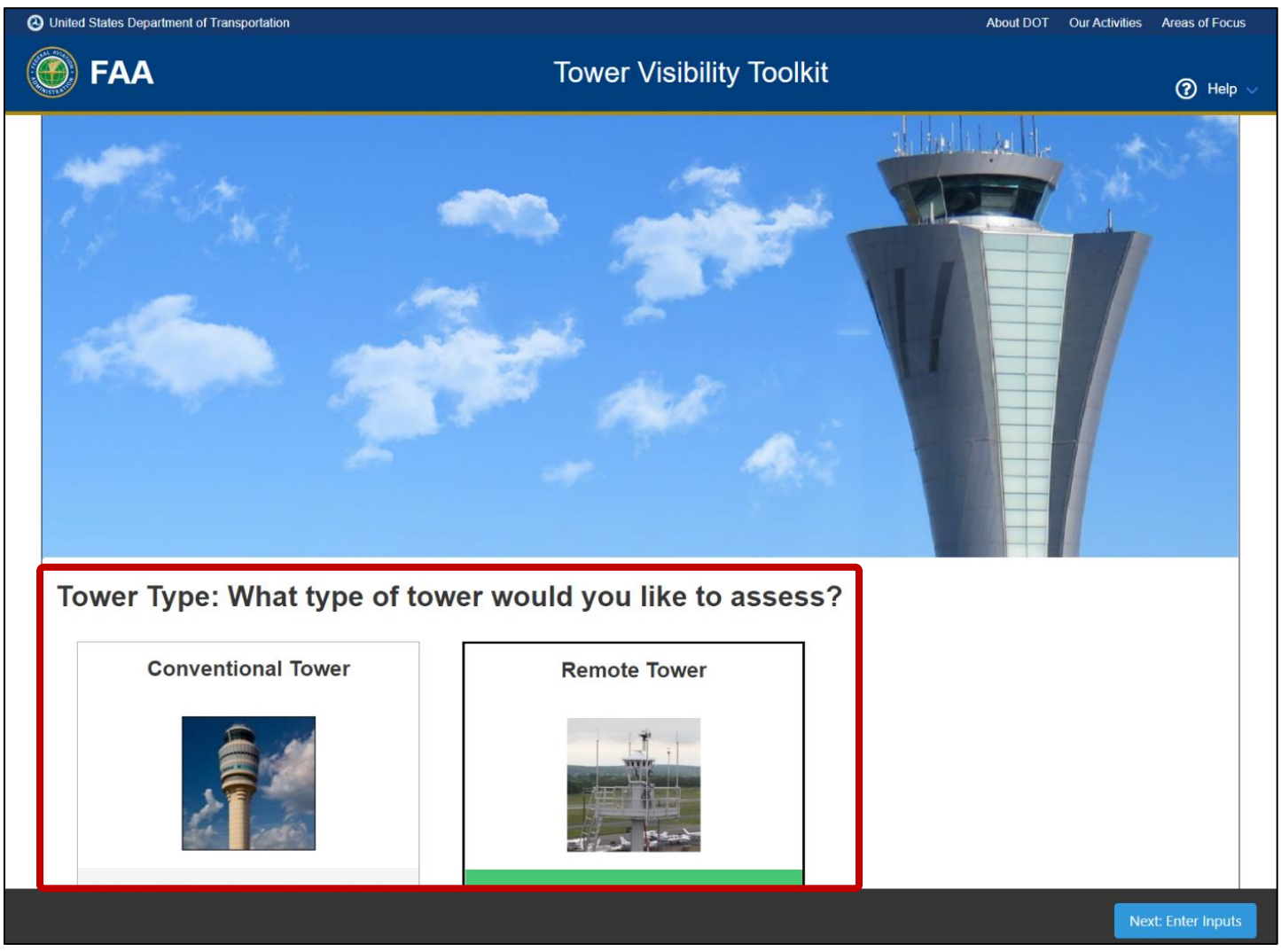
1 Introduction

The Tower Visibility Toolkit supports assessing proposed airport traffic control tower sites against a variety of visibility performance metrics. This toolkit allows assessment of both conventional brick-and-mortar and remote towers. The Federal Aviation Administration (FAA) has a method to assess conventional tower visibility performance that is documented in FAA Order 6480.4, "Airport Traffic Control Tower Siting Process" [1][2]. In 2005, the FAA developed a tool for assessing conventional tower visibility performance called the Visibility Analysis Tool. The Tower Visibility Toolkit replaces the FAA's Visibility Analysis Tool, using updated methods for calculating probability metrics and adding assessment of remote tower visibility performance through the addition of video camera system modeling.

2 Getting Started

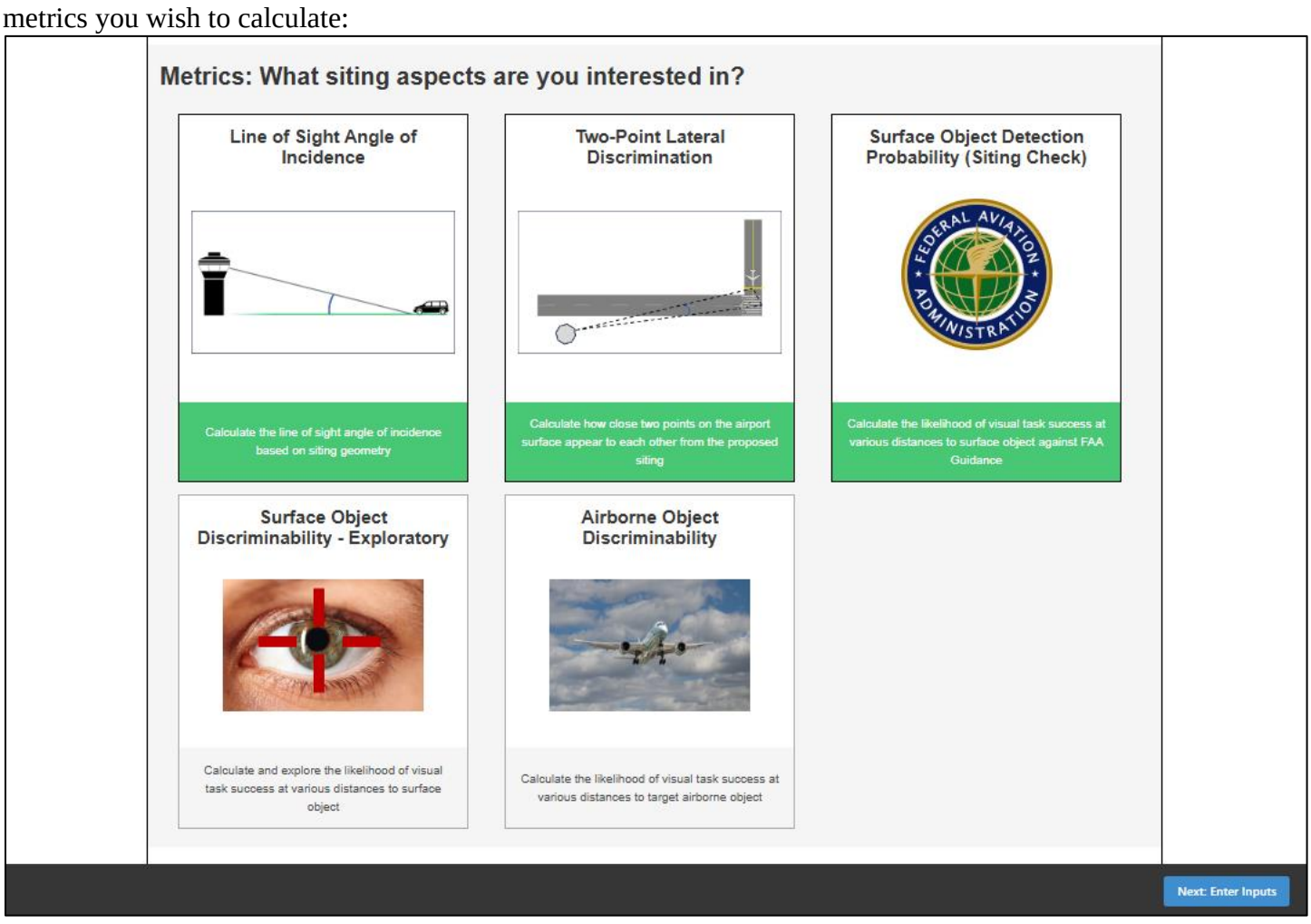
2.1 Tower Type

You can choose the type of tower you would like to assess by clicking on either tower type. Choosing "Conventional Tower" assumes that the observer is directly viewing the scene; choosing "Remote Tower" assumes that there is a video camera system between the observer and the scene.



2.2 Metric Selection

You can choose which siting metrics that you would like to calculate for your tower site by clicking on all the metrics you wish to calculate:



The toolkit offers five metrics to assess tower visibility, which are based on FAA Order 6480.4:

- "Line of Sight Angle of Incidence" is the angle at which the observer's view of a distant object intersects with the airport's surface. A higher value indicates a steeper look-down angle and a more "bird's eye" view of the airport surface. Higher values are preferred because they support making spatial judgments about objects on the airport surface. For conventional towers, the toolkit evaluates whether the tower meets the FAA's guidance of a 0.08 degree minimum.
- "Surface Object Detection Probability (Siting Check)" and "Surface Object Discriminability – Exploratory" are two related metrics for assessing surface target acquisition probability. Surface target acquisition probability is the estimated probability that an observer would be able to detect, recognize, or identify an object on the surface of an airport based on an Army visibility performance model ([2]). The three target acquisition tasks are defined as follows [1][2][3] :
    - *Detection*: The ability to notice the presence of an object on the airport surface without regard to the class, type, or model. The observer knows something is present but cannot recognize or identify the object.
    - *Recognition*: The ability to discriminate between object classes (e.g., can specify class of aircraft such as single engine general aviation).
    - *Identification*: The ability to specify individual models (e.g., Cessna 172).

  Although an observer is making a single correct or incorrect judgment on any one occasion (e.g., present or absent for detection), using probability allows description of how often a correct judgment would occur across many observation opportunities. Higher values indicate that an observer will more often detect, recognize, or identify the object. Using detection as an example, a probability of 100% indicates the observer will detect an object on every observation. A probability of 0% indicates that the observer will never detect the object. A probability of 50% indicates that the observer will detect an object on half the observations.

  The Tower Visibility Toolkit computes probability metrics using the Target Task Performance (TTP) method, rather than the Johnson method that the legacy Visibility Analysis Tool uses. The TTP method is

preferred because of its increased validation and closer match to human performance [3] [4]. The TTP method achieves improved estimates through more accurately modeling how the human visual system processes contrast changes, as well as better quantifying how spatial details in the scene are coupled to the human observer through a camera (when applicable).

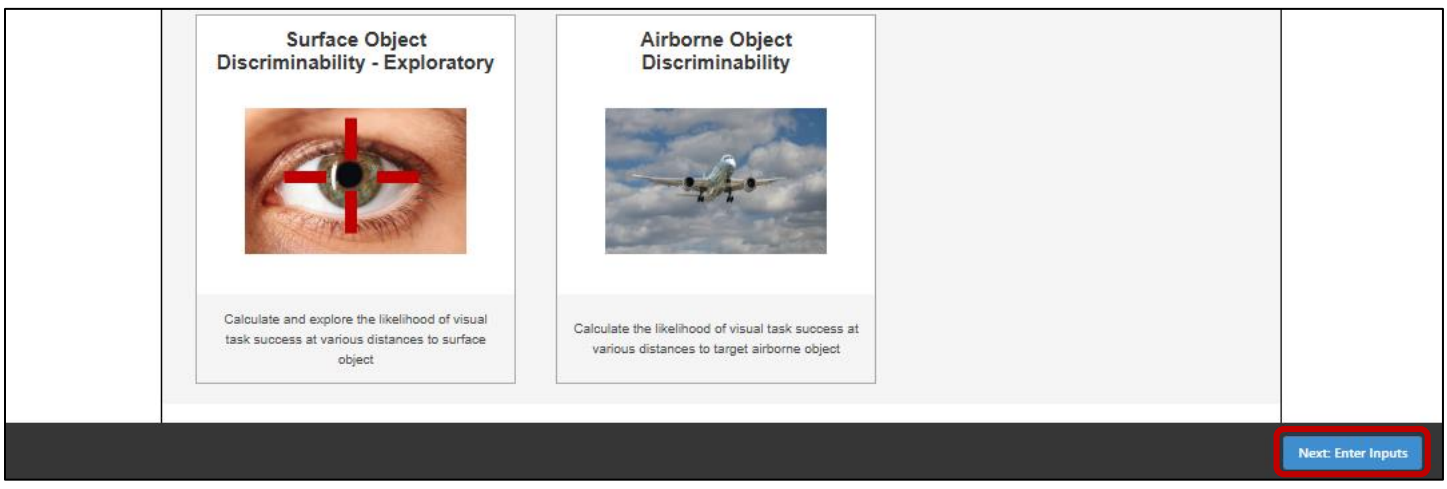
The toolkit offers the following two separate target acquisition probability metrics:

- The "Surface Object Detection Probability (Siting Check)" metric assumes object and background characteristics consistent with FAA Order 6480.4 and the legacy Visibility Analysis Tool default values, and does not allow those parameters to be edited. The toolkit results include indication of whether the metric value meets FAA Order 6480.4 guidance for surface detection probability. For conventional towers, the toolkit evaluates whether the tower meets the guidance of 97.0% (calculated using the TTP method).
- The "Surface Object Discriminability – Exploratory" metric provides pre-filled but editable values for object and background characteristics. This metric does not include comparison to FAA guidance because the guidance assumes the object and background characteristics have not been changed.

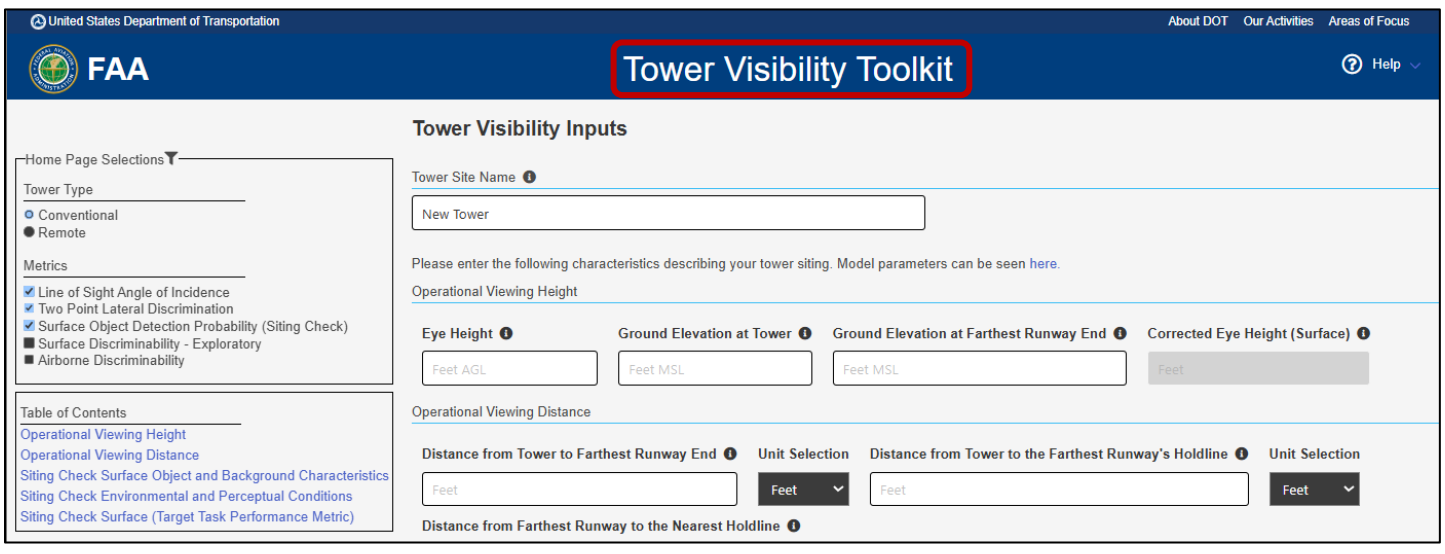
- The "Airborne Object Discriminability" metric operates similar to the Surface Object Discriminability - Exploratory metric except that the toolkit computes the probability that an observer will be able to detect an airborne object. The airborne detection model differs from the surface model in its use of a Cessna 172 object rather than a Dodge Caravan, the view direction (looking up), and its computation of effective turbulence. This metric is for informational purposes only and the FAA does not provide guidance for it.
- "Two-Point Lateral Discrimination" refers to the angle between two laterally separated points on a distant portion of the airport surface. The purpose of the Two-Point Lateral Discrimination metric is to ensure the tower position provides controllers with a view to distinguish between operations at critical points of the airport surface. A higher Two-Point Lateral Discrimination angle is preferred. For conventional towers, the toolkit evaluates whether the tower meets the FAA Order 6480.4 guidance of a 0.13 degrees minimum. Two-Point Lateral Discrimination is calculated using the following formula:

$$cos^{-1}\left(\frac{A^2 + B^2 - C^2}{2 * A * B}\right)$$

Upon selection of a tower and at least one metric, the "Next: Enter Inputs" button along the page's footer section becomes enabled and clickable. You can proceed to the next step of the tool kit by clicking this button.



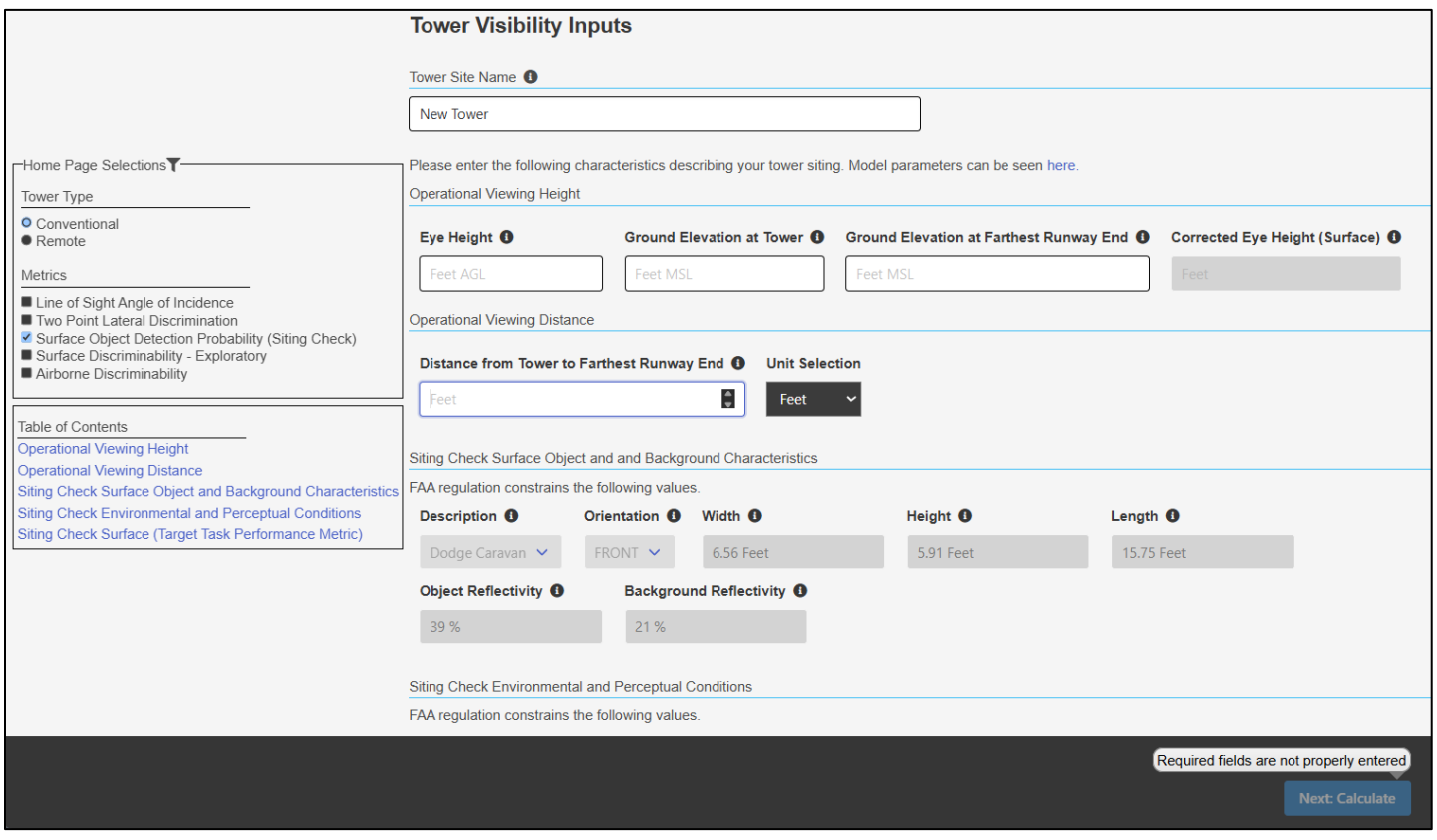
If at any point you want to return to this home page, clicking the "Tower Visibility Toolkit" title in the header will redirect you back to this page.



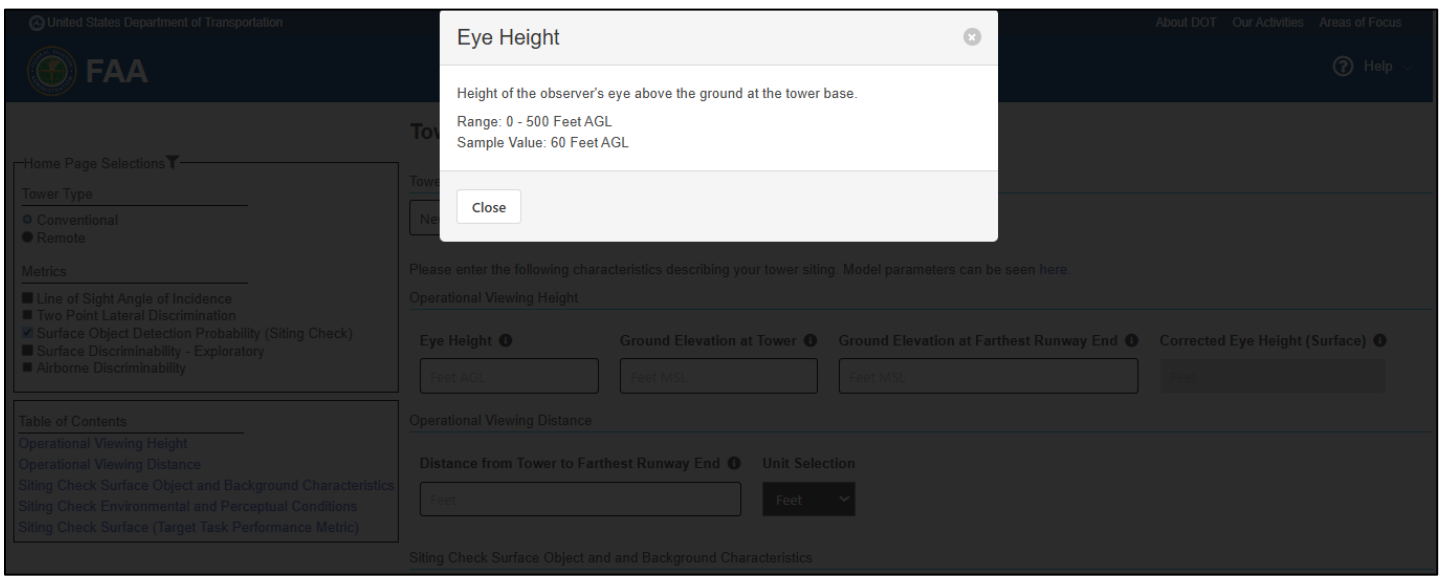
3 Entering Inputs

3.1 Tower Visibility Inputs

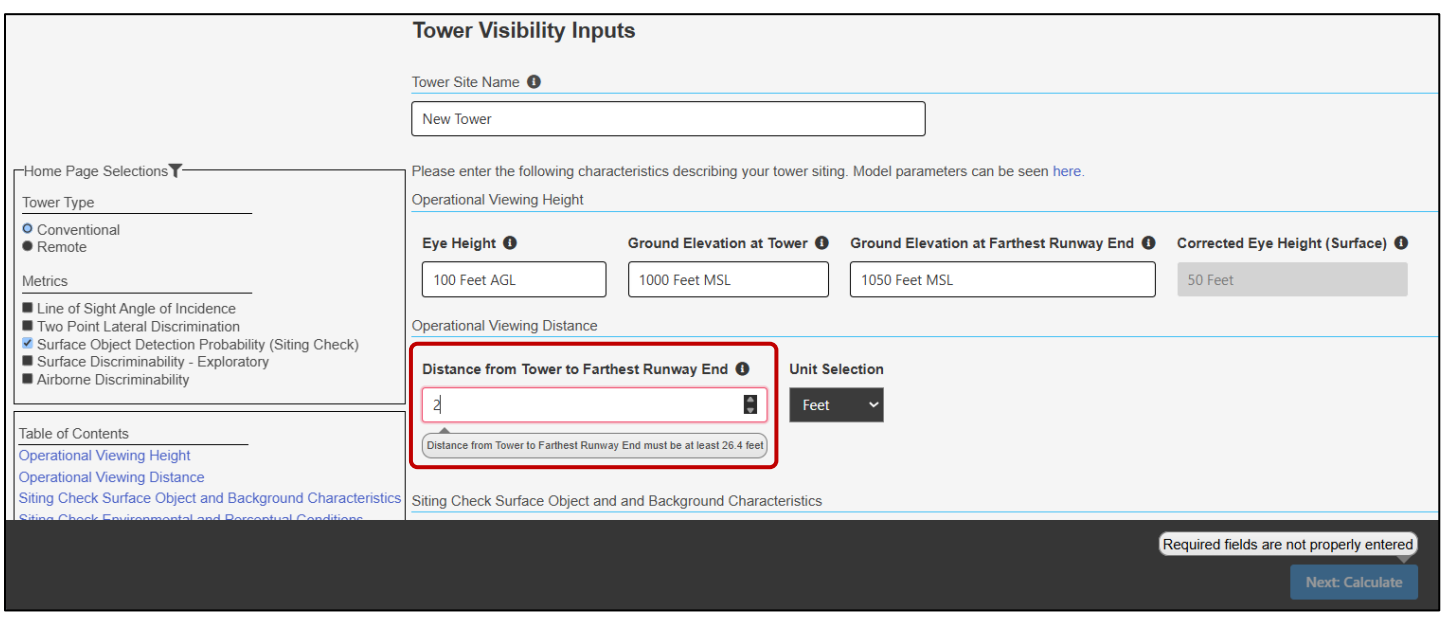
The toolkit's displayed inputs depend on the metrics selected. Input formats include both fields for numerical values and drop-down menus for categorical values. The inputs default to whole numbers, but decimal places can be added if desired. If you choose the Surface Object Detection Probability (Siting Check) metrics, values constrained by FAA guidance are disabled.



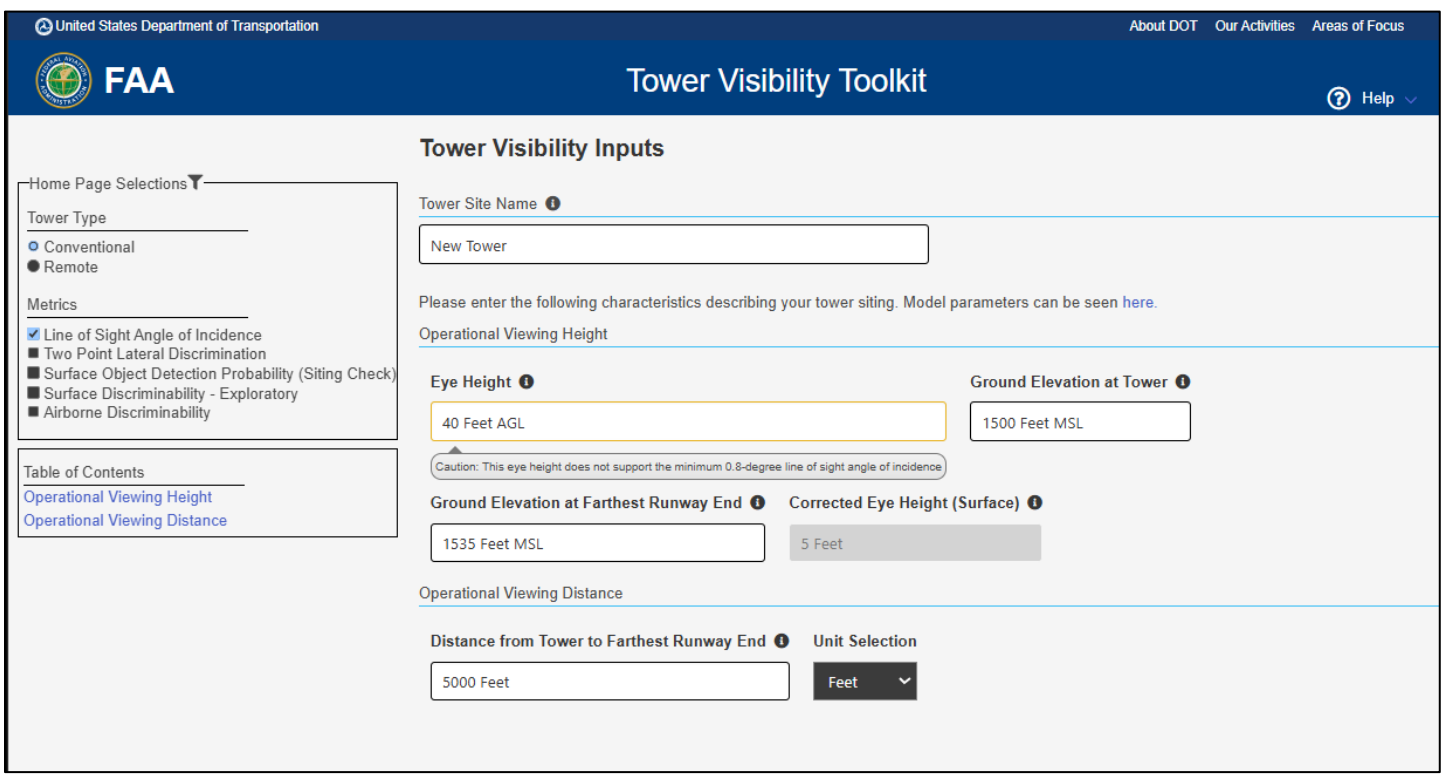
Each input field has an information icon near the field. Upon clicking the icon, a pop-up will appear that contains a description of the input field, a range of acceptable values, and a sample input value.



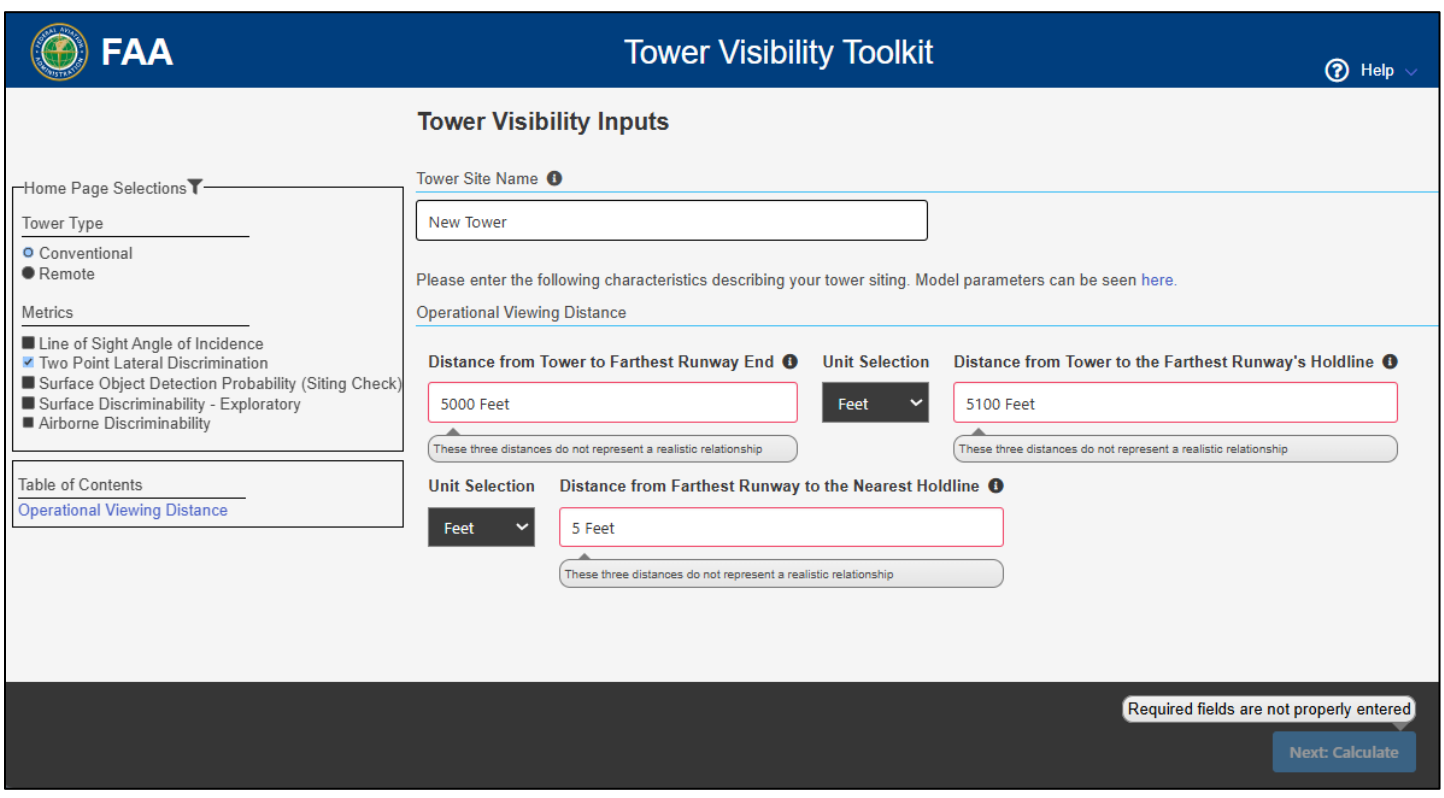
Entering a value outside the range of acceptable values causes the toolkit to highlight the input with an error message and prevents you from advancing.



When calculating the Line of Sight Angle of Incidence metric, a cautionary note will appear if the entered values do not support the minimum value of 0.8 degrees. The toolkit will allow you to proceed with calculating this metric even if the value is below 0.8 degrees.

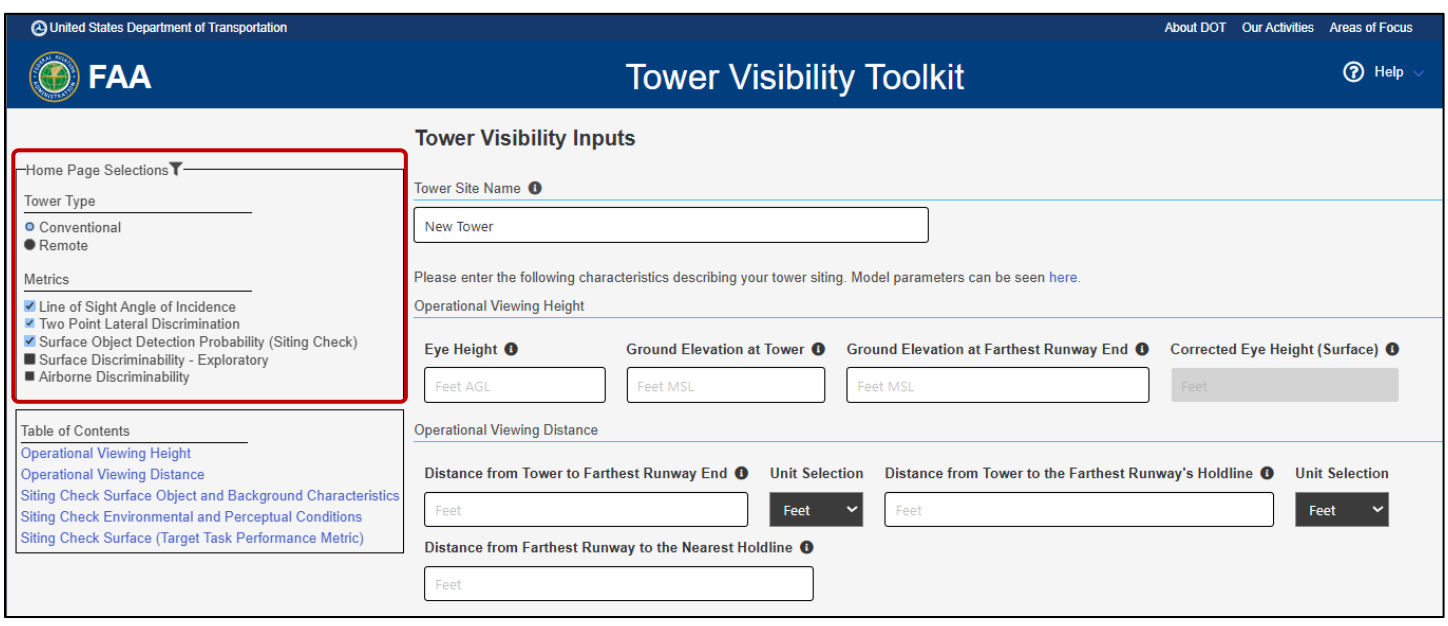


When calculating the Two-Point Lateral Discrimination metric, entering values inconsistent with airport layouts will highlight the input with an error message and prevent you from advancing.

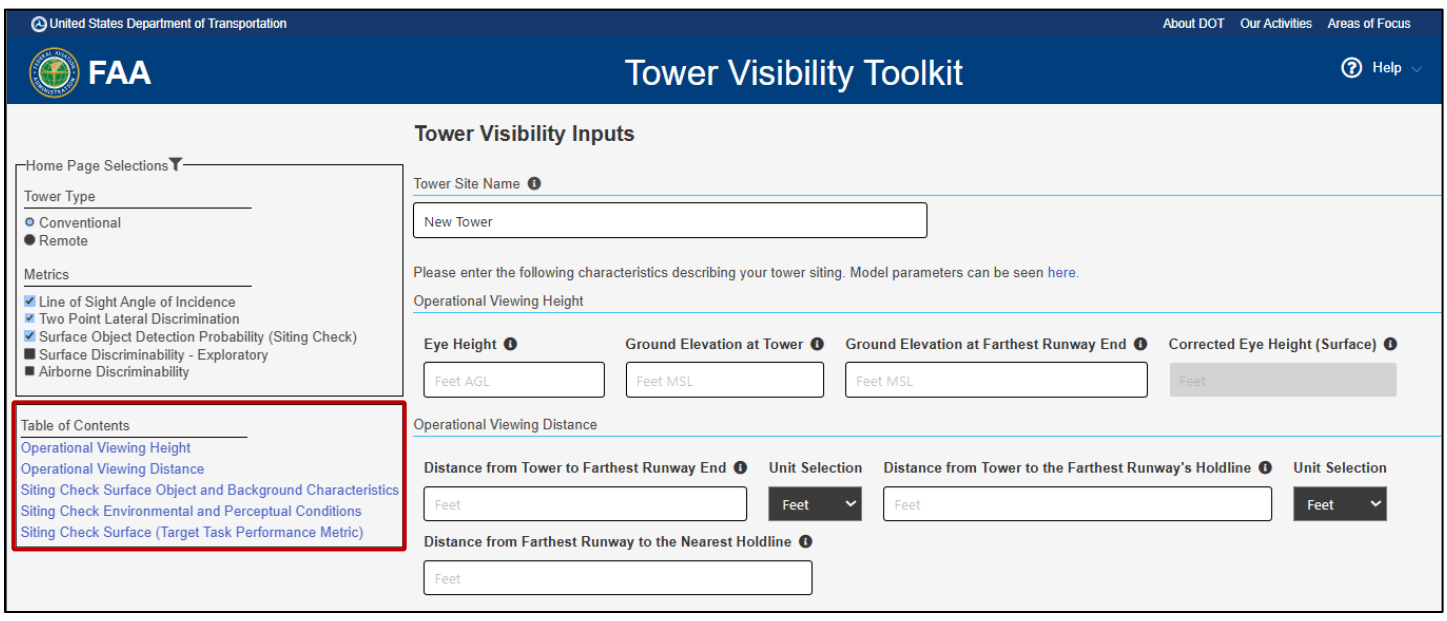


3.2 Home Page Selections

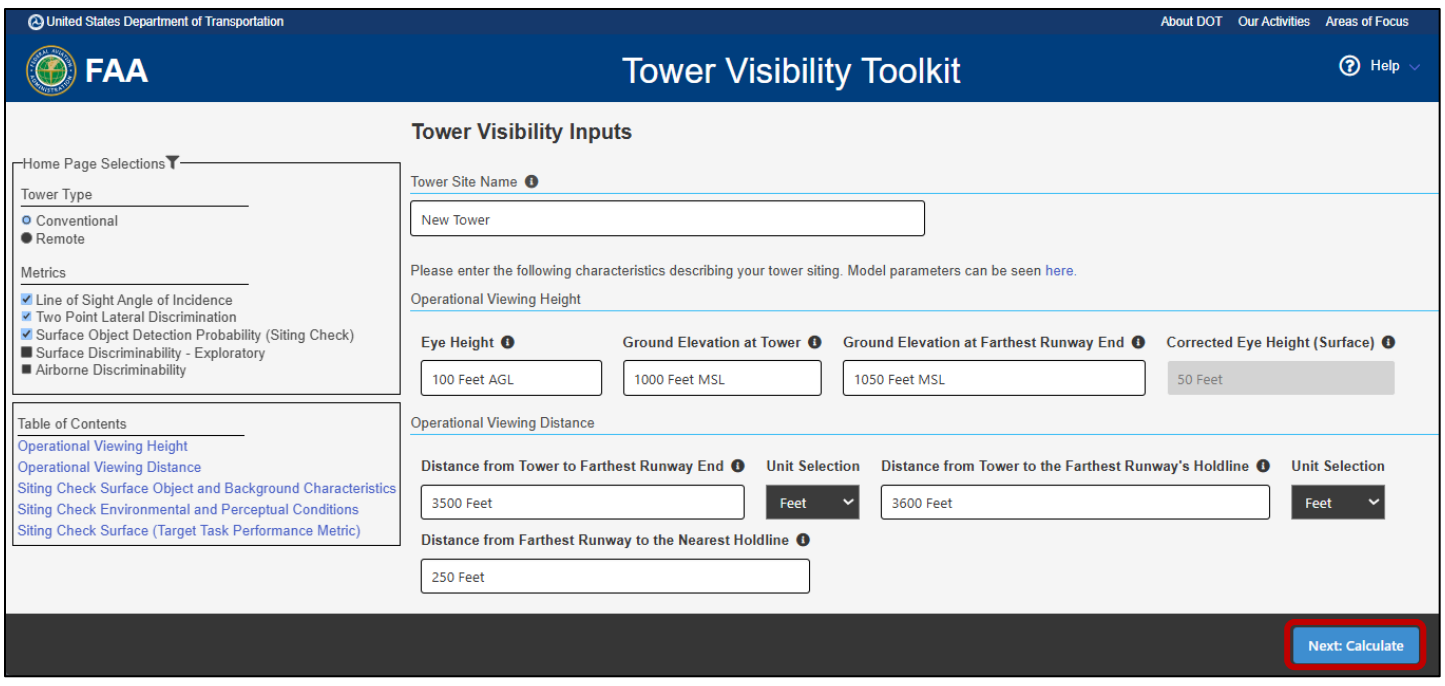
On the left-hand side of the inputs page, you can view your home page selections (Tower Type and Metrics). You can change the home page selections from this menu, and the input fields will change accordingly.



A table of contents also exists for input section navigation. Clicking on links in the table of contents will take you to the relevant section of the inputs page. The table of contents updates if home page selections change.



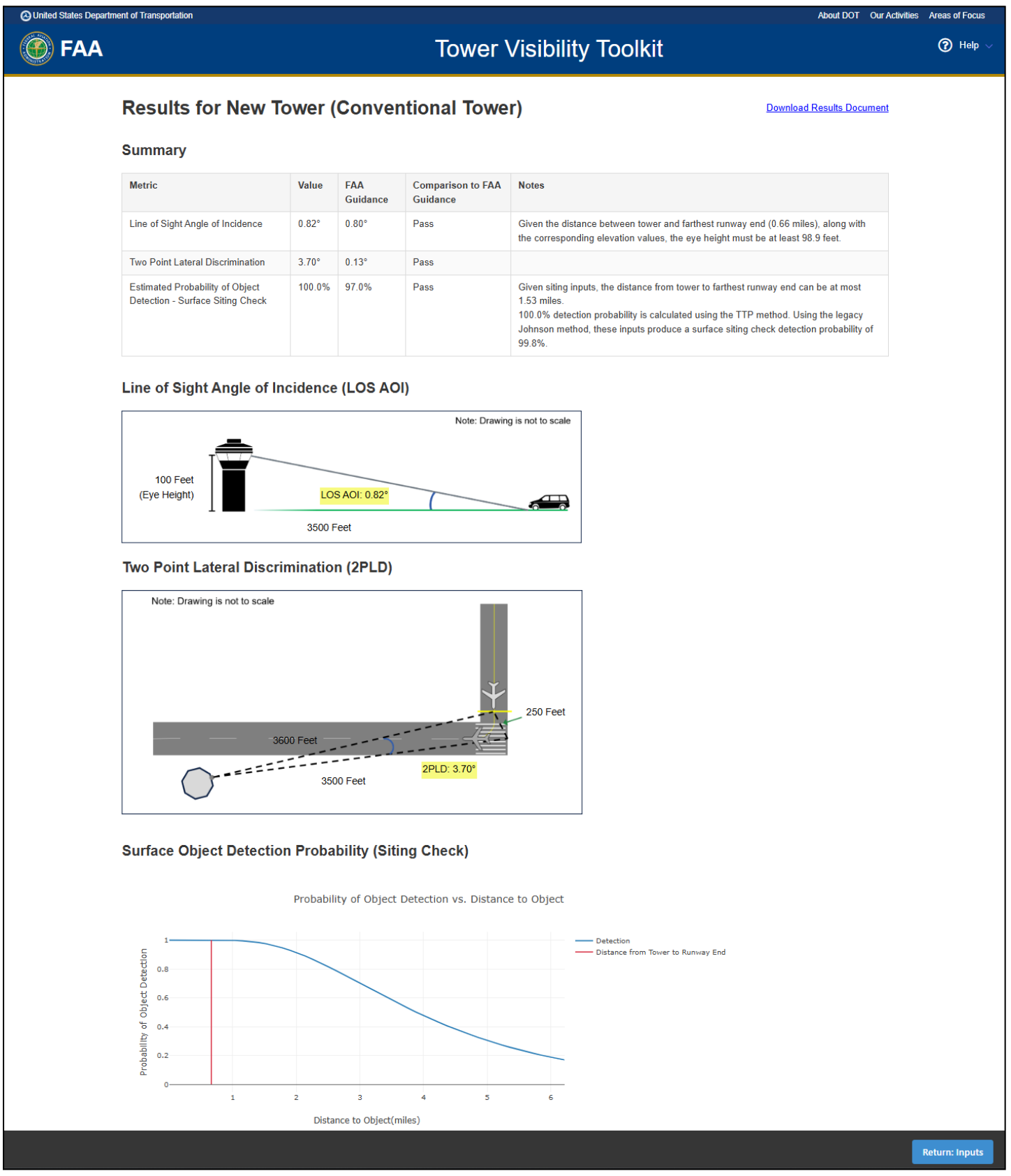
Once you have provided valid values for all the required input fields, the "Next: Calculate" button along the page's footer section becomes enabled and clickable. You can proceed to the next page of the toolkit by clicking this button.



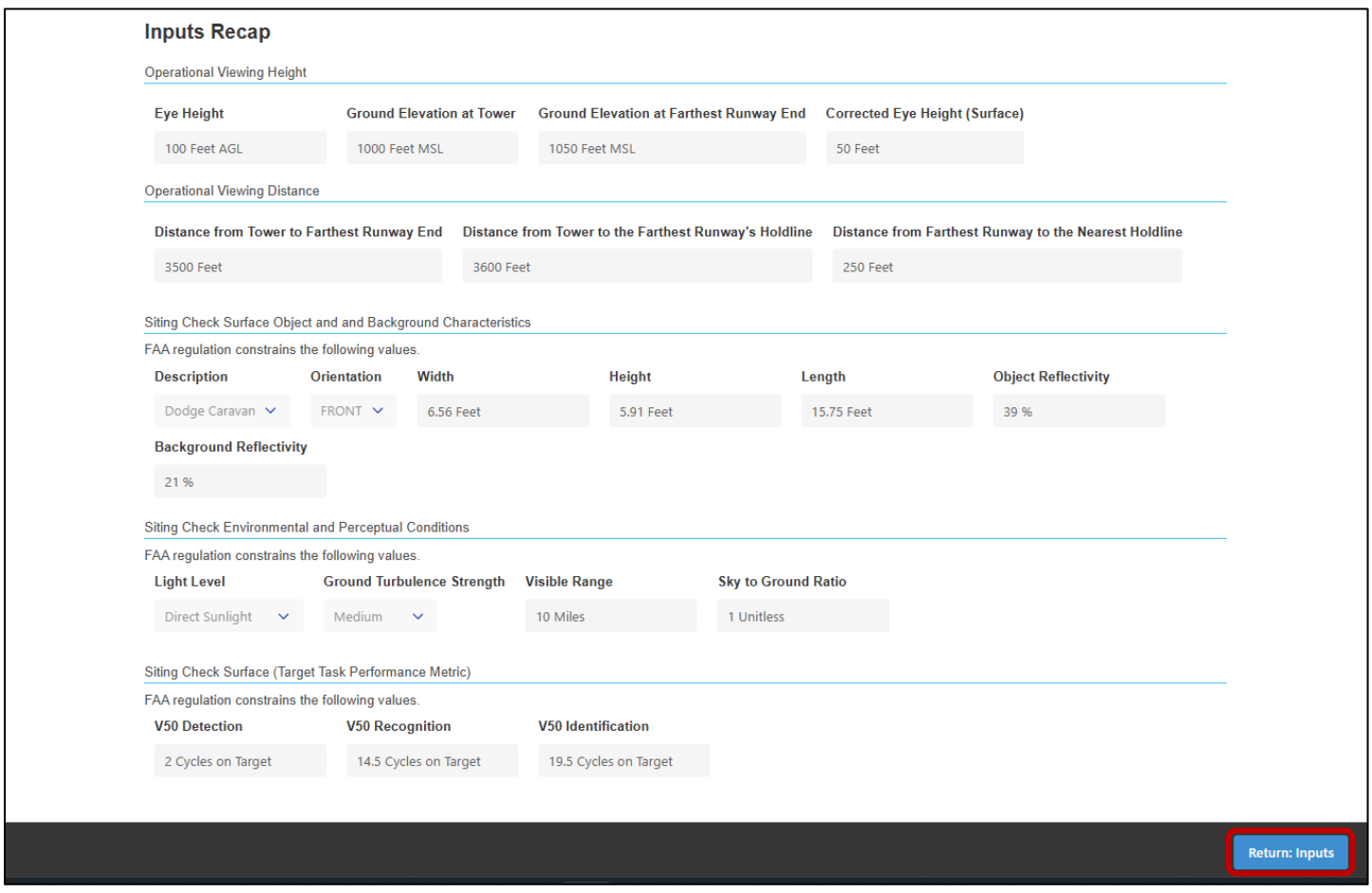
4 Viewing Results

The results page begins with a table of visibility metric values and related information. When applicable, the toolkit compares the metric values to FAA guidance. The toolkit also provides additional notes to help you interpret the results. You can download all the results to a Portable Document Format (PDF) file by clicking the "Download Results Document" link next to the "Results for…" header.

If Line of Sight Angle of Incidence or Two-Point Lateral Discrimination metrics are chosen, the toolkit also shows a diagram of the spatial relationships with the key input values and the resulting metric value. If surface or airborne discriminability metrics are chosen, the toolkit also shows interactive plots of probability values by distance. The interactive plots provide exact values when you hover over the lines with your mouse.

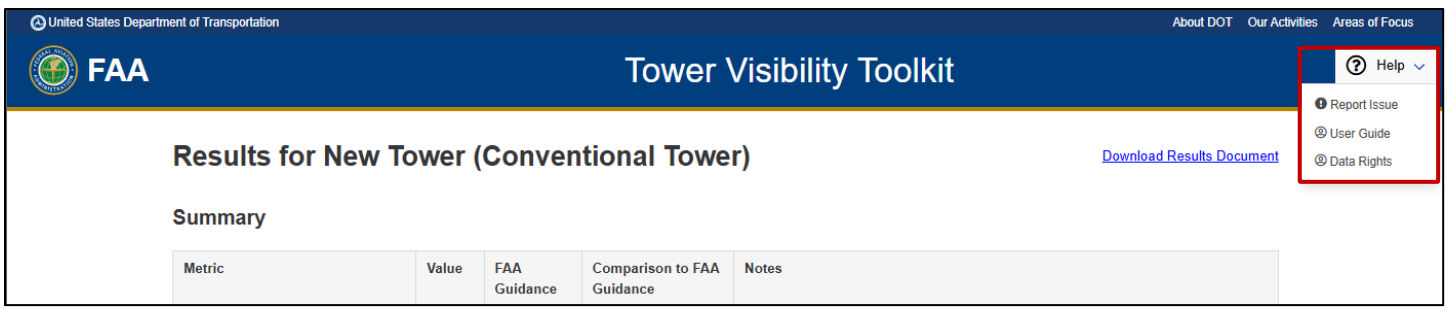


Below the summary table and plots are all the inputs that you entered to produce the results. If you wish to change what values are used, you can press the “Return: Inputs” button along the page’s footer to return to the inputs page and change their values or the tower type and metric selections.



5 Help Menu

The top right of the page in the header provides access to a “Help” menu. The “Report Issue” option generates a feedback email you can use to report issues with the toolkit. The “User Guide” option opens this user guide. The “Data Rights” option describes copyright and contract information for the toolkit.



6 User Guide References

[1] The Federal Aviation Administration, "FAA Order 6480.4B: Airport Traffic Control Tower Siting Process," 2021.

[2] The Federal Aviation Administration, "FAA Order 6480.4C: Siting of Airport Traffic Control Towers," 2024.

[3] R. Vollmerhausen and E. Jacobs, "The Targeting Task Performance (TTP) Metric: A New Model for Predicting Target Acquisition Performance," U.S. Army CERDEC, Fort Belvoir, VA 22060, 2004.

[4] E. Boettcher, T. Maurer, S. Murrill and B. Miller, "Experimental Determination of Visibility Modeling Parameters for Aircraft," in Society of Photo-Optical Instrumentation Engineers: Defense, Security, and Sensing, Orlando, FL, 2010.