WINGARD PE

VERSION 6.2

USER GUIDE

March 2020

Contents

1. INTRODUCTION

WIINdow Glazing Analysis Response and Design (WINGARD) was developed for the General Services Administration by Applied Research Associates (ARA). The goal was to develop a simple but accurate mode of the response of windows to the effects of an explosion. The program, which has become the national standard for analysis of glazing for blast loadings, calculates and graphically displays the response of window systems subjected to blast loads. ***WINGARD*** is an analysis tool that accepts user input of window system properties and explosion characteristics, and then calculates the performance of the window system when subjected to defined blast loads. The ***WINGARD*** software is available in two versions: ***WINGARD LE (Limited Edition)*** and ***WINGARD PE (Professional Edition).***

WINGARD LE is distributed as a less sensitive, more public version of the program and is capable of determining the response of a range of glazing types subjected to a pressure and impulse loading combination. ***WINGARD LE*** will analyze both single and double pane windows; however, complex stacked plate lay-up assemblies cannot be created.

WINGARD PE is a much more powerful version of the software and is limited to government employees and contractors working on related government projects. The program contains many useful features for engineers and security specialists. It is a convenient tool to explore alternative window layups to determine if they meet required performance levels such as those specified in the GSA and ISC Security Criteria. ***WINGARD PE*** can provide an estimated response for a single loading, evaluate capacity for a target performance condition index, or develop Pressure-Impulse curves for the system. Results are displayed in a variety of formats: a short text summary, graphs of key parameters (including load, resistance, displacement, and fragment flight, support reactions) and a brief report with results and graphs.

The most recent version of ***WINGARD PE,*** Version 6.2 incorporates advanced models for analysis of thick laminate into the interface previously developed for Version 5.0 and adds SentryGlas® Xtra SG 6000 to the standard laminate library. SentryGlas® SG 5000 supersedes the SGP (Elastic) and SGP (Elastic-Plastic) laminates, which remain in the software for backwards compatibility. Improvements have also been made to the Report Writer to make use of the latest Microsoft Word formats. The updated Report Writer eliminates the need to have an installed copy of Microsoft Word or Office to accommodate the varied options of Office 365 functionality.

2. PROGRAM OVERVIEW

The main program screen of **WINGARD PE** is divided into several functional elements. The major program elements include the Program Menu, the Main Toolbar, the Analysis Control Area, the Output Control Area, and the Display Area as illustrated in Figure 2.1.
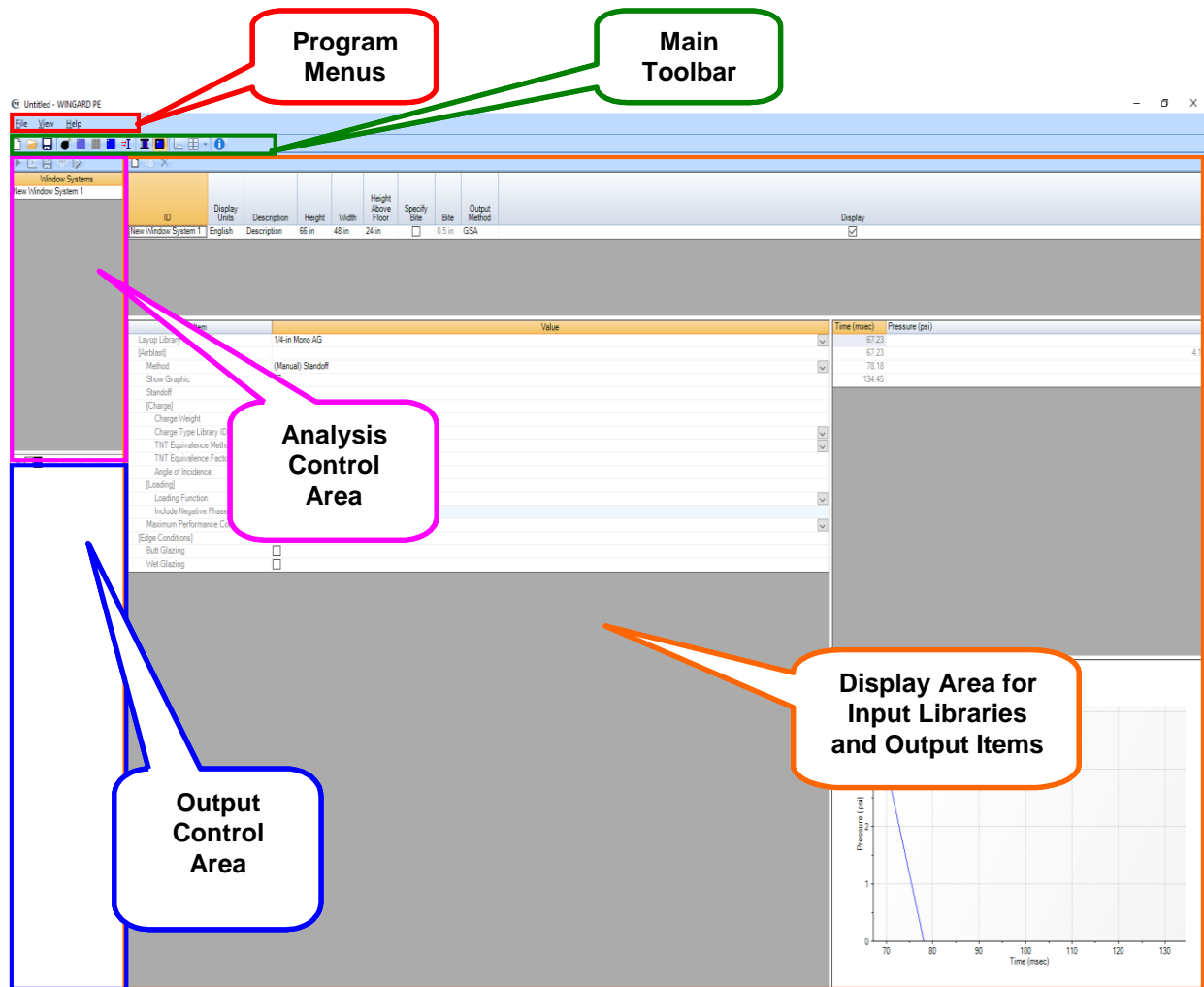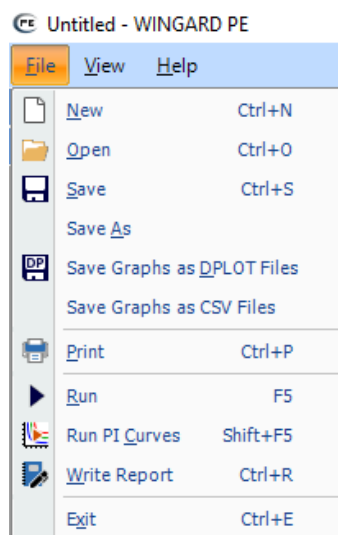

Figure 2.1. Opening screen for **WINGARD PE 6.1**.

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, Print, Exit), as well as operations unique to *WINGARD* (Save DPLOT files, Import *WINGARD 4.1* files, Run Analyses, Run P-I Curves, and Write Report).

Some File Menu options require the user to highlight one or more Window Systems in the Analysis Control Area before the options are enabled (Save DPLOT files, Print, Run Analysis, Run P-I Curves, Write Report). Disabled menu options are gray font, while available options are black font. When enabled, these options will only be applied to the Window Systems highlighted in the Analysis Control Area.

The **View Menu** is associated with the Display Area of the Main Screen. The user may choose to display one of the input libraries or to display available output. When output is being displayed, the user may also control the size of the output items. The output may be sized to fit between 1 and 20 items on the screen at a time.

The output display feature will be disabled until output items are selected in the Output Control Area.
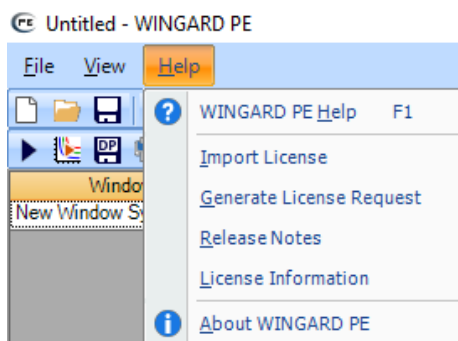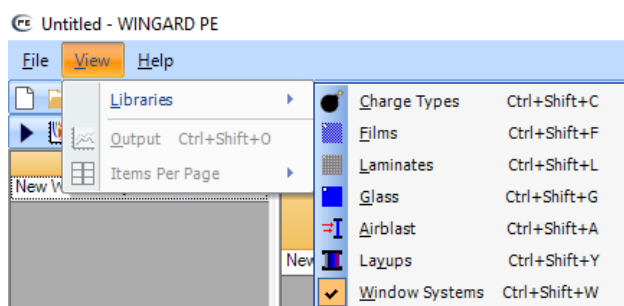
The **Help Menu** provides access to this User Guide, the Technical Manual, the Window System Assessment Guidelines, the Tutorials, the Release Notes, License Information, and the About Screen.

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. A project contains one or more **DCMS** models.

Open File

Click this icon to open previously saved files.

Save File

Click this icon to save your file.

Charge Library

Click this icon to access the Charge Library. This library is used to store and define standard explosive charge types and corresponding TNT equivalency.

Film Library

Click this icon to access the Film Library. This library is used to view and define window films for use in defining custom window layups.

Laminate Library

Click this icon to access the Laminate Library. This library is used to view and define window laminates for use in defining custom window layups.

Glass Library

Click this icon to access the Glass Library. This library is used to view and define both brittle and ductile glass materials for use in defining custom window layups.

Airblast Load Library

Click this icon to access the Airblast Load Library. This library is used to define loads linear equivalent and time-history blast loads that may be used for analysis of **WINGARD** models.

Layup Library

Click this icon to access the Layup Library. This library is used to view and define window layups from combinations of film, laminates, and glass for use in **WINGARD** models.

Output

Click this icon to open the Output View. This icon is only available if there is valid output that can be displayed.

Output Items per page

Use this icon to define the number of output items to display on the screen. Click the down arrow on the right of the icon to view and select the number of items to display. This icon is only active when output is being displayed in the Display Area.

About

Click this icon to learn more about the current version of **WINGARD***.*

2.3. ANALYSIS CONTROL AREA AND TOOLBAR

The main section in the Analysis Control Area consists of a listing of all Window Systems in the WINGARD project file. This list is always visible and allows analysis to be performed or output from any other view within the program. Each time a new Window System is created, the system name is added to a list in the Analysis Control Area. Many of **WINGARD**'s features are applied only to Window Systems selected in the analysis list. To select Window Systems from the list, use the mouse and click on the appropriate window system. The Ctrl and Shift keys can be used to select multiple Window Systems.

The Analysis Control Area also has its own toolbar containing context sensitive operations. The operations performed by this toolbar will be performed on all highlighted Window Systems.
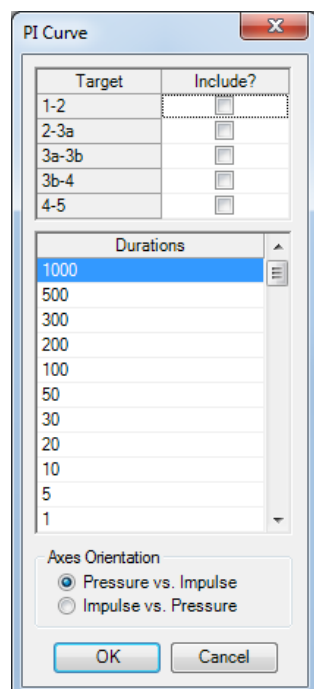
Run Analysis

Select one or more Window Systems and click this icon or press F5 to run analysis of the selected Window System(s).

Pressure-Impulse Analysis

Select one or more Window Systems and click this icon to run a P-I Curve analysis of the selected Window System(s).

A dialog box, as illustrated adjacent, will appear. Select the Target Damage States (Condition Indexes) for each PI Curve desired. If multiple targets are selected, calculations may take several minutes. Double clicking on 'Include?' will select/unselect all conditions.

Each P-I curve will plot one point for each duration shown (in milliseconds). Duration values may be revised or added prior to clicking "OK".

Select Pressure vs Impulse or Impulse vs Pressure to define output graph orientation. Click "OK" to start the PI Curve analysis or "Cancel" to close the dialog without conducting the PI Curve analysis.

D Plot

Select one or more Window Systems and click this icon to Save output graphs as DPLOT files for the selected (highlighted) Window System(s).
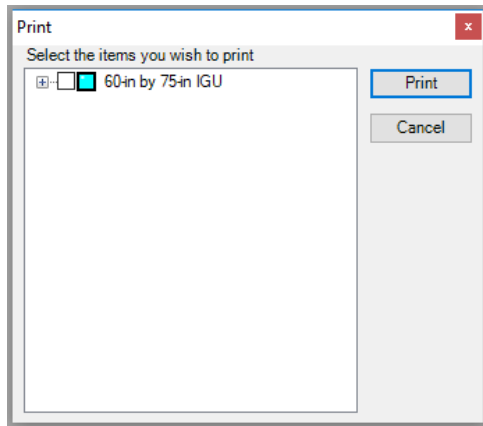
A dialog box, illustrated adjacent, will appear. Click + or – in the tree to expand/collapse the heading and view individual output items.   Right clicking on the tree provides a pop-up menu that allows the user to change the viewing option between "group by window system" and "group by output type". The user also has the option of using default file names and saving in the same folder as the main **WINGARD** file or manually defining the filename and location
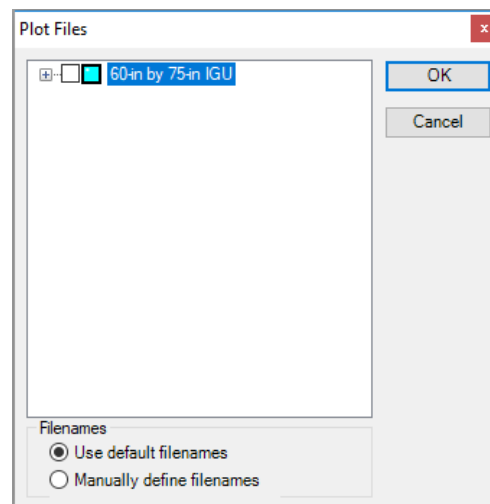
Print

Select one or more Window Systems and click this icon to Print output for the selected Window System(s).

A dialog box, illustrated adjacent, will appear. Select the output items to print for each available window system. Click + or – in the tree to expand/collapse the heading and view individual output items. Right clicking on the tree provides a pop-up menu that allows the user to change the viewing option between "group by window system" and "group by output type".

Write Report

Select one or more Window Systems and click this icon to Write a Report for the selected Window System(s).

A dialog box with three tabs will appear. After completing the fields under each tab, click the Write Report button.

General Information Tab -- Select a logo file, provide a Report Title for the cover page, select a footer from the drop-down menu and optionally insert a Summary File that will be included in the report.

Author Information Tab -- Provide details on the author which will appear on the cover page of the report. This information will be used in all reports generated until changed.

Although the program attempts to save and load the specified company logo and Author Information when the program closes, clicking the Save Info button will allow this information to be saved in a user-specified location. Clicking the Load Info button will allow the user to import saved information. The information is saved in an xml formatted WINGARD Library (*.wgl) format.

Content Tab -- Select the window systems and graphs to include in the report, using the same procedures described for displaying Output.

2.4. OUTPUT CONTROL AREA

Each time a new Window System is created, the system name is added to a tree in the Output Control Area.   Click + or – in the tree to expand/collapse the heading and view individual output items. Right clicking on the tree provides a pop-up menu that allows the user to change the viewing option between "group by window system" and "group by output type".   Right clicking on a particular Window System will also allow the user to switch between English and Metric output units for that system.
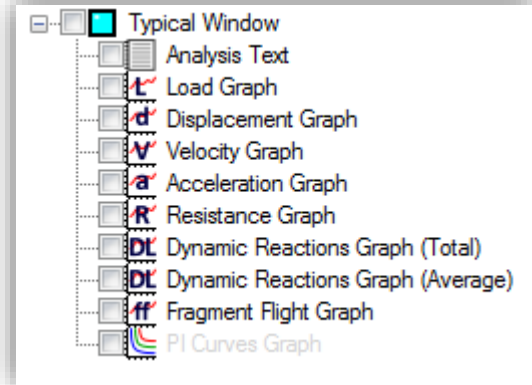
The entries in the output tree are initially disabled (grayed-out). However, once analysis for a Window System is complete, the associated text will change to black to signify that the output is available. Click the applicable check boxes in the expanded tree to select/deselect specific output items or check the main tree headings to select/deselect all associated output options.

2.4.1. OUTPUT GRAPH INTERACTION

All graphs provide standard interactivity features for zooming, panning, copying, printing, changing axis and other graph properties.

Zoom -- Left click and drag a selection box around a section of the graph to zoom in.

Copy -- Right click on a graph, select Copy and the graph will be copied to the Clipboard.

Print -- Right click on a graph and select Print.

Axis Controls -- Right click on a graph and select X-Axis or Y-Axis. The user may convert the axis to a logarithmic scale or reset the axis scale to default after zooming or scaling.

Scale Properties -- Right click on a graph and select Scale Properties. Enter plot ranges for the X and Y-Axes and the number of display intervals. Autoscale scales as appropriate to provide an overall view of the data. A logarithmic view may be selected to convert the axis to a logarithmic scale. It is not possible to plot zero on a logarithmic scale. Therefore, data containing zeros or negative data will not plot on a log scale.

Save as DPlot File – Right click on a graph and it may be saved in DPlot format.

Save as CSV File – Right click on a graph and it may be saved in Comma Separated Values (CSV), text-based format. The first row will list the labels for the data in each comma-separated column and associated units. Subsequent rows will have the data for the curves saved from the plot.

2.5. DISPLAY AREA

The Display area displays the currently selected input library or output items. For example, the input for a glazing layup input is illustrated below.
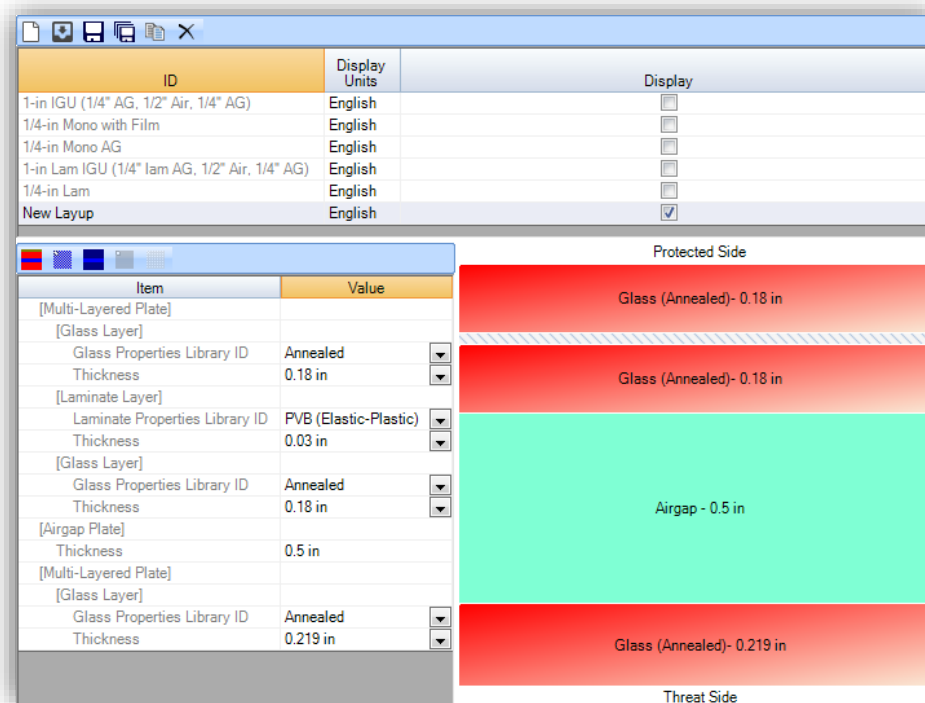
The display area containing output from a typical analysis is illustrated in the following figure.
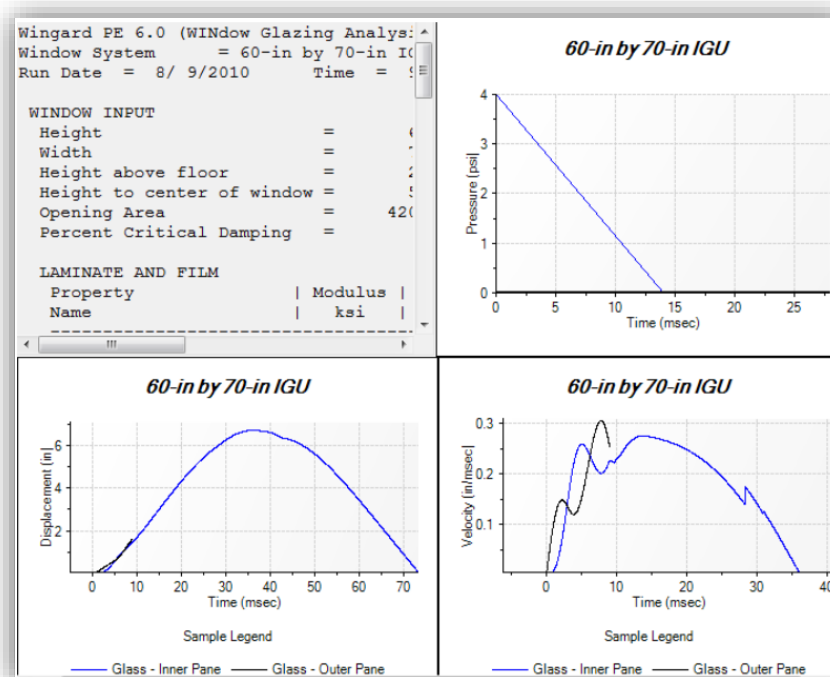
3. INPUT LIBRARIES

Six data libraries may be accessed via the Main Toolbar or the View menu. These libraries include Charge Types, Film Types, Laminate Types, Glass Types, Airblast, Lay-up, and Window System. All libraries share common features and operations. These common features include a table of library entries and a Library Toolbar. Default library entries are provided and cannot be altered or deleted. The default entries appear in grey font in the table. User defined entries will appear in black font and can be edited or deleted.

3.1. BASIC TABLE OPERATIONS

A basic feature of **WINGARD PE** is the input table. Input tables consist of a series of cells arranged to form rows and columns. Cell values may be replaced by single clicking on the appropriate cell and typing a new entry. Double click to edit the existing information in the cell.

Individual library entries appear as rows in the libraries main input table. Many of the library functions, such as copy, save, and delete, require the user to first highlight one or more library entries. Selecting any cell will highlight the entire entry. To highlight multiple entries the shift and ctrl keys may be used. To select a block or range of fields, single click the first entry in the block, then hold the shift key while selecting the final entry in the block. All entries between those selected will be highlighted. Blocks of entries may also be selected by dragging the mouse over a series of entries while holding the left mouse button. The user may also add or remove entries to the highlighted group by holding the ctrl key and selecting the appropriate entries.

There are four basic types of cells in **WINGARD**:

3.1.1. TEXT INPUT

As the name suggests, text input cells allow the user to input a text string. The string may include letter, numbers, and symbols (including spaces).

3.1.2. NUMBER INPUT

Number input cells allow the user to input numerical values. All numbers should be input in a decimal format with a period '.' as the placeholder. Exponentials may be defined by appending the 'E' or 'e' characters to the end of a number followed by the power of the exponential, e.g., 1200000 may be entered as 1.2E06.

Number input cells generally have units associated with them. The user should enter the decimal number only. Units will be automatically assigned based on the selected Display Units for the corresponding library entry.

Number input cells generally have constraints placed on their input values. Entry of a value outside the cells constraints will result in a pop-up error message with a description of the constraints.

3.1.3. SELECTION BOX

Selection Boxes consist of a check box allowing the user to turn a feature on or off by clicking on the box.

3.1.4. DROP-DOWN LISTS

Some table entries have a down arrow in the right corner of the cell. Clicking the arrow will display a list of possible entries for the associated cell. In some cells, this is the only means of defining the entry. In other cases user defined entries are also allowed.

3.2. LIBRARY TOOLBAR

Individual library entries appear as rows in the main input table. The library toolbar is used to perform operations on these entries. Many of the library functions, such as copy, save, and delete, require the user to first highlight one or more library entries. Selecting any cell will highlight the entire row. To highlight multiple entries, use the Shift and Ctrl keys. To select a block or range of fields, single-click the first entry in the block, then hold the Shift key while selecting the final entry in the block. All entries between those selected will be highlighted. Blocks of entries may also be selected by dragging the mouse over a series of entries while holding the left mouse button. The user may add or remove entries to the highlighted group by holding the Ctrl key and selecting the appropriate entries.

The Toolbar functions above are: Add, Import, Save, Append, Copy or Delete.

Add

Begin a new library entry. Library entries are created with default parameters. Select the appropriate cells to alter the default values.

Copy a Library Entry

Highlight one or more library entries then click the copy icon. The new entries will be appended at the end of the list.

Import

Load previously saved library entries.

Save

Click this icon to save selected entries to a new library file.

Append

Click this icon to append selected entries to an existing library file.

Delete a Library Entry

Highlight a library entry and click the delete icon. Default entries may not be deleted.

3.3. CHARGE TYPE LIBRARY

The Charge Type Library consists of two items: the table of library entries and the Library Toolbar. A set of default charge types and parameters appears in grey font in the table; the default charge types may not be altered or deleted. Click on the Add entry icon on the Library Toolbar to add new charge types. As new charge types are added, they are saved to the global template and will be available when the program is opened again.

3.4. FILM TYPES LIBRARY

The Laminate Type Library consists of two items: the table of library entries and the Library Toolbar. A set of default laminate types and parameters appears in grey font in the table; default laminate types may not be modified or deleted. Display Units is the only field which may be modified; click the field under the Display Units heading to change the units. Click on the Add entry icon on the Library Toolbar to add new laminate types. As new laminate types are added, they are saved to the global template and will be available when the program is opened again.

3.5. LAMINATE TYPES LIBRARY

The Laminate Type Library consists of two items: the table of library entries and the Library Toolbar. A set of default laminate types and parameters appears in grey font in the table; default laminate types may not be modified or deleted. Display Units is the only field which may be modified; click the field under the Display Units heading to change the units. Click on the Add entry icon on the Library Toolbar to add new laminate types. As new laminate types are added, they are saved to the global template and will be available when the program is opened again.

3.6. GLASS TYPES LIBRARY

Data for Glass Types are separated into tables for Brittle and Ductile materials. Each table contains input parameters relevant to the selected type of glass. Default glass types and parameters appear in grey font. The default glass types may not be altered or deleted. Two fields which may be modified in the default entries are the Display Units and Display Color. Click the field under each heading to change the unit or color. The display color is used to represent the glass type in the glazing lay-up display. Click on the Add entry icon on the Library Toolbar to add new glass types. As new glass types are added, they are saved to the global template and will be available when the program is opened again.

3.7. AIRBLAST LIBRARY

The airblast library contains two default entries:

> 4   psi / 28 psi-msec (ISC Medium)
>
> 10 psi / 89 psi-msec (ISC High)

Default airblast types may not be altered or deleted.

Two types of user defined entries may be added:

> Linear Equivalent
>
> Time-Pressure History

Click on the down arrow next to the add entry icon ⬚ on the Library Toolbar to choose between these two entry options. New airblast types will not be saved to the global template, but will be saved with the problem data when the program is closed. Additional information becomes available in the lower section of the Display Area once the selection box in the 'Display' field is checked and includes a table of pressure-time pairs and a graph of the loading function.

3.7.1. LINEAR EQUIVALENT ENTRY

A linear equivalent entry will require the 'Peak Pressure' and 'Load Duration' Fields to be completed in the table of library entries. The pressure-time history table cannot be otherwise edited for a linear equivalent airblast library entry.

3.7.2. TIME PRESSURE HISTORY

The time-pressure history toolbar allows the user to define a series of time-pressure pairs in the in the table near the center of the screen. The time-pressure table has it own toolbar as shown below:

Click the icons to Import, Add, Insert, Delete points in the table or to Copy and Paste from the clipboard. Time-Pressure histories may be imported from text files that are comma-delimited or tab-delimited. Clipboard entries can be copied and pasted from programs such as Excel and DPLOT that store information in a tabular format. The current pressure-time history is plotted as the data points are being created and/or edited. Right-clicking on the graph allows the user to perform the same operations available with any output graph.

3.8. LAY-UP LIBRARY

The term "glazing layup" refers to the through-thickness composition of the glazing. Figure 3.1 shows the cross-section of a generic glazing layup with the various components labeled.
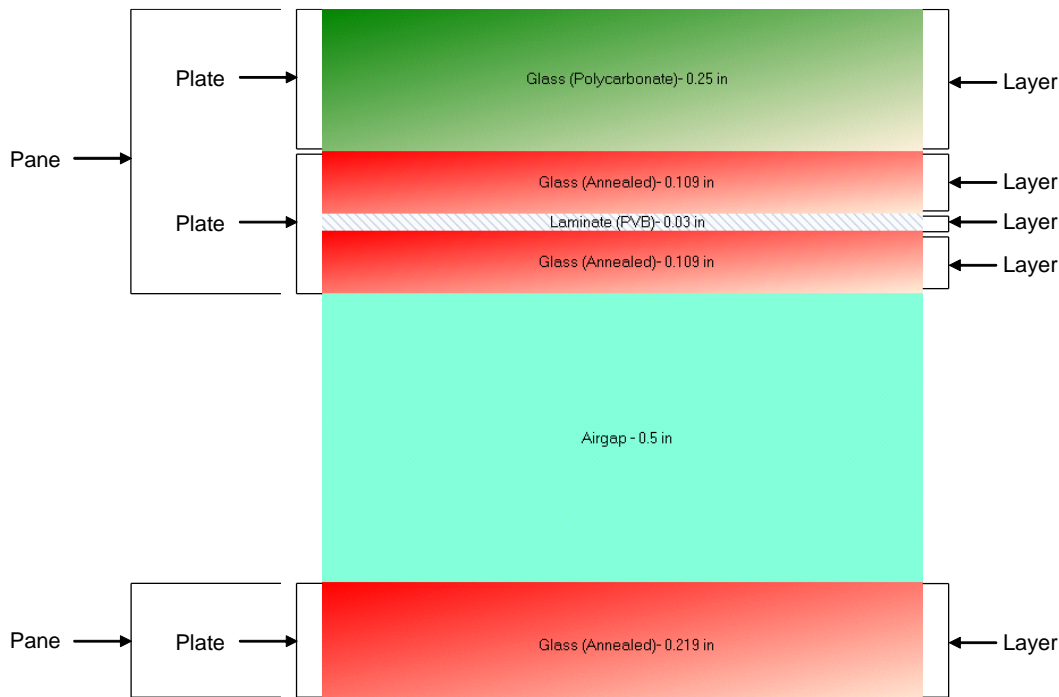

Figure 3.1. Complex glazing system.

The glazing lay-up is composed of panes, plates, and layers. The most basic component of the lay-up is the layer.   Material properties and thickness are defined for individual layers.   An assembly of one or more layers that act together in a composite fashion is called a plate, and one or more adjacent plates can combine to form a pane. Panes are separated by airgaps and move separately. Plates and layers, on the other hand, are assumed to move as a unit. Plates are treated in the analysis as "stacked", with no horizontal shear transfer between then. Multiple layers in a plate, however, are assumed to act in a composite fashion. The program is currently limited to analysis of two panes. The inner pane may have applied film, but the outer pane may not. Either or both panes may consist of one or more plates and each plate may consist of one or more layers.

A table of lay-up library entries appears in the upper portion of the display area and detailed parameters on each lay-up type may be displayed below in the lower table by checking the selection box in the rightmost column of the upper table. Several typical layups are included as defaults in the program. These default layups include single pane and double pane layups, with monolithic and/or laminated panes. These default layups may not be modified but may be copied and edited to create similar layups.

3.8.1. ADDING, MOVING, OR REMOVING LAYERS OR PLATES

Layers and plates may be added or removed using the right click menu or the Lay-up Toolbar. Right clicking on a layer or plate in the lay-up table will bring up a menu of editing options. These options include:

Layer Level	Plate Level
Add glass layer	Add multi-layered plate
Delete glass layer	Delete multi-layered plate
Clone glass layer	Clone multi-layered plate
Insert glass layer	Insert airgap plate
Add laminate layer	Insert multi-layered plate
Delete laminate layer	Insert film plate
Clone laminate layer	
Insert laminate layer	

New layers and plates may also be added using the Lay-up Toolbar.

 Add new multi-layered plate

 Add new film plate

 Add new airgap plate

■ Add new glass layer

■ Add new laminate layer

Plates and layers may be moved in the lay-up by selecting the desired component and dragging it to the appropriate position in the lay-up.

3.9. DEFINE A NEW WINDOW SYSTEM

■ Configure a new window system in the upper table by selecting the Add entry icon ☐ on the Library Toolbar or selecting an existing window system for editing. When a new window system is created, the window system ID appears in the Analysis Control Area list. Enter basic window system data to include a name for the system, a description, dimensions, and height above floor. To specify bite, click the Specify Bite check box and enter a bite value. If the Specify bite check box is not checked **WINGARD** will calculate the minimum bite required to fully develop the window response. Click the Display box to view specific window analysis selections in the lower Display Area.

Specific window system conditions including Output Method, Layup ID, Airblast Method and Edge Conditions are defined in the lower table. Click the appropriate field in the Value column to enter or adjust the required parameters.

3.9.1. OUTPUT METHOD

WINGARD can provide output based on either GSA Performance Conditions or ASTM Hazard Conditions. If GSA is selected, the glass response will be designated as Performance Condition 1 (Uncracked, glass remains in frame) to Performance Condition 5 (Hazardous Failure). If ASTM is selected, the output will report glass hazards consistent with ASTM F1642, ranging from No Break to High Hazard.

3.9.2. LIBRARY LAYUP ID

A lay-up is selected from the Layup Library using a dropdown menu. If the desired lay-up is not available from the drop-down menu, go to the Lay-up Library by selecting the layup icon Ⅲ from the Main Toolbar. Return to the Window System Library after creating the desired layup and select the new layup from the dropdown menu.

3.9.3. AIRBLAST METHOD

Select an entry from the airblast library or choose one of the two manual entry options. The airblast library is typically used for loadings that may be used/re-used in a number of window system analyses. Manual entry is typically used for more specific problems where a charge weight is specifically defined. If Manual entry is selected, the user may optionally show a graphic illustrating the required input.

Manual Entry -- There are two options for manual entry:

Standoff and charge weight. Charge weight, standoff distance, angle of incidence, and device and loading parameters are specified.

Location (X, Y, Z) and charge weight. For a Cartesian coordinate system, the x-, y- and z-offsets from the bomb to a vertical plane surface are entered and the program calculates the angle of incidence. Additional device and loading parameters are required.

Maximum Performance Condition -- It is possible to select a target hazard condition and let WINGARD vary the loading parameters to determine the maximum load that will result in the target hazard condition. Pressure will be varied for the defined duration if a linear equivalent airblast library entry is defined. Charge weight will be varied for the specified standoff or location if manual entry is selected. In either case, the user defined values will be used as an initial guess in the iterative solution.

3.9.4. EDGE CONDITIONS

Set edge conditions for film attachment (if applicable), butt glazing, and/or wet glazing as appropriate. Wet-glazed and/or butt-glazed conditions are defined by clicking the respective checkbox.

For Attached Film select the attachment method and attached edges as appropriate (i.e., daylight, two-sided vertical, two-sided horizontal, four-sided).

For Butt Glazing choose the supported edge (i.e., vertical or horizontal edge). Note that the supported edges are not the butt-glazed edges.

For Wet Glazing choose the attached edge (i.e., vertical or horizontal edge) and the silicone properties (i.e., depth and strength).

4. ANALYSIS STEPS

Some or all of the following steps may be required to prepare and analyze a window system in **WINGARD PE**:
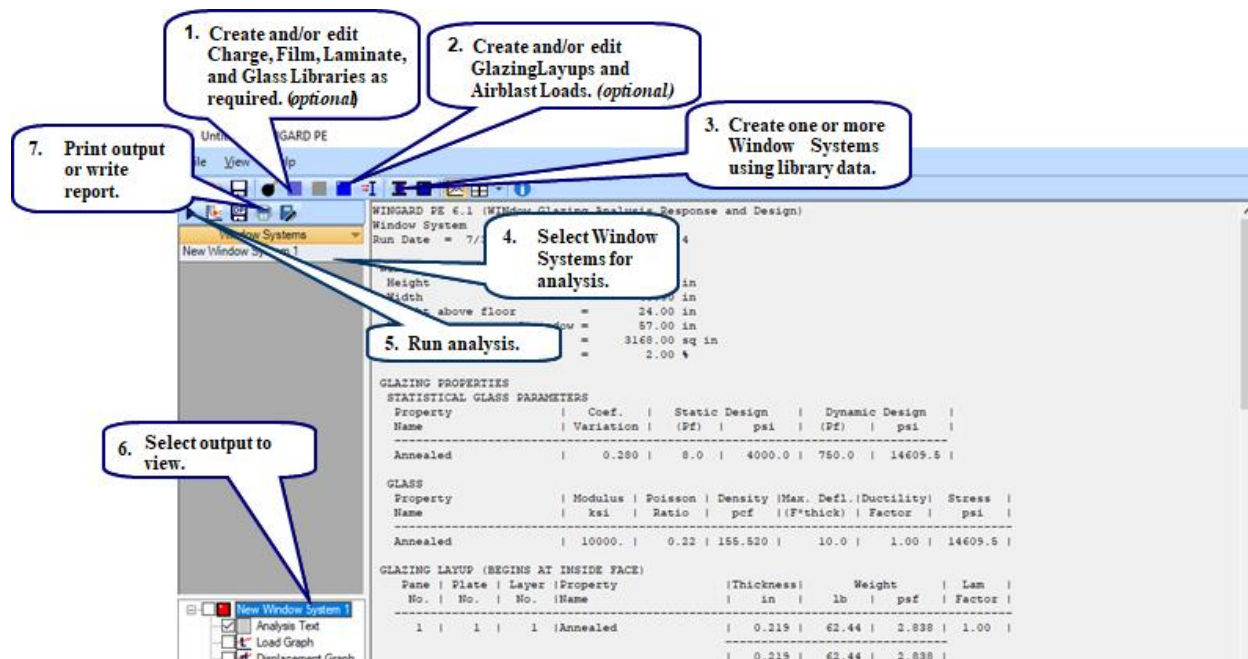
All of the data on the Window System screen must be completed prior to analysis of the window system. To set additional lay-ups and airblast loading not available on the Window Systems screen, go to the relevant library and add new entries. In many cases, the default data is sufficient for an analysis.

The relationship between the various data libraries is presented in the following Figure 4.1. This chart indicates the dependencies between data libraries, e.g., the window system is dependent on the defined layup library, which is in turn dependent on the glass, film, and laminate libraries.
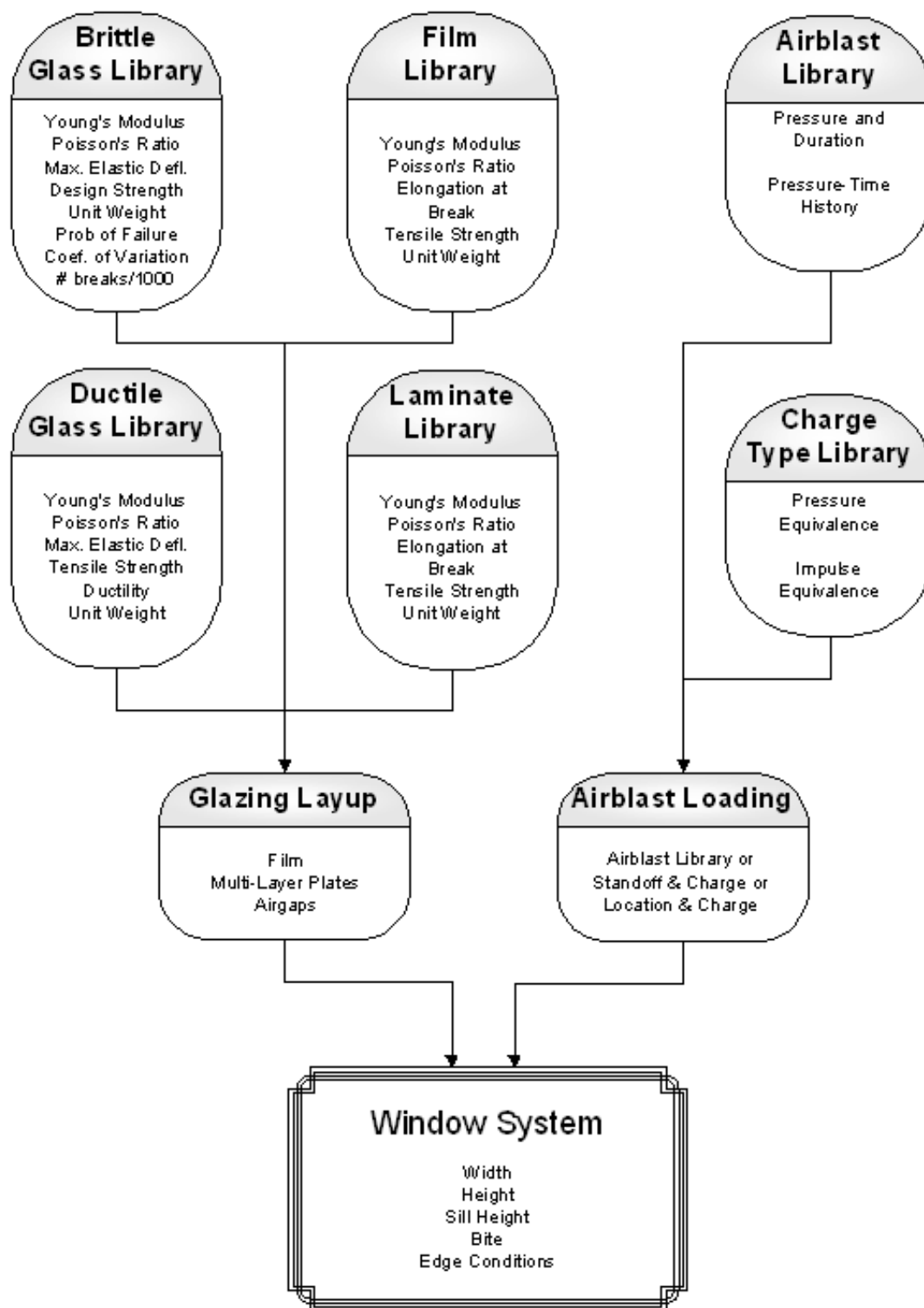
Figure 4.1. Input data dependencies.

5. SAMPLE PROBLEMS

Task

Analyze a window system for a 4 psi and 28 psi-msec blast load. The rough opening dimensions are 60 inches by 75 inches, and the windowsill is located 28 inches above the floor. The glazing consists of a 1-inch insulating glass unit (IGU) with a 1/4 inch laminated thermally tempered inner pane, 1/2 inch air gap and a 1/4 inch monolithic heat strengthened outer pane. Determine the gasket centerline dimensions as appropriate. The frame bite should be 1/2 inch.

The following figure is a sketch showing the window system. The figure illustrates the vision opening, rough opening, and centerline gasket dimensions. The centerline gasket dimensions should be used in the **WINGARD PE** analysis.
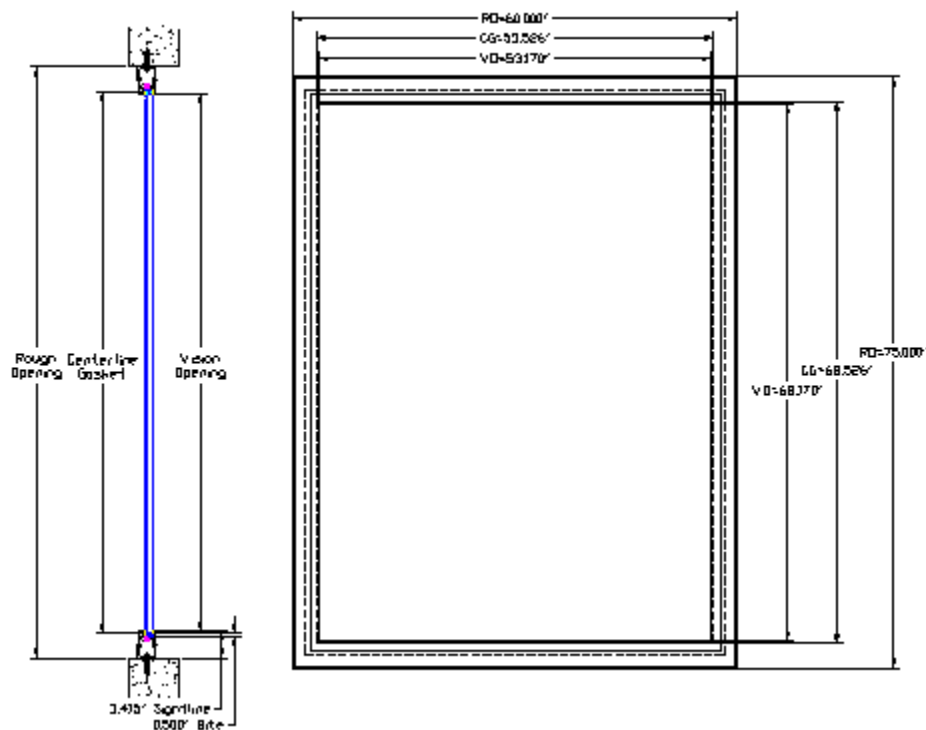
The analysis will use standard glazing and laminate types. Therefore, the film library, laminate library, and glass library will not be modified. In addition, the ISC Medium design load is a default entry in the airblast library, so the airblast library will not be modified.

5.1. STEP 1: BUILD THE APPROPRIATE GLAZING LAYUP IN THE LAYUP LIBRARY

The first step in the analysis process is to build the appropriate glazing layup.

Begin by selecting the Layup Library ▥ on the Main Toolbar.

Go to the Library Toolbar ▭▾ ⬇ 🖫 🖫 🗐 ✕ and select add layup ▯ .

On the Layup Toolbar 🟥🟦🟦🟦⬜ add new multi-layered plate 🟥

Then, add a new glass layer 🟦, a new laminate layer ⬜, and a new glass layer 🟦.

The inner pane is complete, and the **WINGARD PE** input screen should now look like this:
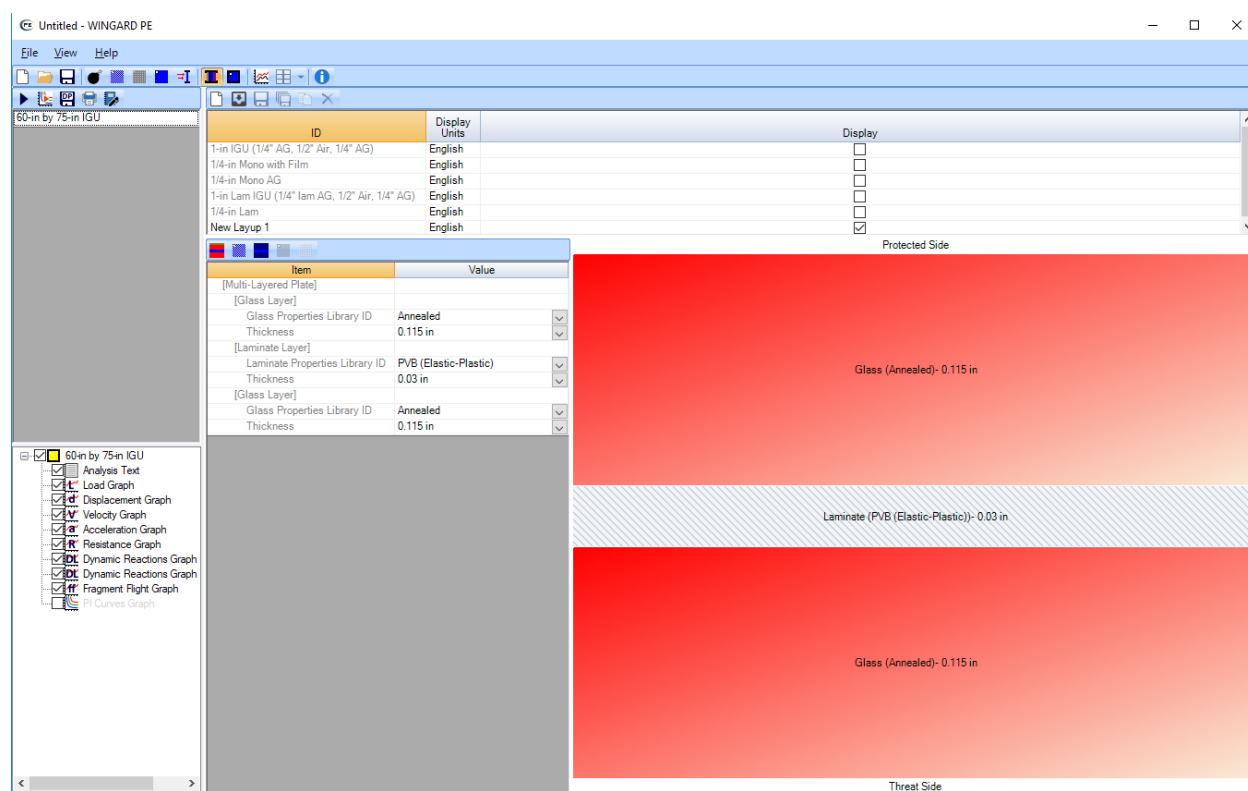
Continue to add to the glazing layup by adding a new airgap plate 🟦 and a new multi-layered plate 🟥, and a new glass layer 🟦.

At this point, all plates and layers have been created. The input screen should look like the following:
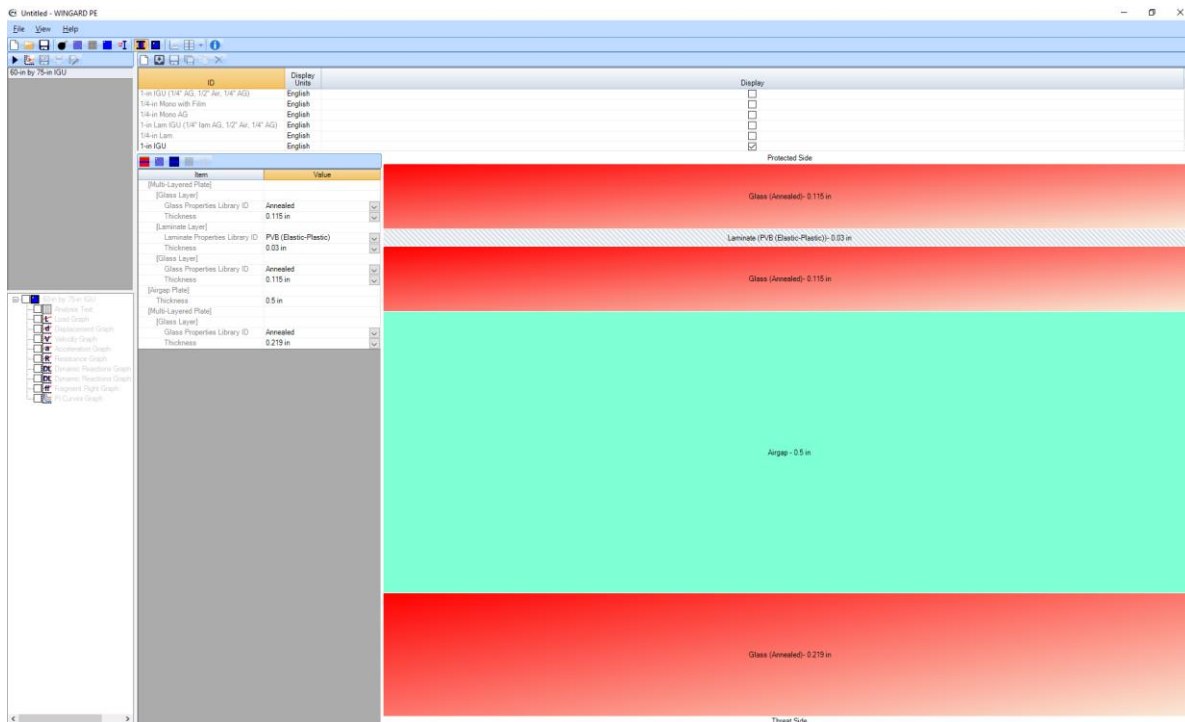
5.2. STEP 2 MODIFY THE GLAZING TYPES AND THICKNESS OF THE LAYUP

Begin by setting the glass types on the inner pane layers to Thermally Tempered.

Set the glass type on the outer pane to Heat Strengthened.

Next, set the glass thickness on the outer pane to ¼ inch using the drop-down menu and selecting a nominal thickness of ¼ inch. (Note that the actual thickness of 0.219 inch is used for the layer).

Finally, rename the layup by clicking on the ID. Set the name to "1-in IGU".

ID	Display Units
1-in IGU (1/4" AG, 1/2" Air, 1/4" AG)	English
1/4-in Mono with Film	English
1/4-in Mono AG	English
1-in Lam IGU (1/4" lam AG, 1/2" Air, 1/4" AG)	English
1/4-in Lam	English
1-in IGU	English

5.3. STEP 3 CREATE THE AIRBLAST LOAD

Begin by selecting the airblast input screen � on the Main Toolbar.

Go to the Library Toolbar and select Add entry and choose Linear Equivalent from the pull-down menu.

Name the Linear Equivalent load "4 psi/ 28 psi-msec".

Choose the Display Units (English) and enter the peak pressure (4 psi) and load duration (14 msec).

5.4. STEP 4 DEFINE THE WINDOW SYSTEM

Begin by selecting the window system input screen ■ on the Main Toolbar.

Go to the Window System Library Toolbar and select Add entry .

Name the window system "60-in by 75-in IGU.

Enter the centerline gasket dimensions for the window opening (68.526 inches x 53.526 inches) and the height above floor (28 inches).

Enter a bite of 0.5 inches.

Next, select the layup library ID for the layup you created.

| Item	Value
Layup Library ID	1-in IGU
[Airblast]	1-in IGU (1/4" AG, 1/2" Air, 1/4" AG)
Method	1/4-in Mono with Film
Maximum Performance Condition	1/4-in Mono AG
[Edge Conditions]	1-in Lam IGU (1/4" lam AG, 1/2" Air, 1/4" AG)
Butt Glazing	1/4-in Lam
Wet Glazing	1-in IGU

Then, select the newly created 4 psi/28 psi-msec airblast load from the airblast library.

Item	Value
Layup Library ID	1-in IGU
[Airblast]	
Method	(Library) 4 psi / 28 psi-msec
Maximum Performance Condition	(Library) 4 psi / 28 psi-msec
[Edge Conditions]	(Manual) Standoff
Butt Glazing	(Manual) Location (X,Y,Z)
Wet Glazing	

5.5. STEP 5 RUN ANALYSIS AND VIEW RESULTS

The window system is now complete. The next step is to run the analysis and view the results.

Run the analysis by selecting the "60-in by 75-in IGU" window system in the upper left Analysis Control Area and clicking the run analysis icon ▶ on the toolbar.
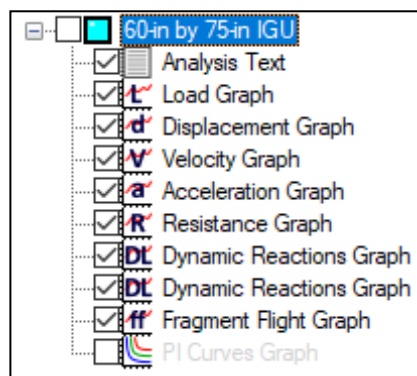
Results can be viewed by selecting the desired output plots in the lower left window.

Selecting the plus sign by the system name will expand the output tree and allow the user to select between the individual types of output available. Control of individual output is controlled by the associated check boxes.

The color of the icon beside the model name now represents the performance condition of the window. These colors are based on the Fragment Flight Graph. As you can see in this model the window has a performance condition of 2.

60-in by 75-in IGU
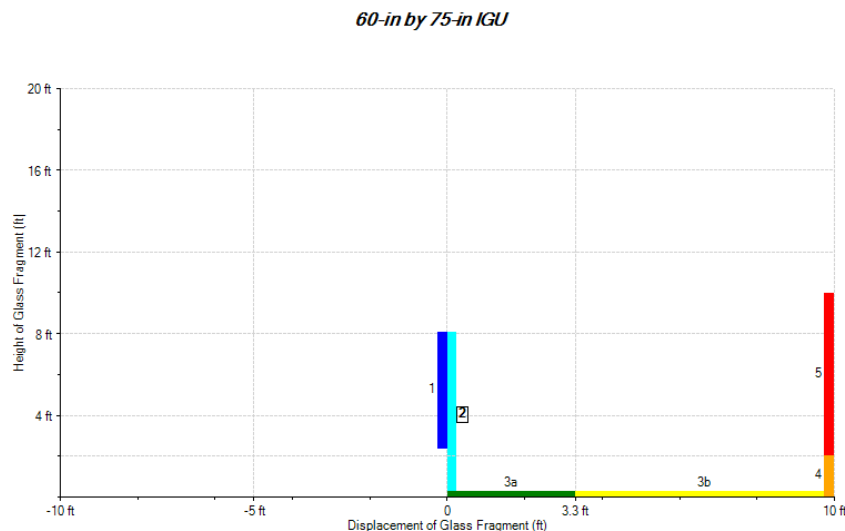
This can be verified in the "RESULTS" of the Analysis Text.

```
RESULTS
 Plate  3, Layer  1, Fails at Time =       9.03 msec
   Pane  2 Failure
      Displacement at Failure      =       1.56 in
      Velocity at Failure          =     232.93 in/sec
 Contact First Occurs at Time      =      12.90 msec
 Plate  1, Layer  3, Fails at Time =      12.95 msec
 Plate  1, Layer  1, Fails at Time =      15.49 msec
 Pane  1 Does Not Fail
      Maximum Displacement         =       3.29  in
      Time at Maximum Displacement =      47.53 msec
 Calculation Ends at Time          =     229.10 msec


********************************************************************
*      PERFORMANCE CONDITION =            2                       *
********************************************************************


********************************************************************
* Note: This report was produced using WINGARD PE.  The developers of    *
*       this software (Applied Research Associates, Inc.) highly          *
*       recommend that all blast-resistant and hazard-mitigating window   *
*       designs and analyses be performed by trained and qualified blast  *
*       analysts.  The use of this software and all results are controlled*
*       by the software license agreement and associated disclaimers.     *
********************************************************************
```
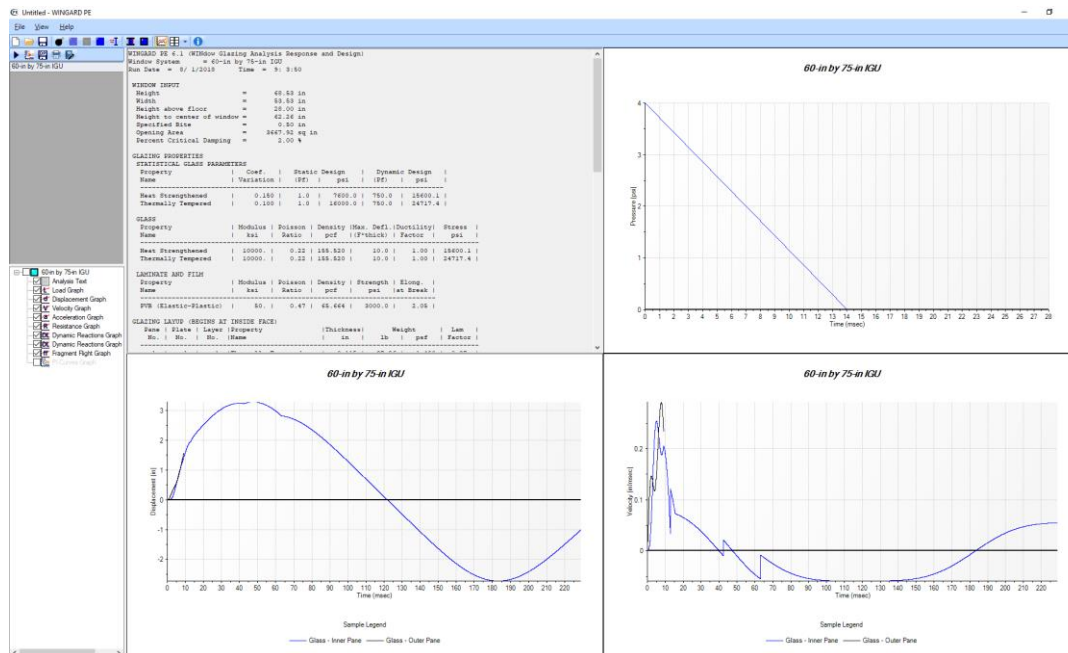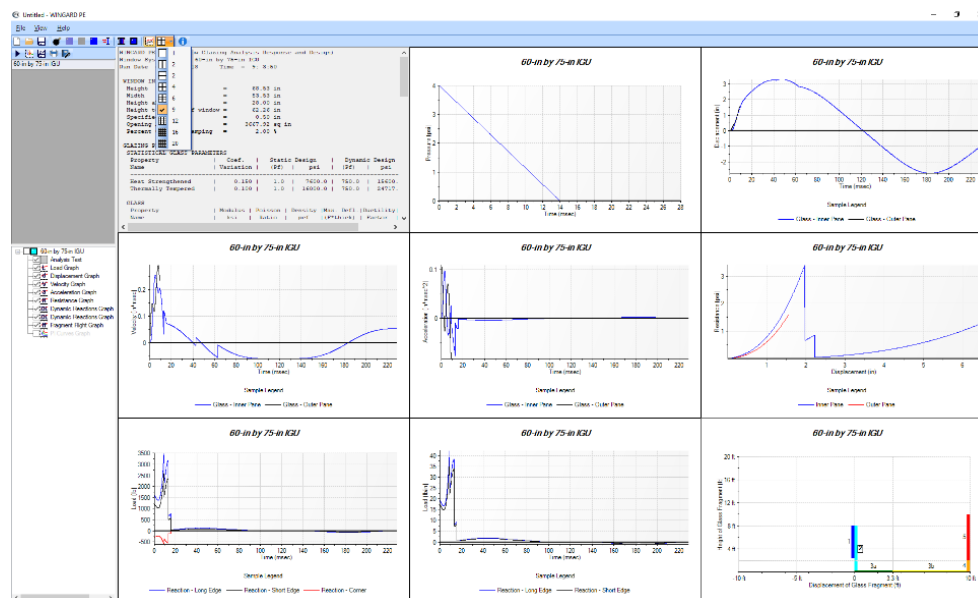
Clicking the checkbox by the system name selects all potential outputs and displays them in the output view area.

The number of output views on screen may be changed as required using the output view dropdown.

Results may also now be printed or saved to DPlot or CSV files or a report may be generated.