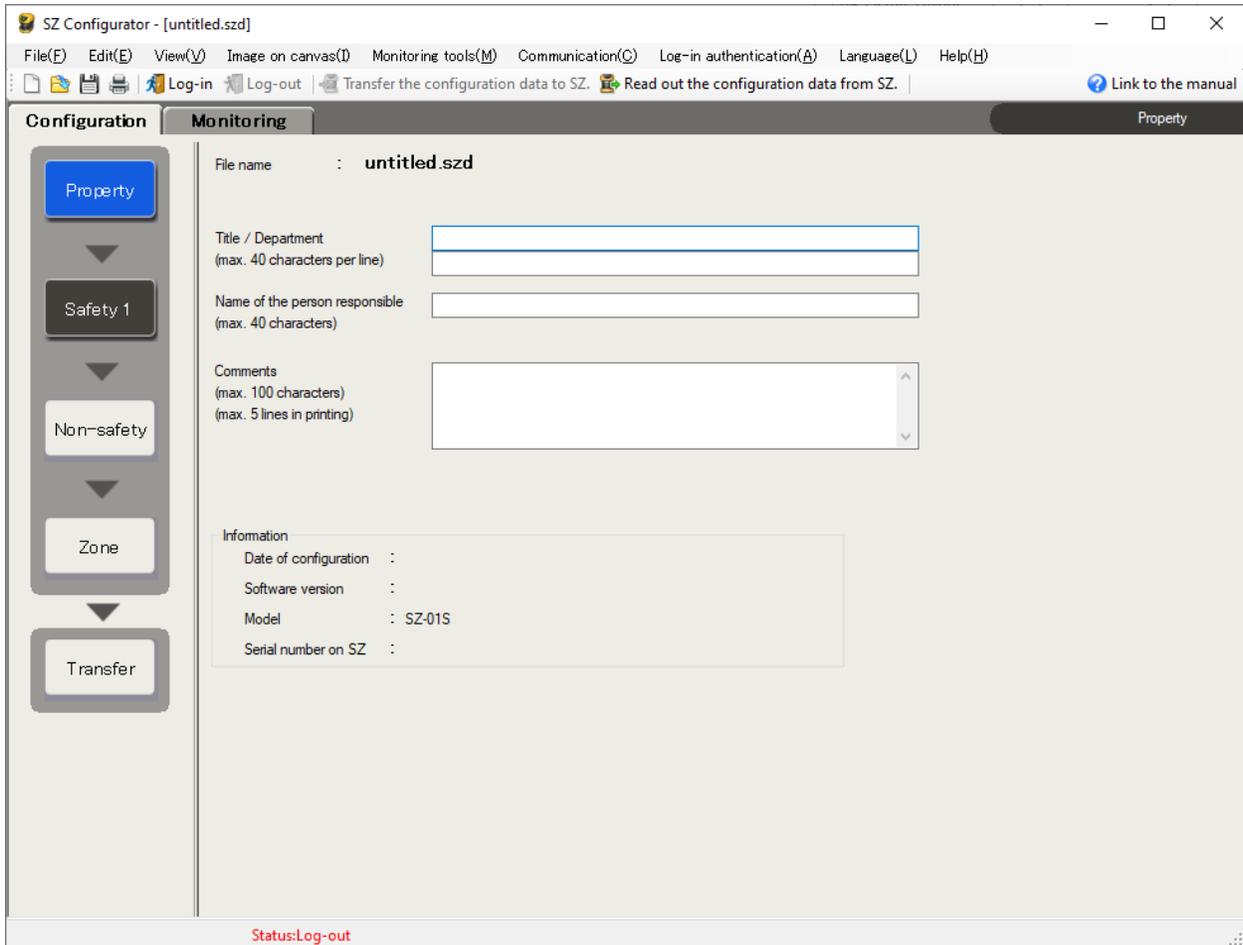
3. The Configurator window opens. Select **Create a new configuration file** and then click **OK**.



4. The Model selection window is displayed. Select your scanner model and then click **OK**.



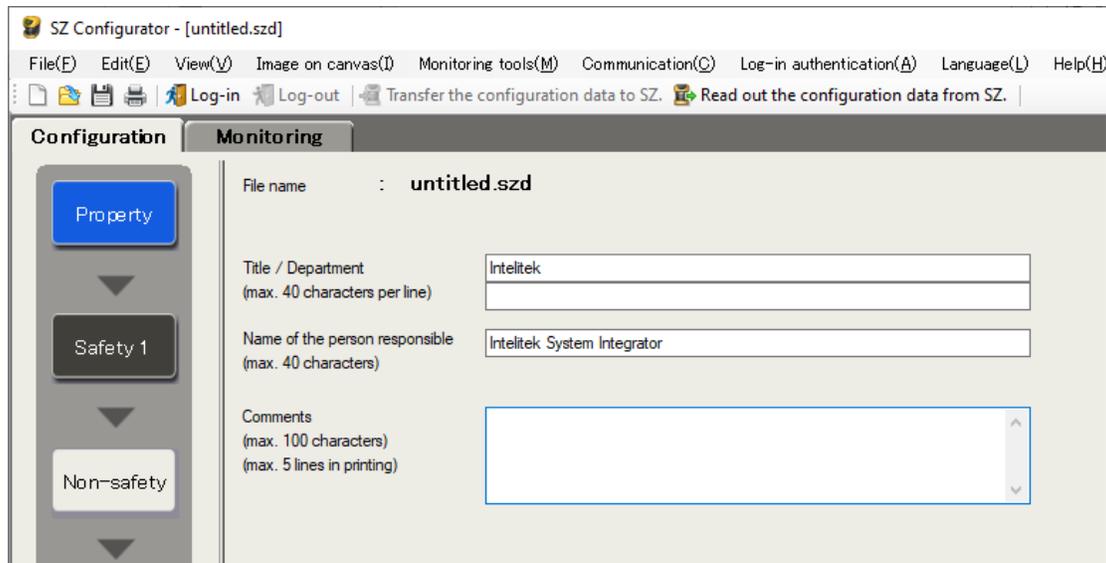
The Configurator’s main window is displayed. There are two modes, Configuration and Monitoring, which are represented by the two tabs. Initially, the Configuration tab is displayed. The Monitoring tab is displayed after the configuration file is transferred to the safety scanner.



Configuration has five steps, as indicated by the buttons on the lefthand side of the tab. This table provides a brief description of each step.

Step	Description
Property	Contains fields for adding information about the system.
Safety 1	Where you define what the scanner can detect in the <b>protection zone</b> , as well as various other parameters.
Non-Safety	Where you define what the scanner can detect in the <b>warning zone</b> , as well as various other parameters.
Zone	Where you set the dimensions of the safety zones.
Transfer	Sends the configuration file to the scanner.

- In the Property menu, enter any relevant information. In the **Name of the person responsible** field, enter your name.



- In the menu on the left, select **Safety 1**.



7. Adjust the following parameters, leaving the rest in their default settings:

- Minimum detectable object size: **50mm (1.97 inch)** (Note: Maximum protection distance changes automatically.)
- Start/Restart mode (Interlock): **Automatic / Automatic**
- EDM Enable: Uncheck

**OSSD**

Minimum detectable object size  
 50mm (1.97 inch)

Maximum protection distance 3.0m (118.11 inch)

Response time

Scan cycle A (General) 120ms

Scan cycle B 132ms

\* Response time must be 90ms or less when SZ series is used for the detection for access protection. See the instruction manual.

Start/Restart mode (Interlock)

Start / Restart

Automatic / Automatic

Manual / Automatic

Manual / Manual

Restart delay (ON-delay)

Enable

Delay time(2 to 60 sec.) 2 sec.

EDM Enable

**Reference points monitoring**

Enable

\* Reference points monitoring function must be applied when SZ series is used for the detection for access protection. See the instruction manual.

8. Select **Non-safety**.



9. Set both AUX1 and AUX2 to **Detection in warning zone**.

Detection in warning zone

Minimum detectable object size  
50mm (1.97 inch) ▼

Maximum warning distance 7.5m (295.27 inch)

Response time

Scan cycle A (General) 120ms ▼

Scan cycle B 132ms ▼

AUX

Output for	AUX1	AUX2
Not used	<input type="radio"/>	<input type="radio"/>
Error	<input type="radio"/>	<input type="radio"/>
Alert	<input type="radio"/>	<input type="radio"/>
Error or alert	<input type="radio"/>	<input type="radio"/>
OSSD state	<input type="radio"/>	<input type="radio"/>
Detection in protection zone	<input type="radio"/>	<input type="radio"/>
Detection in warning zone	<input checked="" type="radio"/>	<input checked="" type="radio"/>
Interlock-reset-ready	<input type="radio"/>	<input type="radio"/>

Wire color and assigned function

Check input

Enable

OSSD OFF with laser shutdown

OSSD OFF with check points monitoring

\* Check input can not be applied if you apply the interlock mode other than "Automatic/Automatic" as Start/Restart interlock mode.

\* Check input can not be applied if you apply the reference points monitoring.

Information display

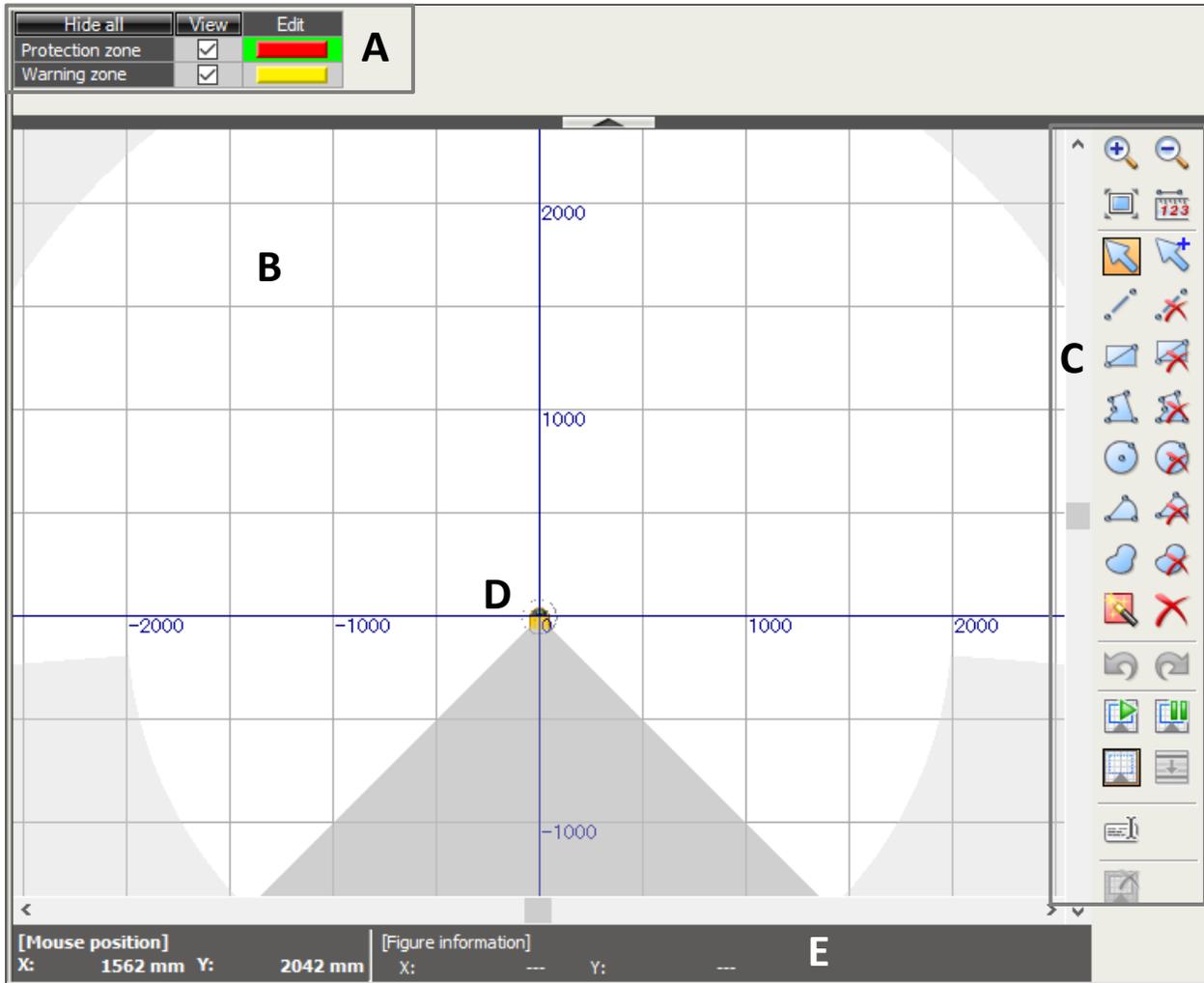
Turn off backlight

10. Select **Zone**.



The Zone menu allows you to configure the physical dimensions of the safety zones. Over the next several steps, you will use several of the commands in this menu to draw safety zones that are specific to your lab setup. If you want to get to know the other commands and options, refer to the *SZ Safety Scanner User Guide*.

The graphic and table on the next page provide an overview of the Zone window.

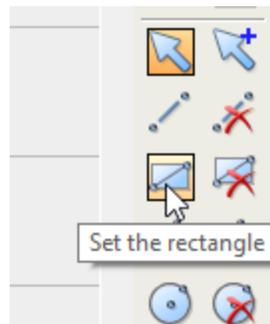


Label	Item	Description
A	Zone display panel	Select the zone to be configured and the zone(s) to be viewed.
B	Canvas	Draw the zones in this work area.
C	Drawing toolbar	Contains tools that help you draw the zones.
D	Safety scanner	Represents the location of the safety scanner. The scanner’s blind spot is represented by the grey triangle on the canvas. All grey areas are unconfigurable areas. The small circle surrounding the scanner represents an area with limited detection capability.
E	Drawing properties	Shows information about the drawing, mouse position, and size and angles of objects on the canvas.

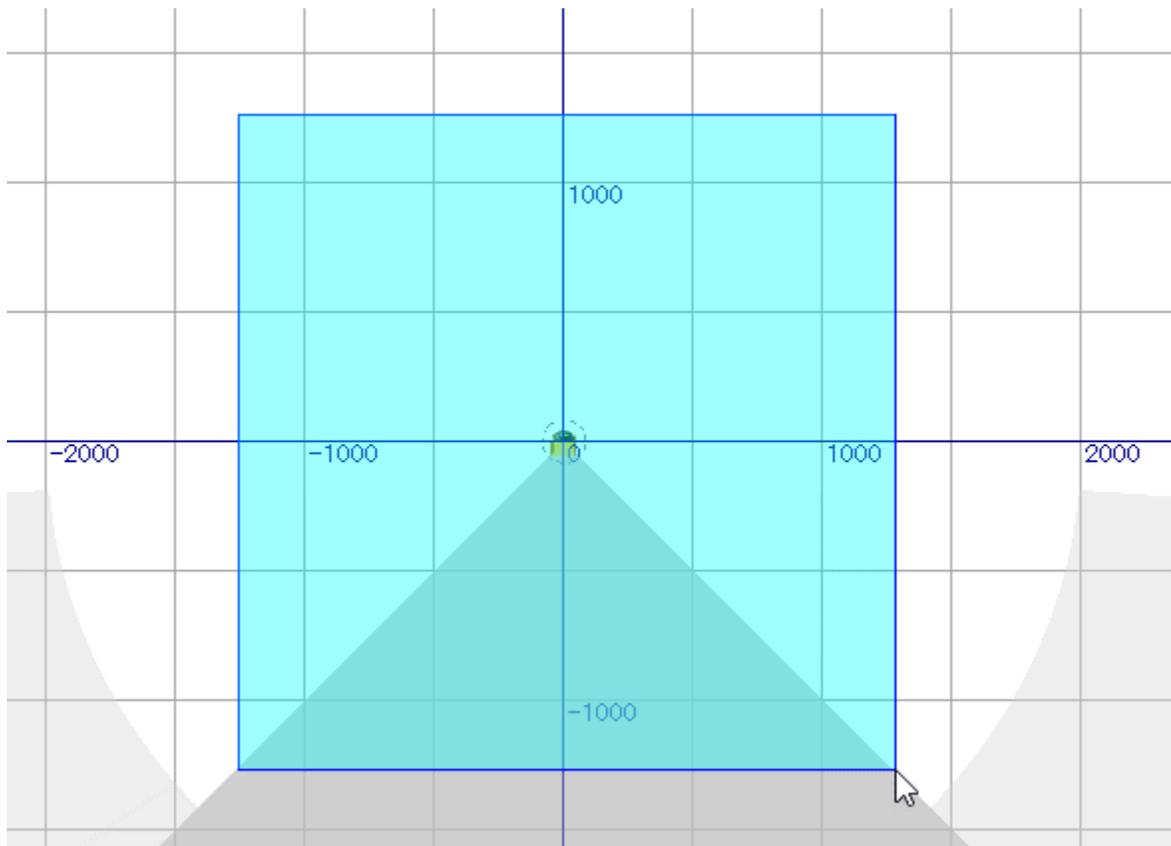
11. You will draw the protection zone first. In the zone display panel, select the red Protection zone edit bar.



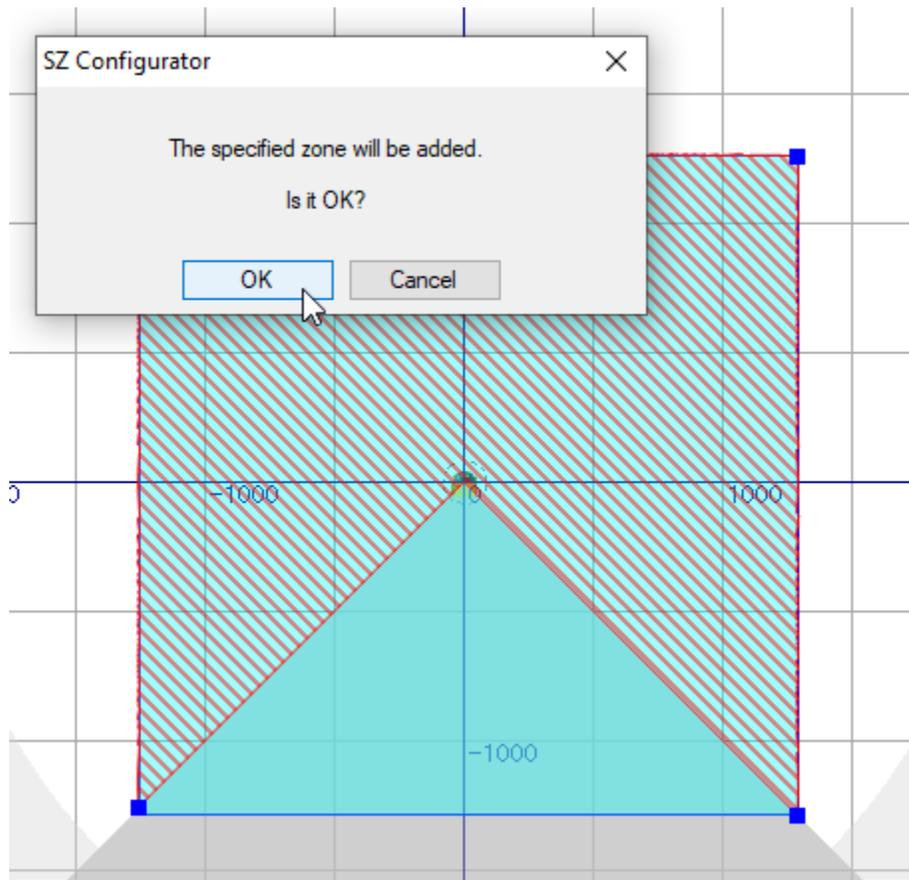
12. In the drawing toolbar, select the **Set the rectangle** tool.



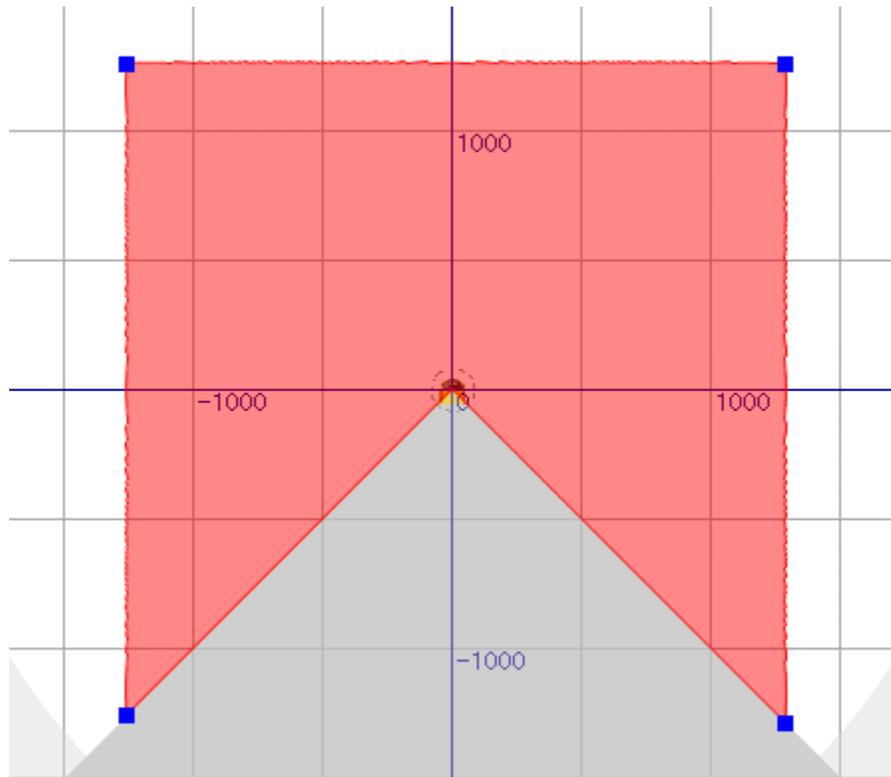
13. Click an area of the canvas to start drawing a rectangle and then move your cursor to extend the dimensions of the rectangle. Create the rectangle so that its edges are located approximately 1250 mm (1.25 meters or about 50 inches) from the scanner in the four major directions as shown. Click a second time to confirm the final shape of the rectangle.



14. A preview of the zone is displayed. If you are satisfied with the zone, click **OK**. Otherwise, click **Cancel** to delete it and then return to the previous step.



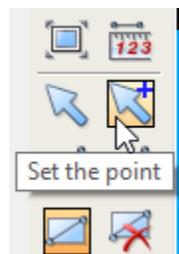
The zone is displayed in red.



- ① **Note:** The triangular area behind the scanner is not configurable and remains grey.
- ① **Note:** Press **Ctrl + Z** on your keyboard to undo the last action and **Ctrl + Y** to redo it. You can also use the undo and redo arrows in the drawing toolbar.
- ① **Note:** You can use the Delete options in the drawing toolbar to remove areas of the zone.

You may have to adjust your zones in order to create exclusion zones for stationary objects. The next several steps provide instructions on how to make spot changes to the zone.

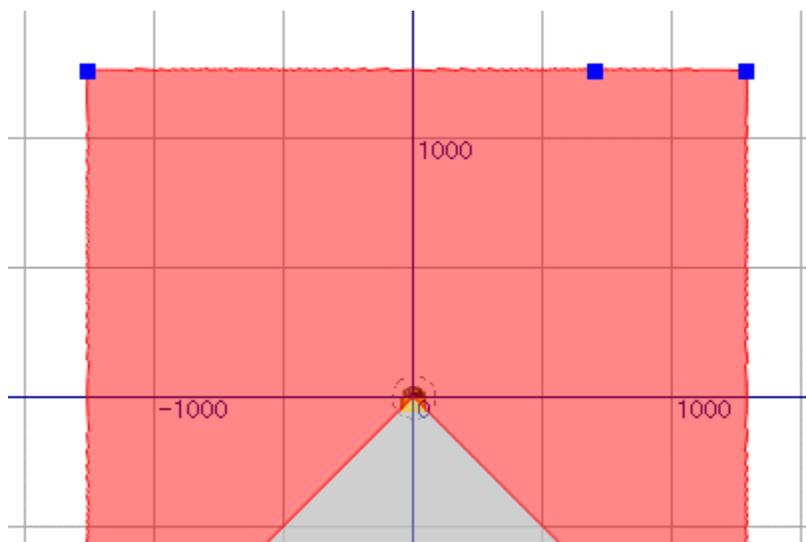
**15.** In the drawing toolbar, select the **Set the point** tool.



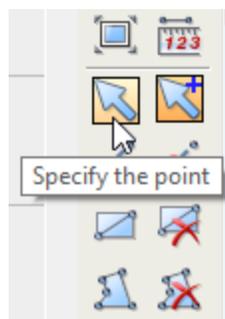
- Click the edge of the zone in front of the scanner. Note that the cursor turns into crosshairs when it hovers over the edge.



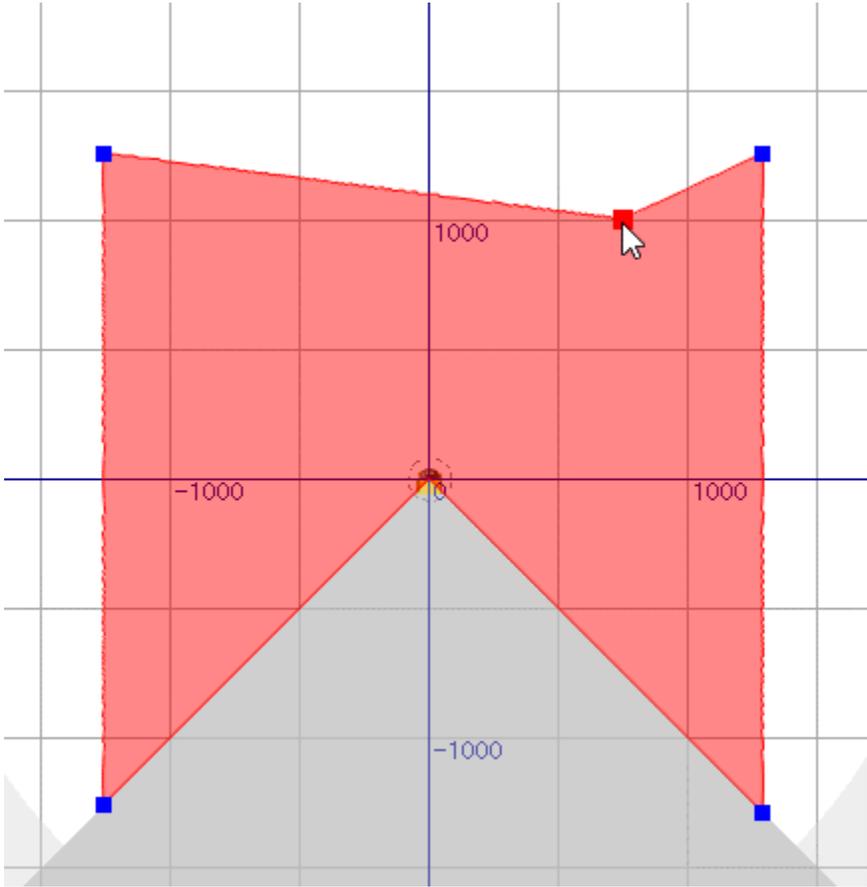
A point appears at the location where you clicked.



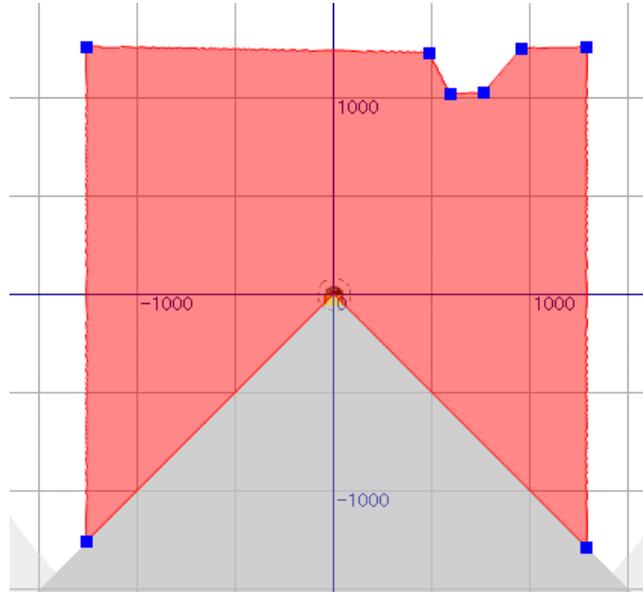
- In the drawing toolbar, select the **Specify the point** tool.



18. Click and drag the point to a location closer to the scanner.

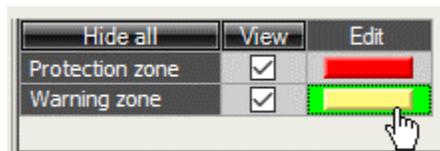


19. Continue adding points and adjusting them as necessary in order to create small exclusion zones where you believe the stationary objects are located. An example is shown below. Note that you will be able to adjust and fine-tune the zone after you have turned on monitoring and the scanner detects exactly where the stationary objects are.



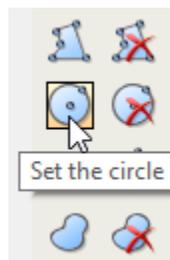
When you are satisfied with the protection zone, continue to the next step.

20. You will now create the warning zone. In the zone display panel, select the **Warning zone** edit bar.

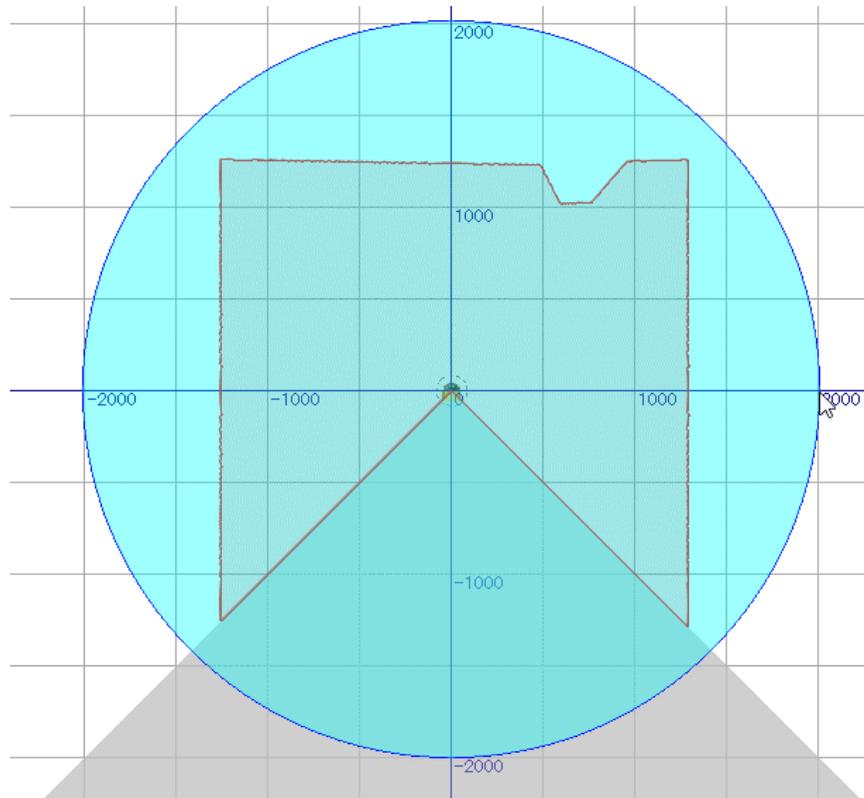


In the canvas, the color of the protection zone lightens. Note that you can hide the warning zone by unchecking its view checkbox in the zone display panel.

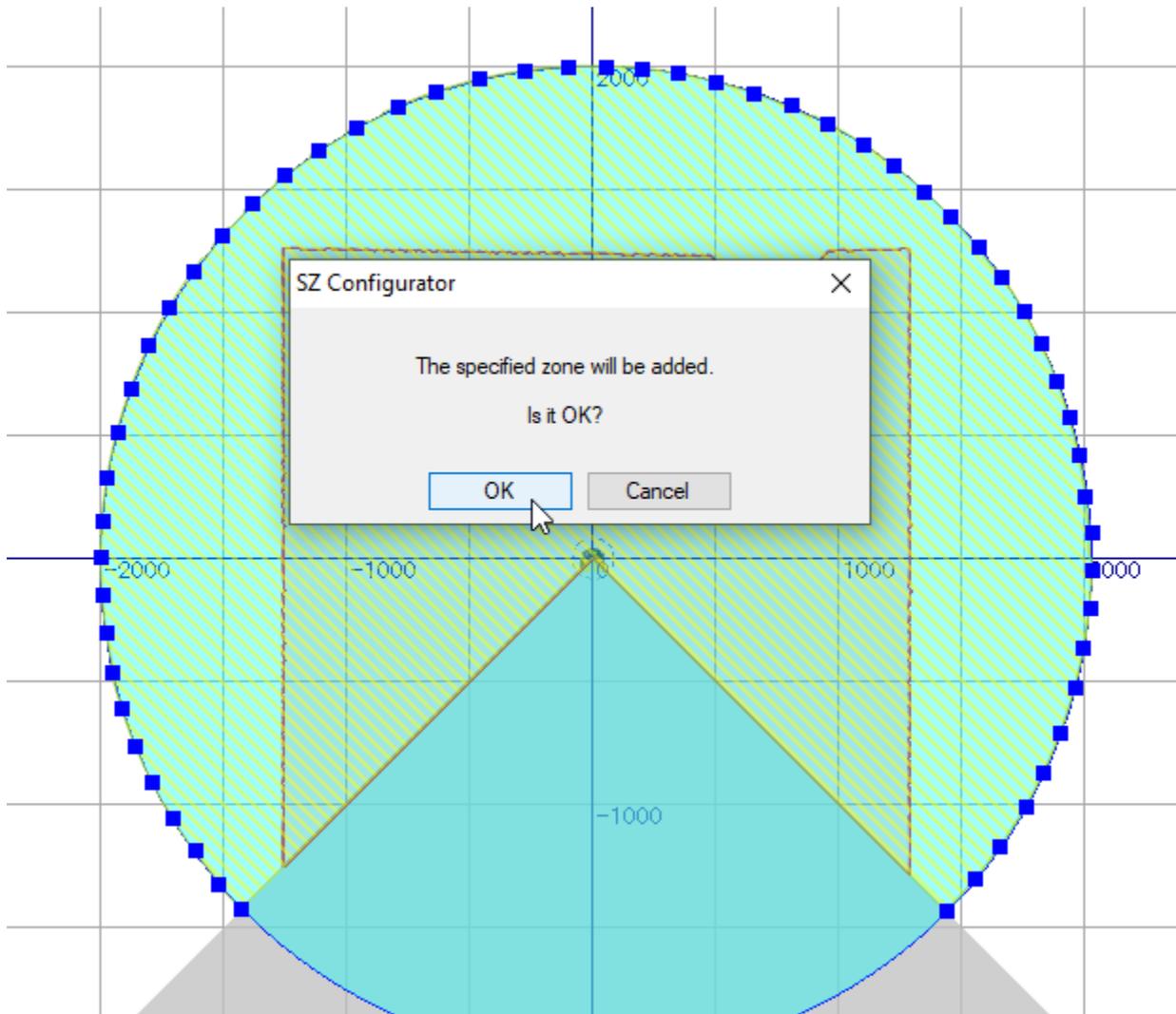
21. In the drawing toolbar, select the **Set the circle** tool.



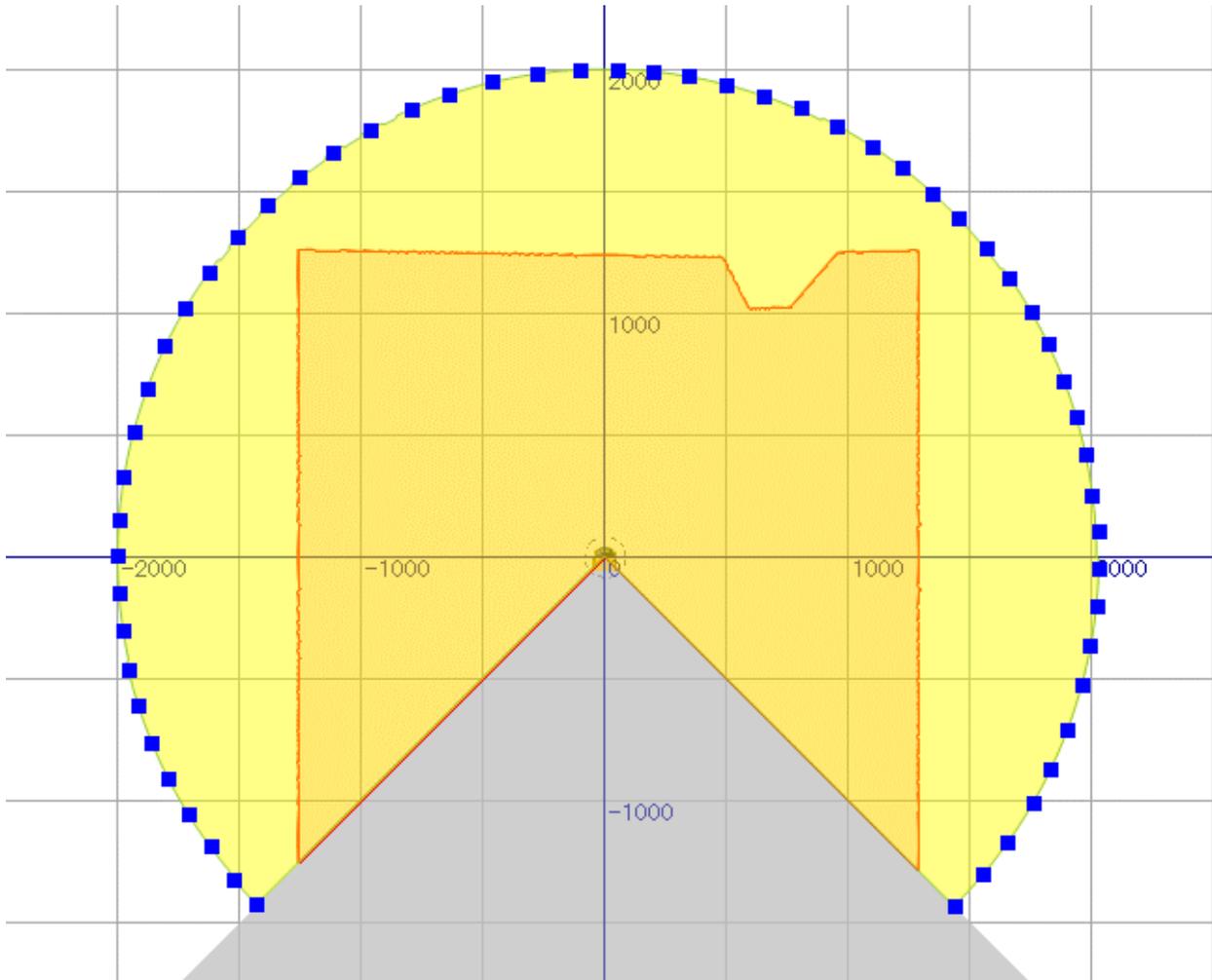
22. On the canvas, click the safety scanner to create a circle that will center on the scanner. Move the cursor until it is 2000 mm (approximately 6 feet) from the scanner. Click a second time to complete the circle.



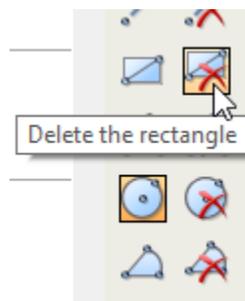
23. In the popup window, click **OK** to confirm the placement of the circle. (If you are not satisfied with the circle, click **Cancel**.)



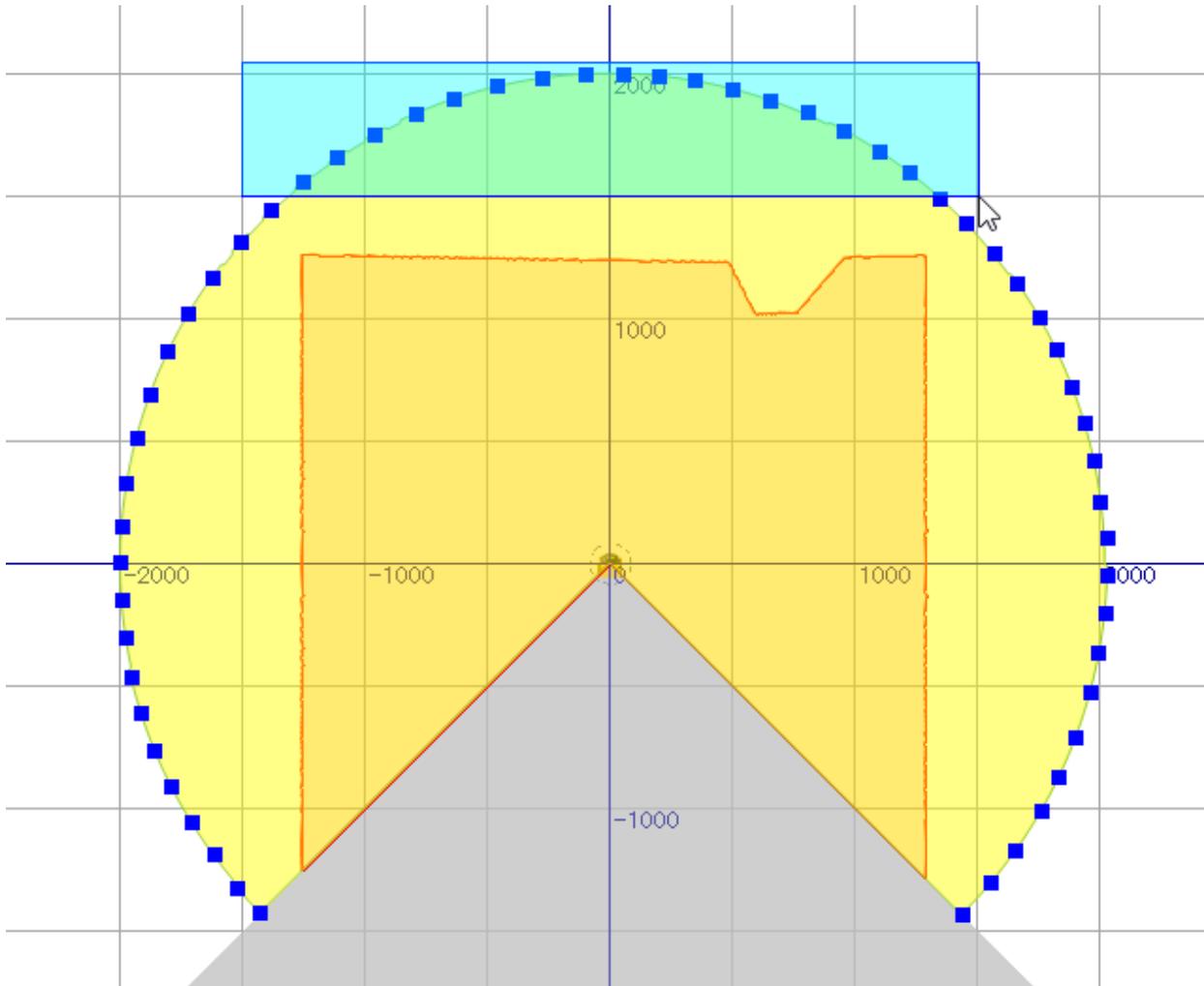
The circular warning zone is created. It is yellow. As with the protection zone, points can be added or relocated.



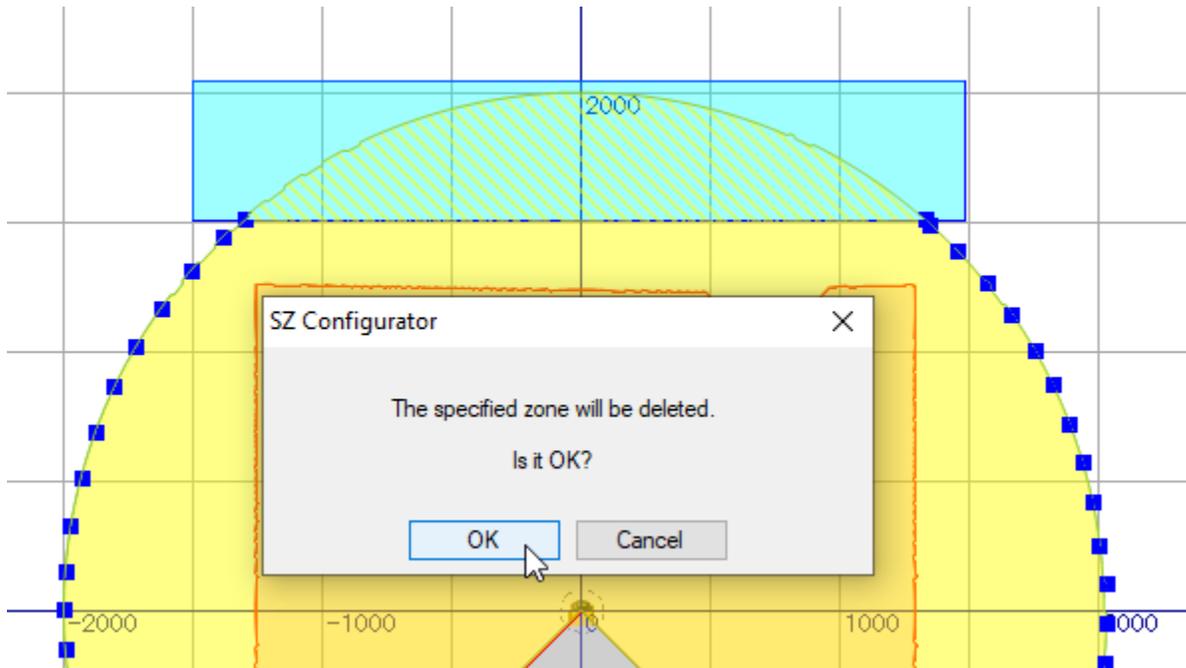
24. Select the **Delete the rectangle** tool.



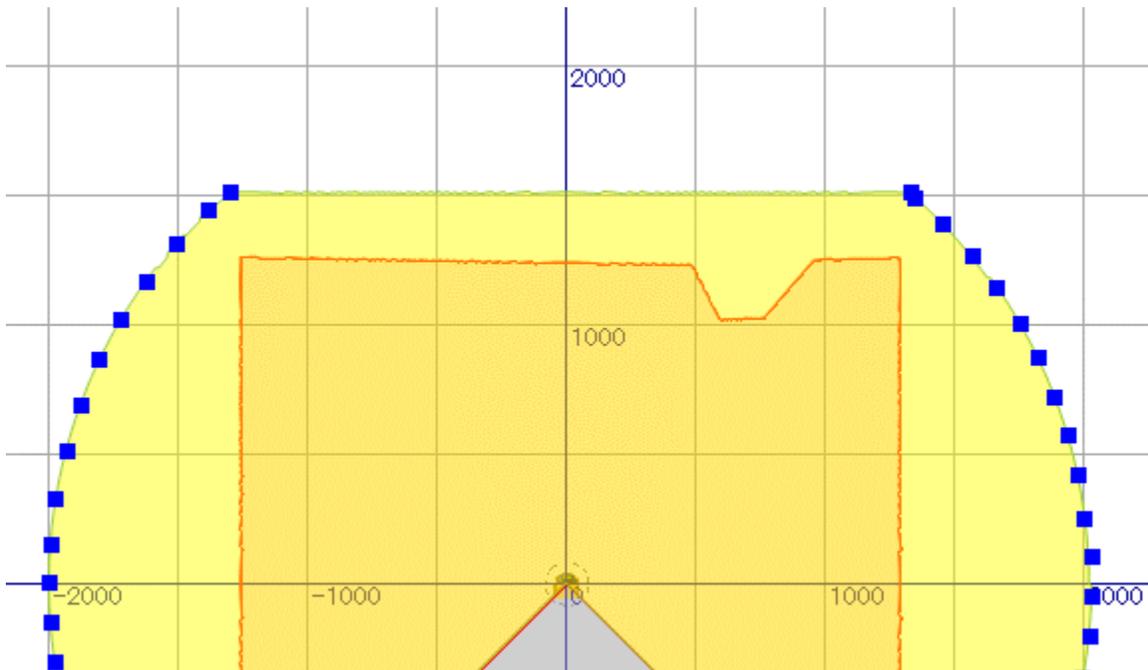
25. Using the Delete the rectangle tool, draw a rectangle that covers the top of the circle from 1500 mm as shown. Remember to click a second time to complete the rectangle.



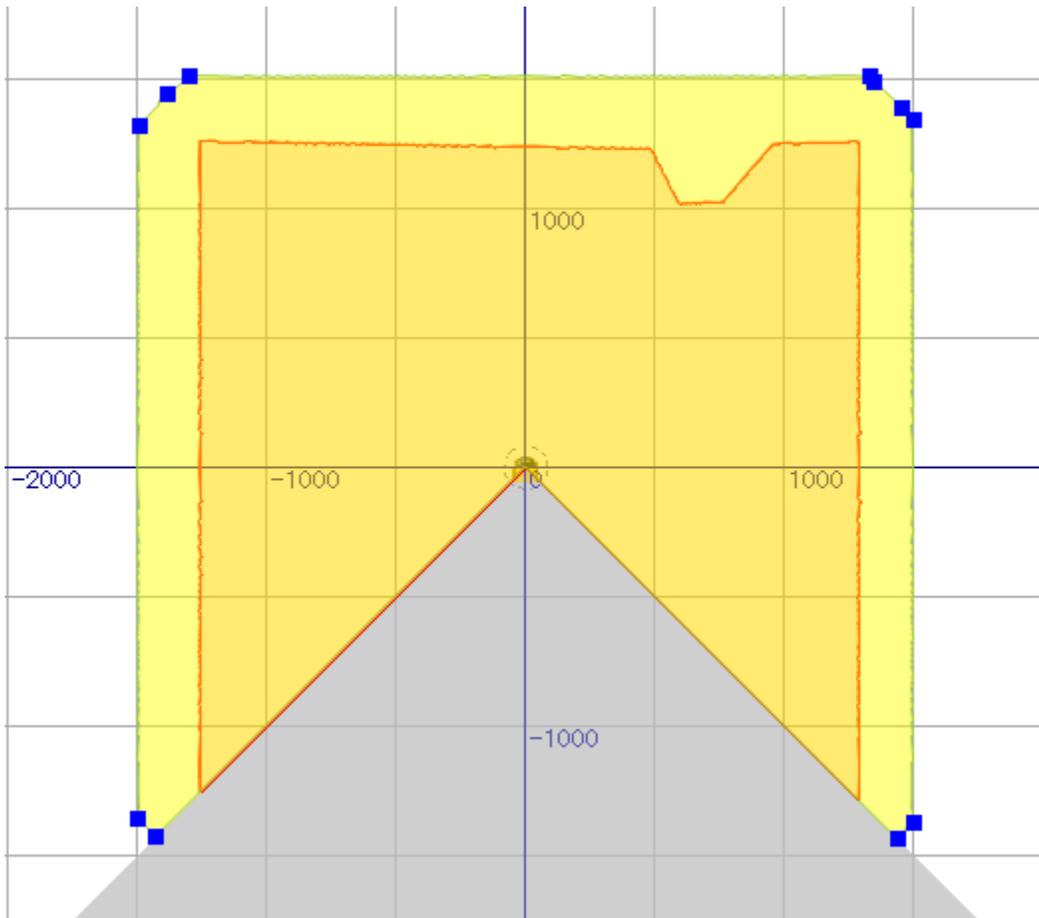
26. A popup window asks for confirmation. Click **OK**.



The top of the zone is deleted.

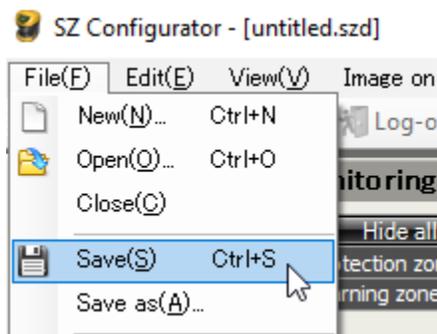


27. Using the same tool, crop the two sides of the zone from 1500 mm as shown.



28. Your safety zones are now ready to be transferred. Take some time to adjust both or either of the zones to match your actual lab setup. Once you are satisfied, continue to the next step.

29. Navigate to **File > Save**. Save your SZD file with an appropriate name. Ensure that the file name contains your name or initials.



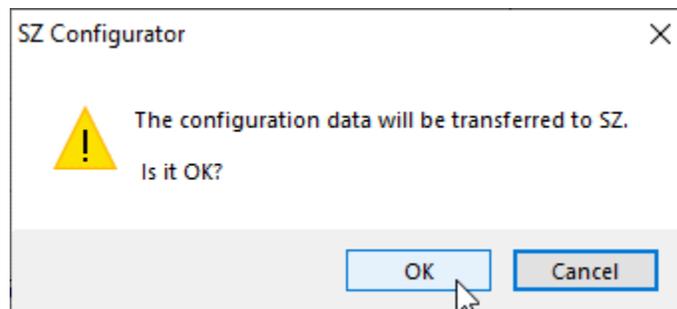
## 7.2. Transferring the Configuration File

In this task, you will transfer the configuration file to the safety scanner.

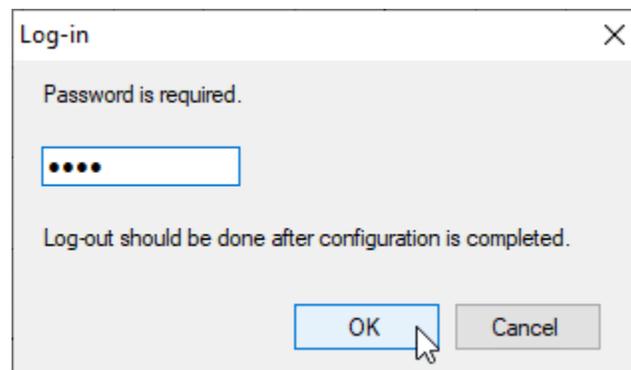
1. Power the robot cart or cell's I/O box on. Ensure that the safety scanner powers on.
2. Power the robot controller on.
3. Ensure that the controller has at least one basic motion job that you can run on a loop for testing. If it does not have one, program (teach) one now. Do not run the job yet.
4. Connect your computer to the safety scanner using the USB cable.
5. Return to the configurator software window. In the menu on the left, click **Transfer**.



6. In the confirmation window, click **OK**.

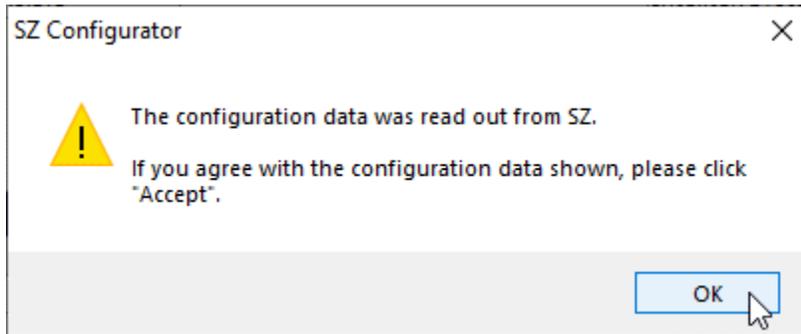


7. Enter the password and then click **OK**.

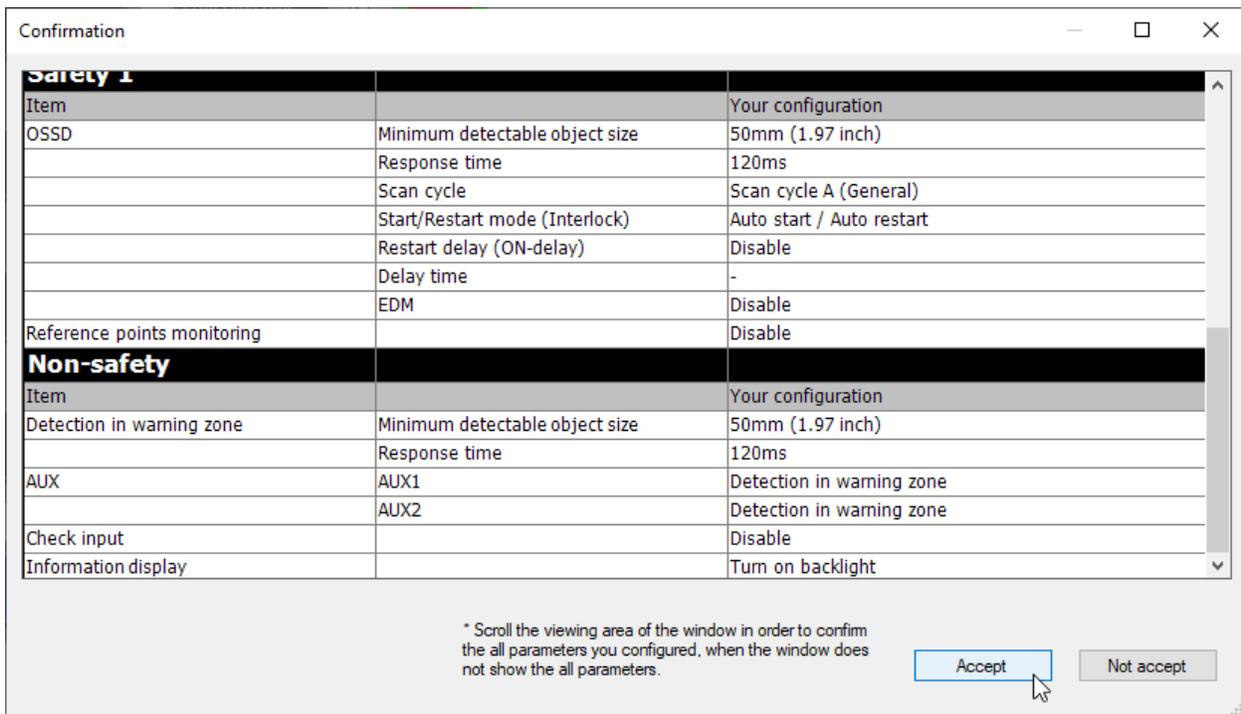


**Note:** If you do not know the password, ask your instructor or system integrator.

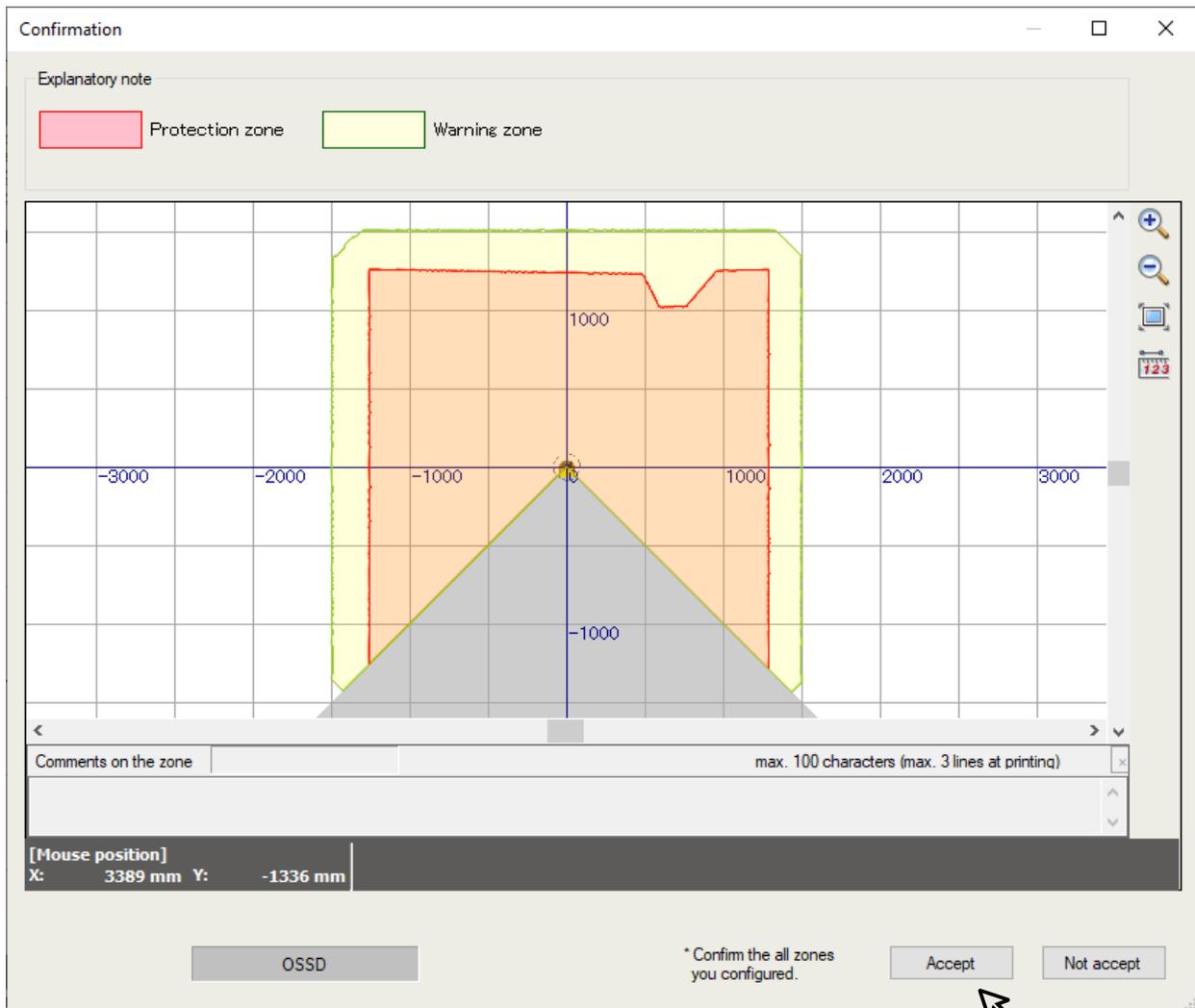
8. The configuration file is transferred. Click **OK**.



9. Scroll down to the bottom of the Confirmation window, and then click **Accept**.



10. Confirm the zones by clicking **Accept**.

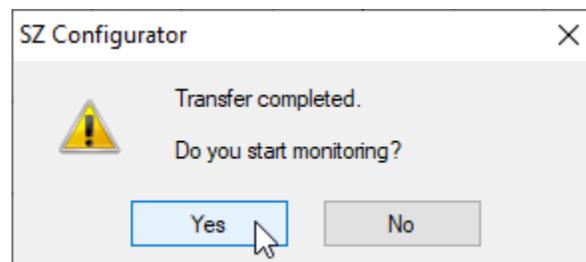


The configuration file has been transferred. In the next task, you will activate the configuration file for monitoring purposes.

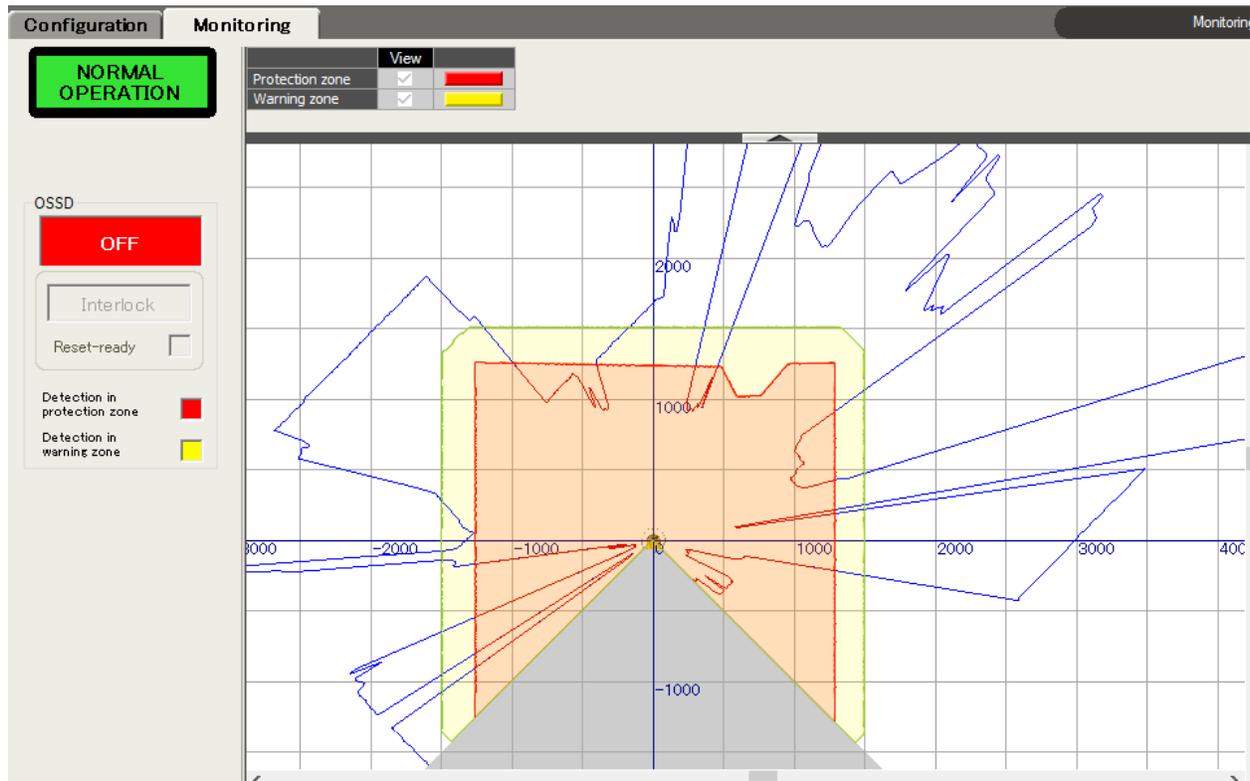
### 7.3. Monitoring

In this task, you will run a robot job and test the configuration file that you transferred.

1. In the popup window, click **Yes**.



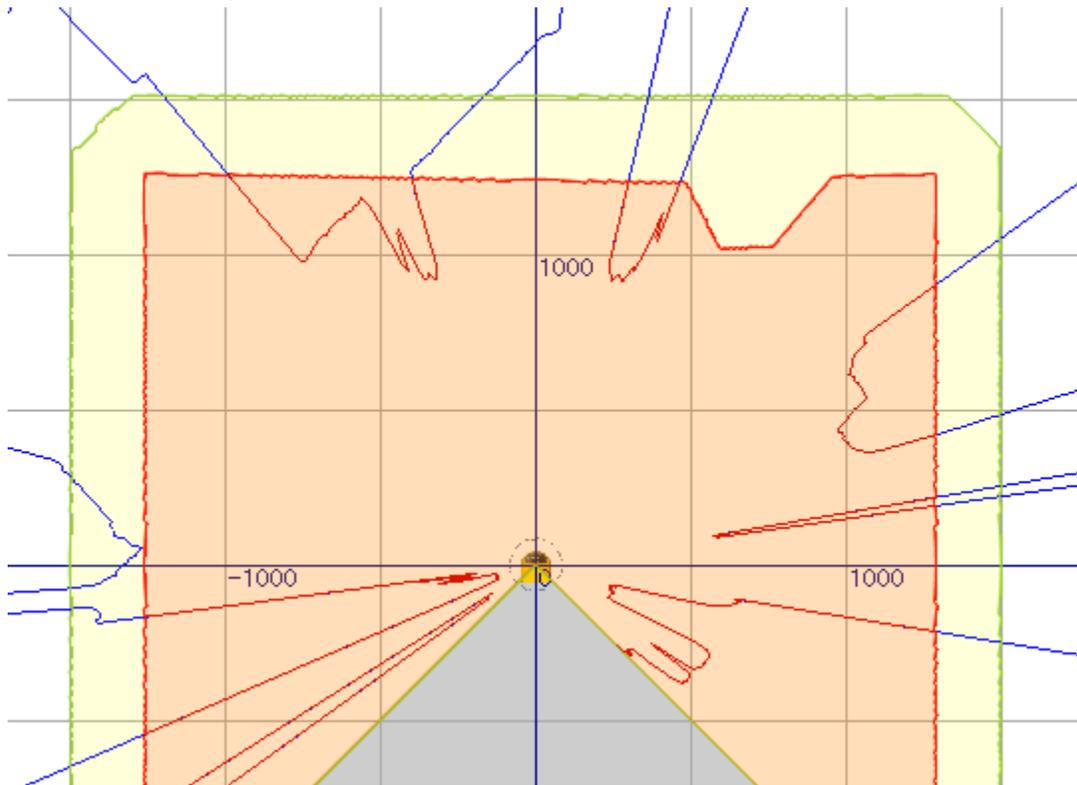
The scanner begins to detect objects. On the screen, the blue lines represent objects or people that are in range of the scanner.



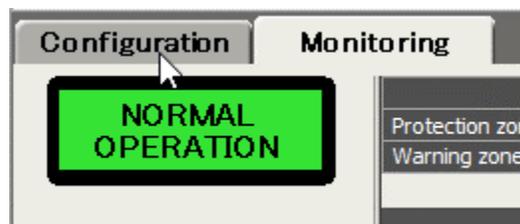
2. Walk around the robot cart or cell while looking at the screen. Try to observe where you are on the screen by finding the moving blue lines. You can see an example of this by scanning or clicking the QR code below and watching a video.



Note that in this example, there are stationary objects within both safety zones. This configuration file needs to be adjusted.



3. Observe your monitoring screen and determine if there are any stationary objects in the safety zones:
  - These objects may be items such as stray wires or chairs that can be moved. Move them out of the way if possible.
  - If the objects cannot be moved away, the safety zones need to be adjusted. If this is the case, click the **Configuration** tab to return to the configuration menus. Change the dimensions of the zones as required, and then transfer the configuration file back to the scanner.



Once the safety zones are free of blue lines, continue to the next step.

4. Hold the robot’s programming pendant in your hand and step outside of the warning zone.
5. Using the robot’s programming pendant, play the loaded job on a loop.
6. Step into the warning zone. The robot should slow down its motion.
7. Step into the protection zone. The robot should stop its motion completely.
- ① **Note:** *The behavior of the robot and the signal lamps may behave differently depending on the way your Intelitek System Integrator has configured the robot controller.*
8. Step out of the safety zones. The robot should resume its motion job.

Click or scan the QR code below to watch an example of this task being executed.



### 8. Authentic Skill Assessment

Have your instructor verify that your work meets the requirements in the performance objectives and sign below. Keep this lab activity sheet for future reference.

Instructor Signature	Date

### 9. Shutdown

Unless instructed otherwise by your instructor, review and complete each of the items on the checklist below.

- Exit the configurator software. Save your file if prompted.
- Return the programming pendant to its hook on the robot cart.
- Power down the I/O box and the robot controller.