3D BLAST

VERSION 3.5

USER GUIDE

July 2020

Contents

1. INTRODUCTION

3D-Blast is a computer program that provides quick calculation and visualization of the effects of an open-air explosion on a variety of building shapes. Given the dimensions of the building and the size and location of an explosive charge, the program will estimate the pressure and impulse distribution on the building and map them as contours on a 3D representation of the structure. After an analysis is complete, the program contains an automated report writer, which can prepare a concise technical report highlighting the results.

3D-Blast uses a special purpose software program that estimates the path the shock wave will follow from an explosion to a grid of points on the building. The range to each of these nodes on the 3D model is determined using the shortest path around the exterior of the facility. The software then uses an airblast driver to determine the appropriate pressure and impulse magnitudes for the range and orientation of each element. A non-cased, hemispherical detonation is assumed. The airblast equations documented in the U.S. Department of Energy's "A Manual for the Prediction of Blast and Fragment Loading on Structures", DOE/TIC 11268 (1992) is the basis for the loading algorithms.

The program provides a simple, quick approximation of the 3D engulfment of a structure. A significant feature of this program is the ability to manipulate the building dimensions and explosive location by clicking and dragging the building dimensions or target with the computer mouse. Once the 3D model is built, the user may rotate the structure, zoom in for detail and zoom out for perspective. These features allow the user to approximate parameters and quickly experiment with various options while visualizing their effects on the structure. The program currently contains nine building footprints for analysis: a Box, an L-Shape, a T-Shape, an S-Shape, a Z-Shape, a U-Shape, an O-Shape, an E-Shape, and an H-Shape.

3D-Blast provides two different forms of output:

- Full color 3D engulfment models

- A report detailing the technical parameters and results including 3D engulfment models

This User Guide contains an index of Toolbar Features and provides guidance for screen input.

2. PROGRAM OVERVIEW

The main program screen of **3D Blast** is divided into several functional elements. The major program elements include the Program Menus, the Main Toolbar, the Model Control Area, 2D Building Footprint, and the 3D Model Screen as illustrated in Figure 2.1.
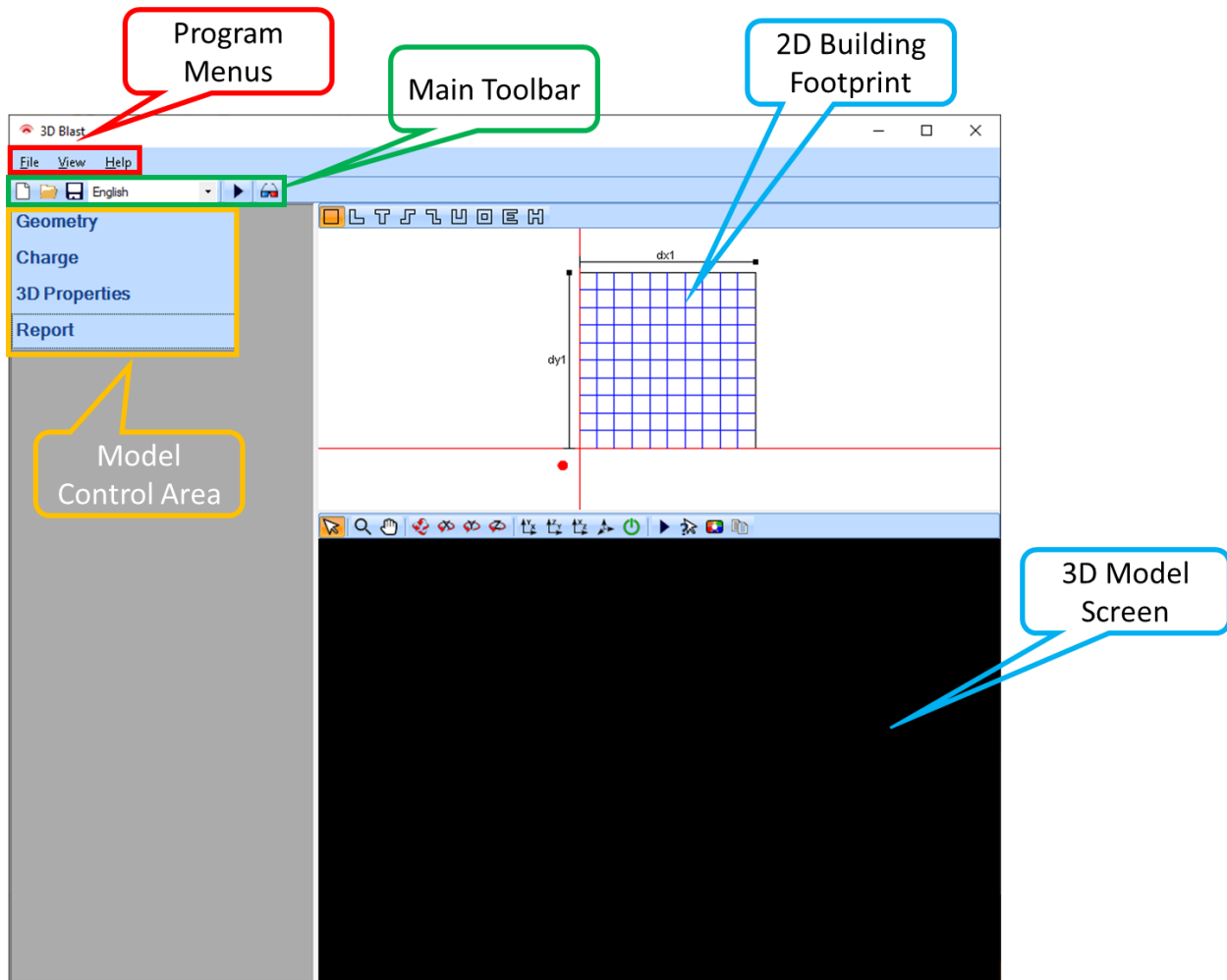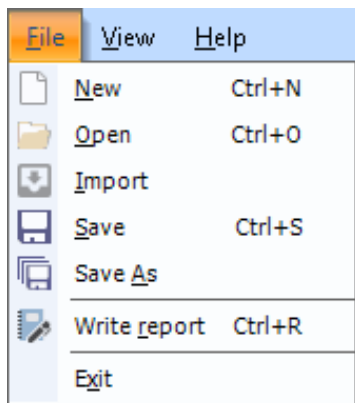

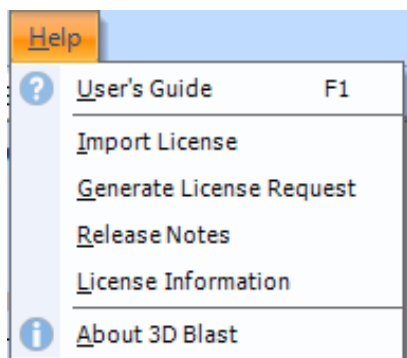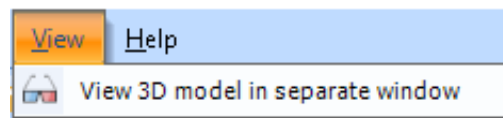Figure 2.1. Opening screen for **3D Blast 3.5**.

2.1. PROGRAM MENUS

Three Program Menus are available: the File Menu, the View Menu, and the Help Menu.

The **File Menu** has standard windows file operations (New, Open, Save, Save As, Exit), as well as an option to write a 3D Blast Report.

The ***View Menu*** provides an option to view the 3D model output in a separate window.

The **Help Menu** provides access to this User Guide, Import License, Generate License Request, the Release Notes, Software License Information, and the About Screen.

2.2. MAIN TOOLBAR
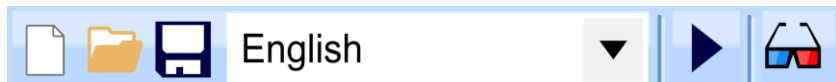
The Main Toolbar provides an alternative method to accomplish most items in the Program Menus. The program utilizes a variety of icons to simplify common tasks and allow quick access to the various libraries.

New File

Click this icon to start a "new" project.

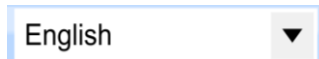**Open File**

Click this icon to open previously saved files.

Save File

Click this icon to save your file.

Display Units

This drop-down box allows the user to select which unit system to use.

Run Analysis

Click this icon to run the analysis for the current set of inputs.

3D View

Click this icon to view the 3D model results in a separate stand-alone window.

2.3. 2D Footprint Toolbar and Area

Typically, the user starts by selecting a building footprint from the 2D footprint toolbar. Select one of the nine shapes on the 2D Toolbar and the program will plot the building footprint selected on the upper portion of the screen. For more complex shapes, footprints consist of a series of rectangles. The user may change the dimensions by changing the line segments on the x and y-axis. The building footprint may be resized by clicking and dragging endpoints of the segment to the correct size or by entering the correct dimensions in the table under **Geometry** in the **Model Control Area**. After making changes, the model will need to be run to update any output results.
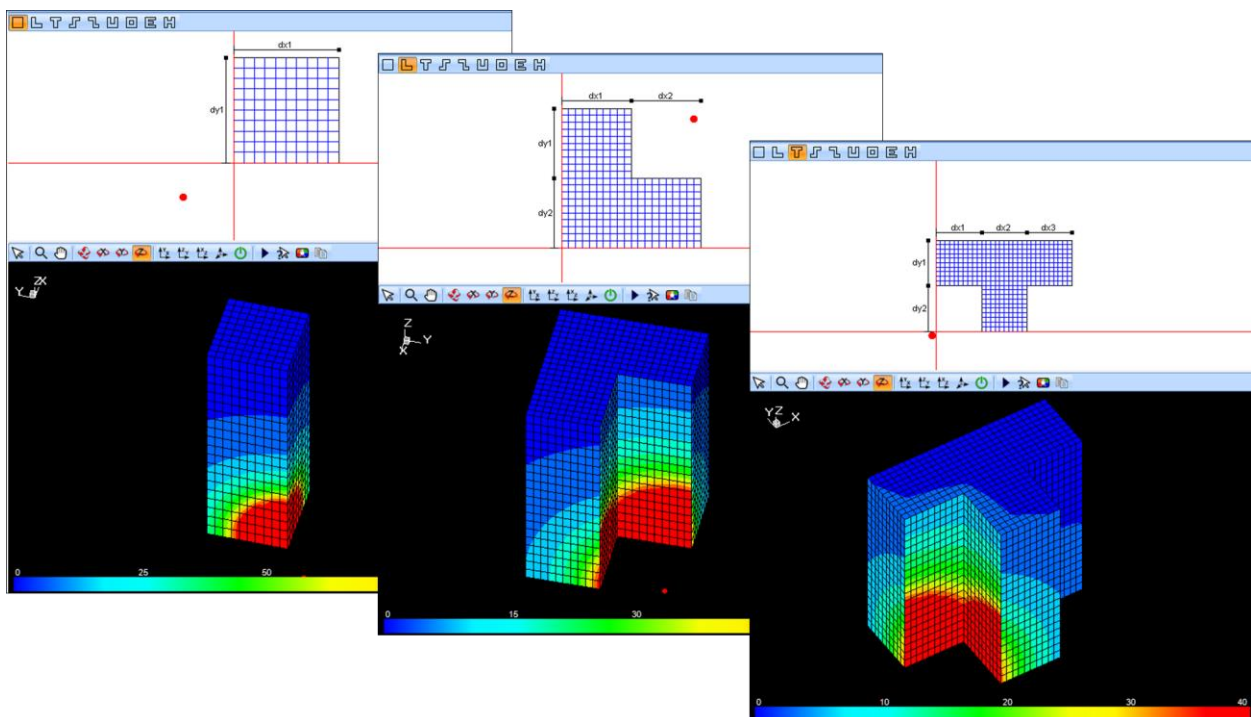
The Box, L-Shape, and T-Shape Building Footprints
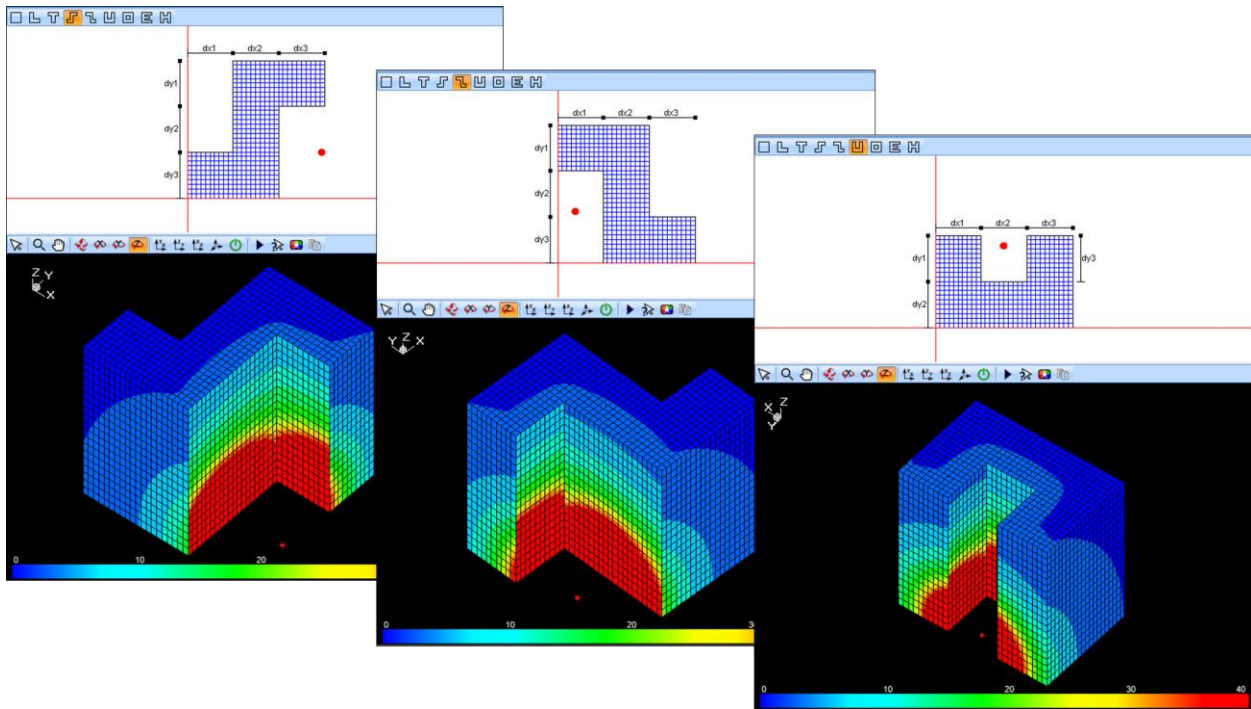
S-Shape, Z-Shape, and U-Shape Building Footprints
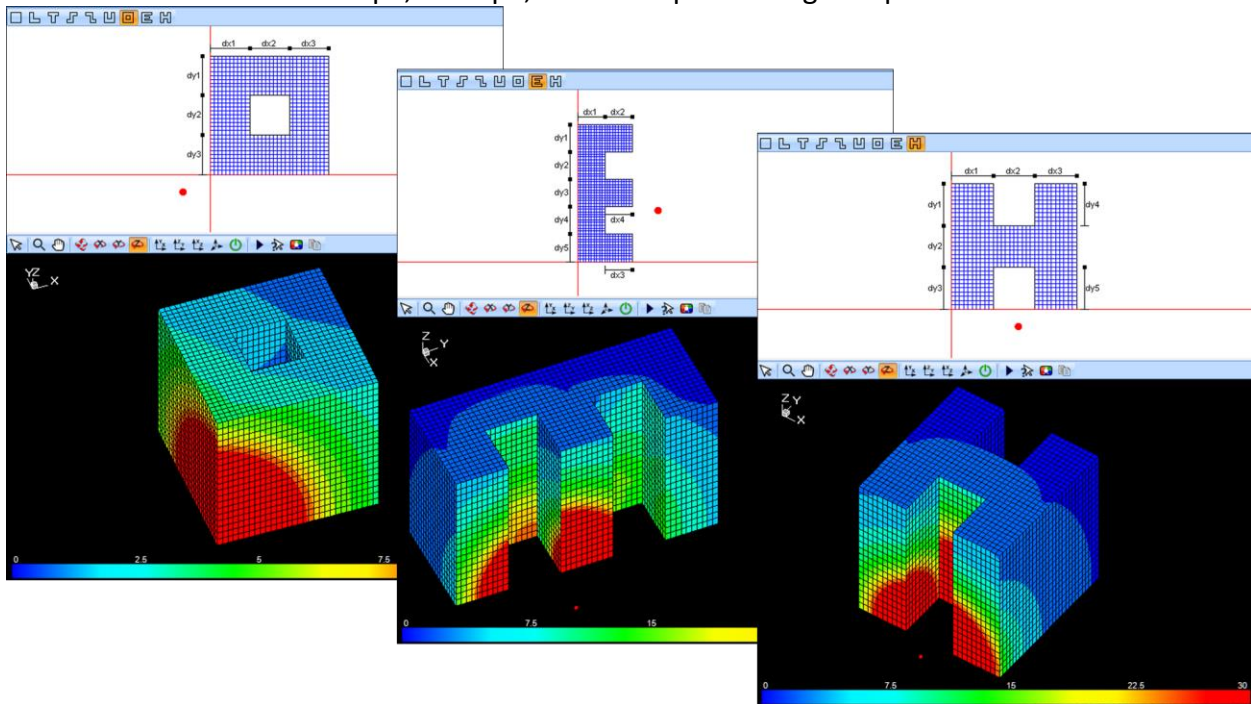
O-Shape, E-Shape, and H-Shape Building Footprints

2.4. MODEL CONTROL AREA

The **Model Control Area** allows the user to define model parameters for the building **Geometry**, the explosive **Charge**, **3D Properties** for the 3-dimensional view of the analyzed building model, and settings for generating a **Report**. All units in this area will be based on the user selection in the main toolbar. Changing this selection will change the display units and convert all values to the corresponding unit system.

2.4.1. GEOMETRY

Setting Dimensions in Geometry

In this section, enter specific dimensions for length, width and height in the dx, dy and dz fields. More complex shapes consist of a series of rectangles where the user must define segments on the x and y-axes. For these shapes, additional X and Y fields will be available for entering dimensions. After entering dimensions, press enter or Tab on the computer keyboard to redraw the 2D building footprint. Dimensions may also be changed by clicking and dragging an endpoint of the x or y-axis segment next to the footprint. As you drag an endpoint, the values for the X or Y-axis will be updated.

Number of Elements and Footprint Scale

Each footprint is divided into elements along the X, Y and Z-axes. When you Run the Analysis and transform the footprint into a 3D Model, the number of elements will be displayed on the model. More elements result in a finer mesh and higher resolution.

The Footprint Scale defines the maximum and minimum values on the footprint display axes for the **2D Footprint Area**. If the building has large dimensions, the scale must have large X and Y values. Autoscale provides the scale that best displays the building shape in the viewing area.
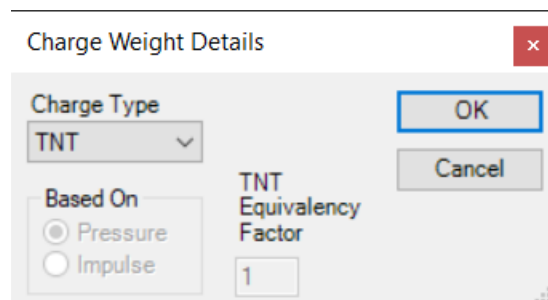
2.4.2. CHARGE

Charge Location

The charge is the explosive device, which is positioned around the building. The coordinates can be entered in the input boxes or can be approximated by clicking and dragging the red circle (explosive charge) around the footprint. If you enter new dimensions and drag the explosive charge (red circle) to a new location around the building footprint, the **2D Footprint View** updates automatically.

Charge Size (Weight and TNT Equivalency)

Specify the appropriate charge weight. By default, the program assumes the explosive charge is TNT equivalent. If an alternate explosive material is needed, click on the TNT Eq. field to bring the up Charge Weight Details form, shown below. Available charge types include TNT, ANFO, C4, or User Defined. If ANFO or C4 is selected, the program converts them into equivalent pounds of TNT based on either pressure or impulse equivalency (as specified by the user). Alternatively, a user-defined explosive may be selected and the user must then define the TNT equivalency factor.

A TNT equivalency factor of 0.5 would mean the charge would be half as energetic as the same weight of TNT explosive. A factor of 2.0 would mean the charge would be twice as energetic as the same weight of TNT. ANFO is 82% as energetic as TNT in terms of both pressure and impulse. C4 is 1.37 times more energetic than TNT when comparing pressure and 1.19 times more energetic when comparing impulse. That means the peak blast pressure of 100 pounds or kilograms of C4 would be the same as that produced by 137 pounds or kilograms of TNT at the same standoff distance. The peak impulse of 100 pounds or kilograms of C4 would be the same as that produced by 119 pounds of TNT.

2.4.3. 3D PROPERTIES

After defining the building footprint, dimensions, and charge properties, the model can be run by clicking the run analysis button in the Main Toolbar, the 3D View Toolbar, or by pressing the F5 key. After running the analysis, the 3D model will be displayed in the 3D model view and the 3D Properties can be adjusted to determine what data will be displayed on the model as well as the range of values to display.

Scalar Variable

Select one of four analysis options for viewing the blast effects on the 3D model. The four options are Pressure (peak positive phase blast pressure from the charge), Impulse (positive phase impulse from the charge), Range (distance to the charge), and Angle (orientation of the loaded element to the charge based on the angle between the element normal vector and the vector to the charge location).

Scalar Range and Legend

The scalar data can be plotted based on the minimum and maximum data values (From Data) or based on user defined minimum and maximum values (User Defined). The model contours and legend will be updated accordingly after making updates.

The legend below the 3D Model defaults to five ticks or intervals. Change the number in the Legend Ticks field to alter the unit division for the legend. The units in the legend are determined by the scalar variable selected.

2.4.4. REPORT

The report section provides inputs for generating a report for the analyzed model. The user must provide a Title and Footer for the report as well as select the 3D plots to include in the report. Author information can also be provided. If a Logo is selected, it will be placed on the cover of the report. A summary file can be selected in MS Word *.docx format and will be added at the beginning of the report. The user may also provide discussion and conclusions by checking each option and clicking the input field to enter plain text into the resulting form. The discussion and conclusions will be inserted at the end of the report. Once all information is provided, the report can be generated by selecting Write Report from the File Menu or by pressing Ctrl+R.

2.5. 3D VIEW AREA

The 3D View Area provides a number of tools for interacting with the 3D model in a 3D View Toolbar, shown below. A description of each tool and option follows.

Basic Cursor

This is the basic cursor and does not interact directly with the 3D model. However, regardless of which tool is selected, the view can be zoomed in and out with the scroll wheel on the mouse and the view can be panned by clicking and dragging with the right mouse button.

Zoom

When this tool is selected, the user may click on the screen and drag down to zoom out or drag up to zoom in. The mouse scroll wheel may also be used to zoom in (scroll up) or out (scroll down).

Pan

When this tool is selected, clicking and dragging with the left mouse button will pan the model on the screen relative to the movement of the mouse. This operation may also be performed at any time or regardless of the tool selected by using the right mouse button.

Rotate

When the rotate tool is selected, clicking and dragging with the left mouse will freely rotate the model in any direction. Dragging up and down will rotate about the current vertical axis. Dragging right and left will rotate about the current horizontal axis.

Rotate about X

When this tool is selected, clicking and dragging up and down will rotate the model about the X-axis.

Rotate about Y

When this tool is selected, clicking and dragging left or right will rotate the model about the Y-axis.

Rotate about Z

When this tool is selected, clicking and dragging left or right will rotate the model about the Z-axis.

View XY Plane

Clicking this button will orient the model to be viewed in the X-Y plane.

View YZ Plane

Clicking this button will orient the model to be viewed in the Y-Z plane.

View ZX Plane

Clicking this button will orient the model to be viewed in the Z-X plane.

Diametric View

Clicking this button will orient the model in a diametric view, with the Z-axis up and split evenly between the X and Y-axis.

Reset View

Clicking this button will reset the view to the default orientation (Y-Z plane) and zoom level.

Run Analysis

Clicking this button will run the analysis based on the current geometry and charge settings.

Query Results

Clicking on the model with this tool selected will display a table of the scalar values from the model. The four nodes of the element selected on the 3D model will be highlighted in blue in the table.

x (ft)	y (ft)	z (ft)	pressure (psi)	impulse (psi-msec)	range (ft)	angle (deg)
50.0	25.0	67.5	9.04	78.89	103.02	90.00
50.0	30.0	67.5	8.43	76.39	106.88	90.00
50.0	30.0	75.0	7.78	73.51	111.66	90.00
50.0	25.0	75.0	8.30	75.82	107.80	90.00

Choose Background Color

Clicking this button will allow the user to select a background color for the 3D View Area. The default color is black.

Copy 3D View to Clipboard

Clicking this button will copy the current 3D View as a bitmap image to the Windows Clipboard.