PACT

Performance Assessment Calculation Tool User Guide

for Beta Version 1.0, May 27, 2007

ATC-58 Guidelines for Seismic Performance Assessment of Buildings

Prepared for:
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FEDERAL EMERGENCY MANAGEMENT AGENCY
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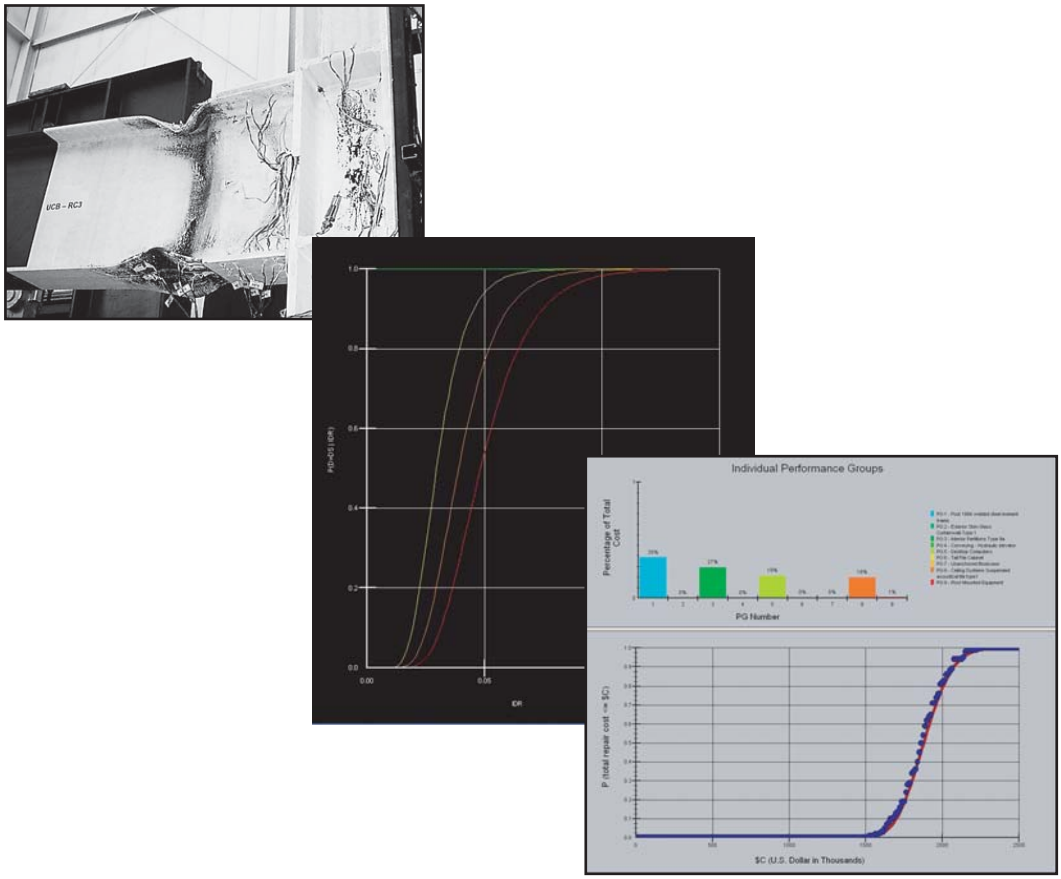

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FEMA

ATC
Applied Technology Council

Notice

This software has been prepared by the ATC-58 Project Team to assist interested parties in obtaining an understanding of the methodology as it is being developed, and to facilitate comment and feedback to the project team on its further development. The data included in this software are incomplete at this time, are not necessarily appropriate for use in actual projects, and should not be used for that purpose. This software will be subject to further revision and enhancement as the methodology is completed in future years.

CONTENTS

1 Introduction

Performance Assessment Calculation Tool (PACT) is the computational companion to the ATC-58 35% Draft Guidelines. PACT provides a user-friendly platform for scenario-based, intensity-based, and time-based loss calculations. It can accommodate results obtained from nonlinear response history analyses as well as simplified analyses.

PACT provides three basic but integrated functions:

1. Gathering and organizing building information, fragility functions and demand parameters;
2. Performing loss calculations using the PEER PBEE methodology; and
3. Providing overall and performance group specific loss information obtained from the above calculations.

The PACT user interface is coded in Microsoft Visual Basic and its computational engine is coded using a mixture of FORTRAN and Visual Basic routines.

2 Hardware and Software Requirements

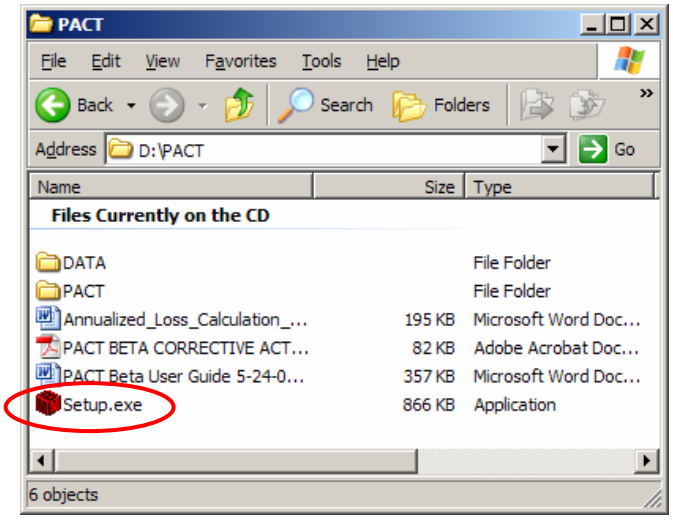
In order to use PACT you need a PC with the following minimum software and hardware:

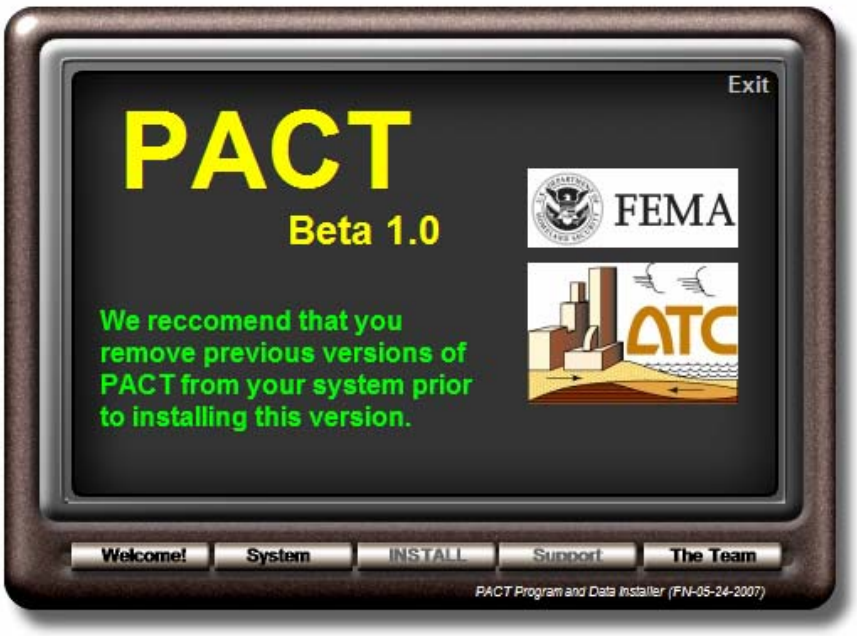
1. Microsoft Windows 2000, NT, XP, or Vista operating system
2. 200 MB of available hard disk
3. A Pentium 500 MHz or faster CPU
4. 256 MB of RAM
5. An XGA or better monitor (1024x768 resolution or higher)

3 Installing PACT Beta

Insert the ATC-58 CD-Rom disc in your PC's CD drive and double-click the PACT folder. Then double-click the Setup icon with the red cube to its left.

The installation process begins and you will see the following screen:

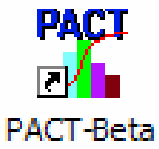




Click "System" to check system compatibility. Your need a Windows 200, XP, or later for PACT-Beta to work. Once you have clicked “System” the “INSTALL” button becomes available.

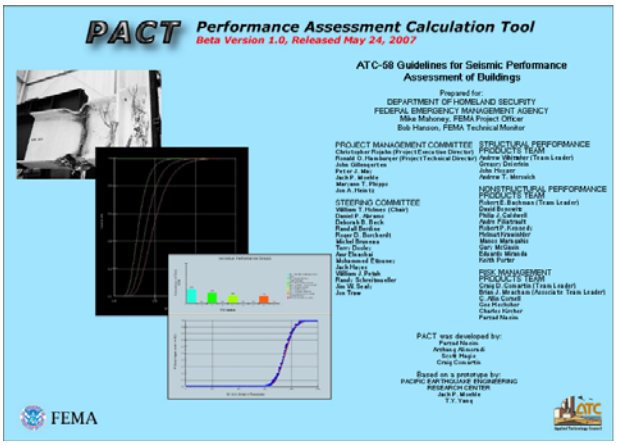
Click "INSTALL" and then make sure you install both the Program and the Data. Installation of the program and data may take several minutes. Please follow the instructions during the installation and click "Exit" at the top right hand side once both the program and data have been installed.

Once the installation is completed, a shortcut to PACT is placed on your desktop that you can use to access the program.



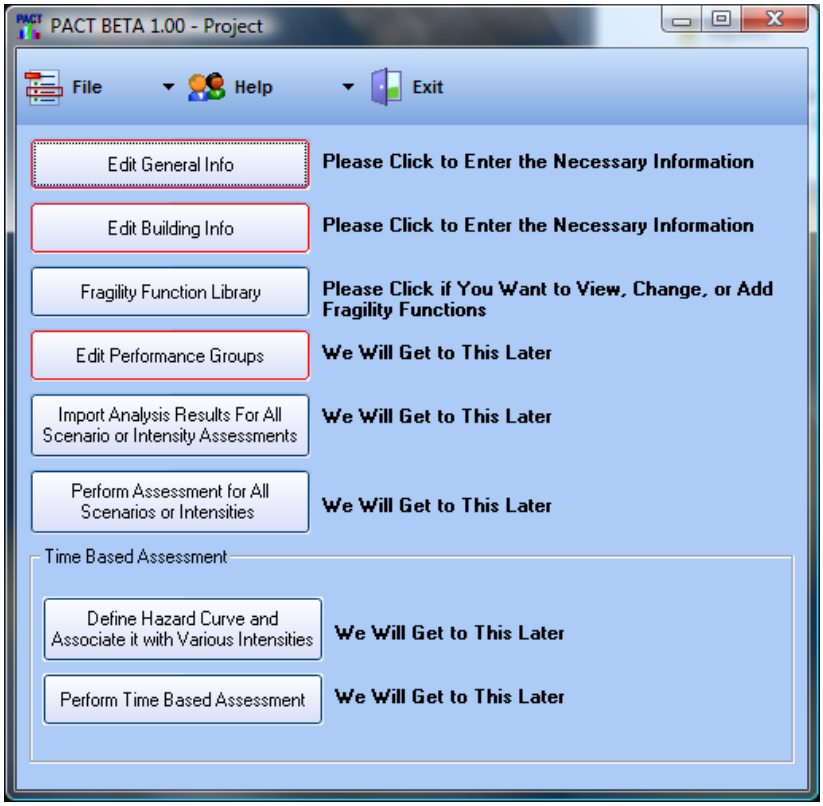
4 Using PACT

Once you start PACT a splash screen appears for a few seconds. You can terminate the splash screen earlier by clicking it. Once the splash screen disappears, if you are using PACT for the first time, you are asked to personalize PACT for your use and then the PACT Control Panel is displayed.

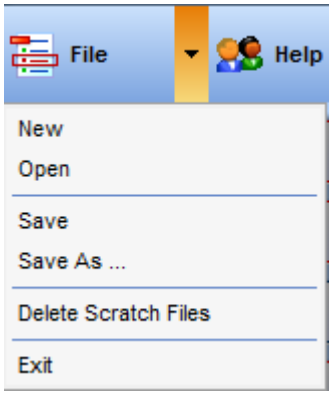


4.1 PACT's Control Panel

PACT Control Panel is the focal point of your activities when you use the program. You will come back to this panel before and after completion of each task.



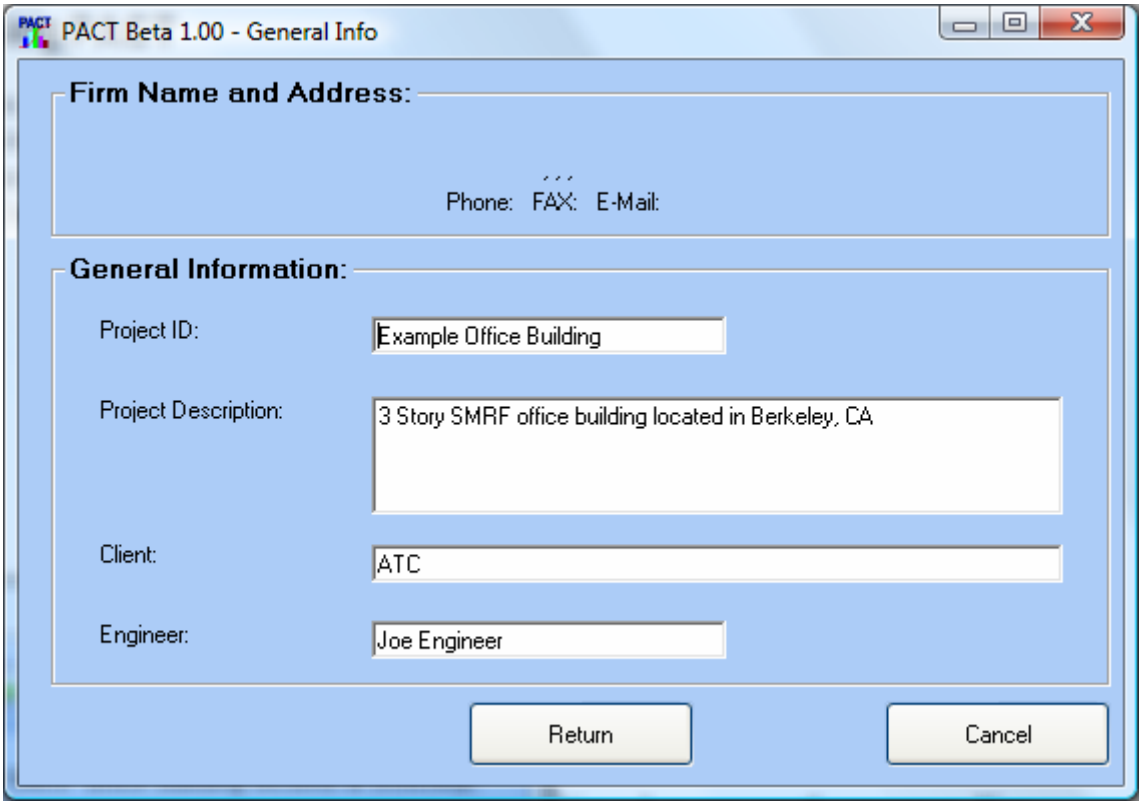
There are three menus on the menu bar at the top of the panel. Click *File* to start a new project, open an existing project or save the project you are working on. You can also use *Save As* to save your project under another name.



Exit terminates PACT. *Help* will provide you with access to the User Manual and other useful information (not functional in the Beta release).

4.1.1 Edit General Information

Use this button to add/edit/review general information regarding the project you are working on.

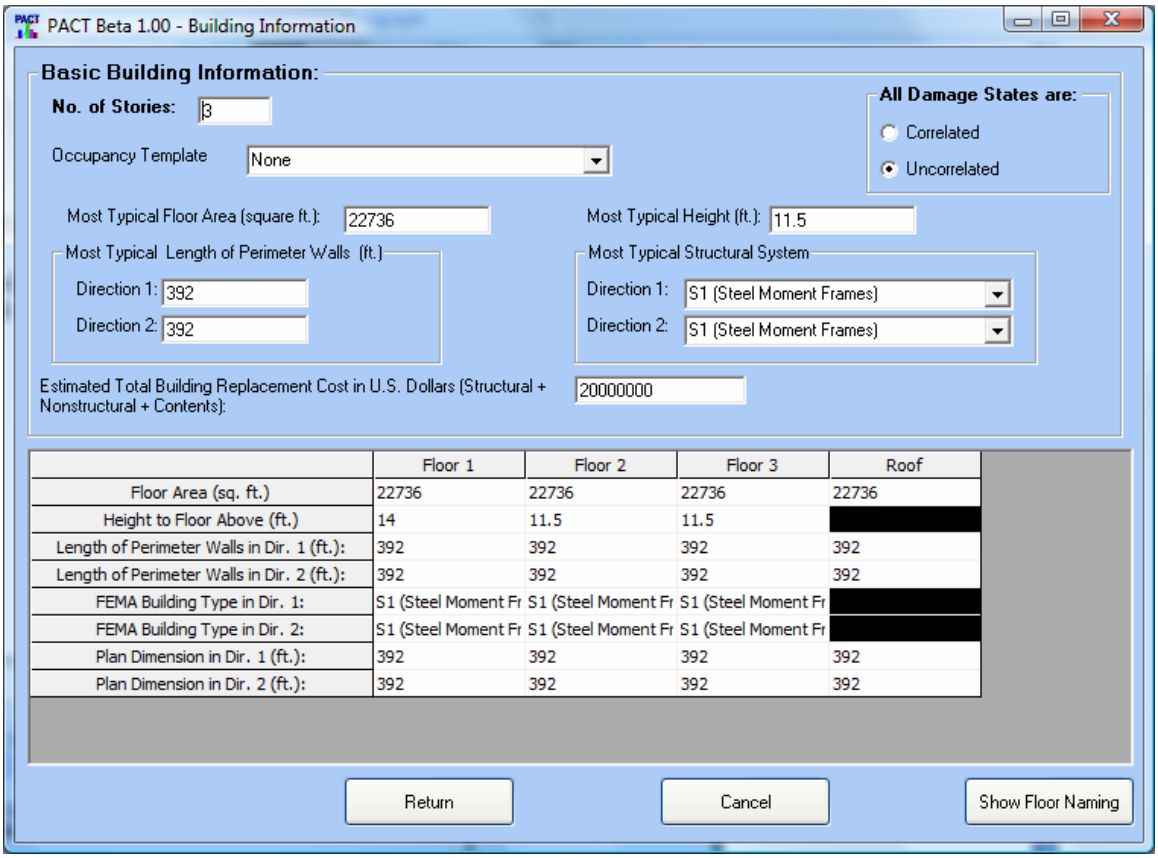


4.1.2 Edit Building Information

Use this button to add/edit/review basic building information such as number of stories, occupancy type, and structural system. PACT Beta comes with two occupancy templates but is easy to add others as we will see later. You enter/select the most typical values for your building in the upper part of the form and PACT fills these values on the table shown in the lower part of the form. At any time you can change the tabulated values in the table by clicking on the corresponding cell. For example, if you have a 10 story building with the first floor height of 20 ft, second floor of 16 ft and other 8 floors of 13.5 ft., you will enter 13.5 ft as the moist typical height and then go to the table and correct the values entered for the first two floors.

You can also treat the table as an Excel spreadsheet by cutting (using CTRL-C) and pasting (using CTRL-V) values for a cell or a selection of cells.

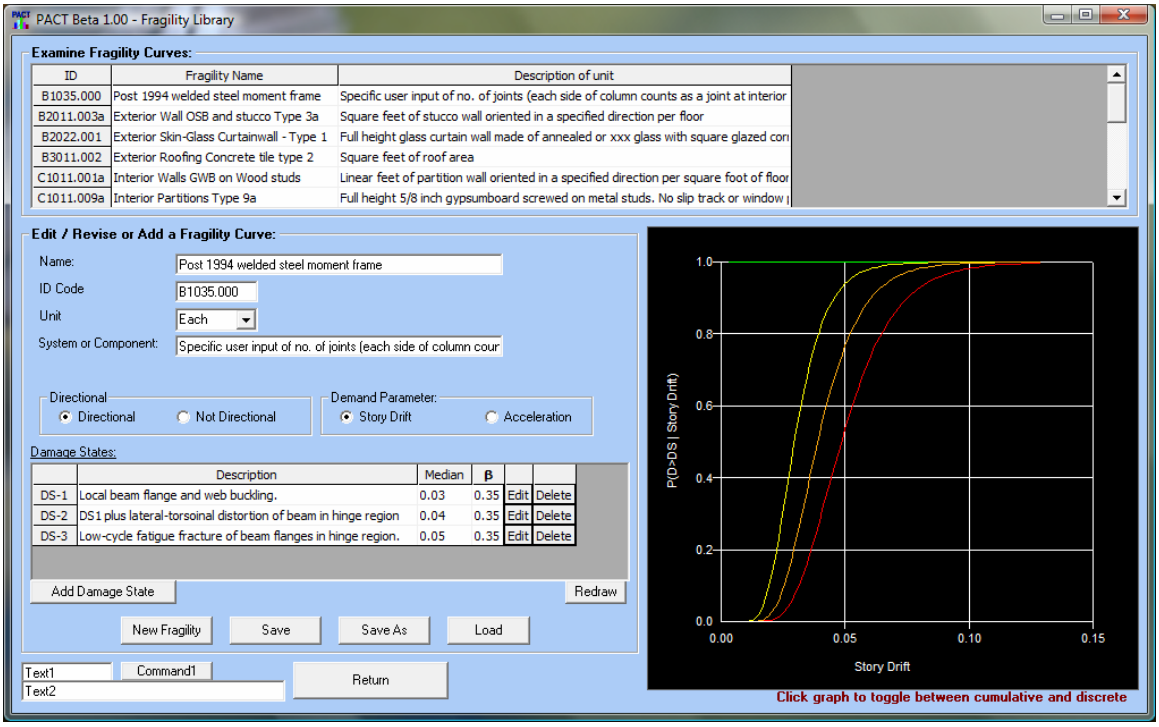
IMPORTANT: Selection of *Correlated* or *Uncorrelated* status for damage states will affect the outcome of your loss calculation. Basically, if *Correlated* option is selected, all members of a performance group when subjected to a given level of demand are assumed to be in the same damage state. In contrast, if *Uncorrelated* option is selected damage state of members of the performance group is treated as an independent variable subject to the controlling fragility constraints.

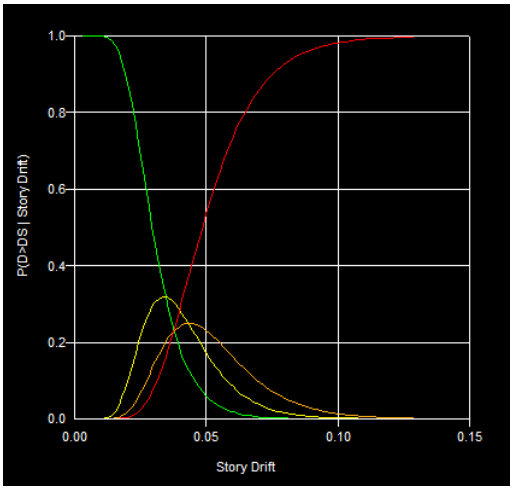


4.1.3 Fragility Function Library

You can use this button if you want to view, edit, or add to the fragility functions supplied with PACT.

PLEASE BE EXTREMELY CAREFUL WHEN EXPERIMENTING WITH THE FRAGILITY FUNCTIONS BECAUSE ANY CHANGES MADE HERE CAN RADICALLY CHANGE THE OUTCOME OF YOUR LOSS ANALYSIS. WE RECOMMEND THAT YOU MAKE A BACKUP OF THE "\ATCCURVES" FOLDER SUPPLIED WITH PACT BEFORE MAKING ANY CHANGES TO THE FRAGILITY FUNCTIONS.



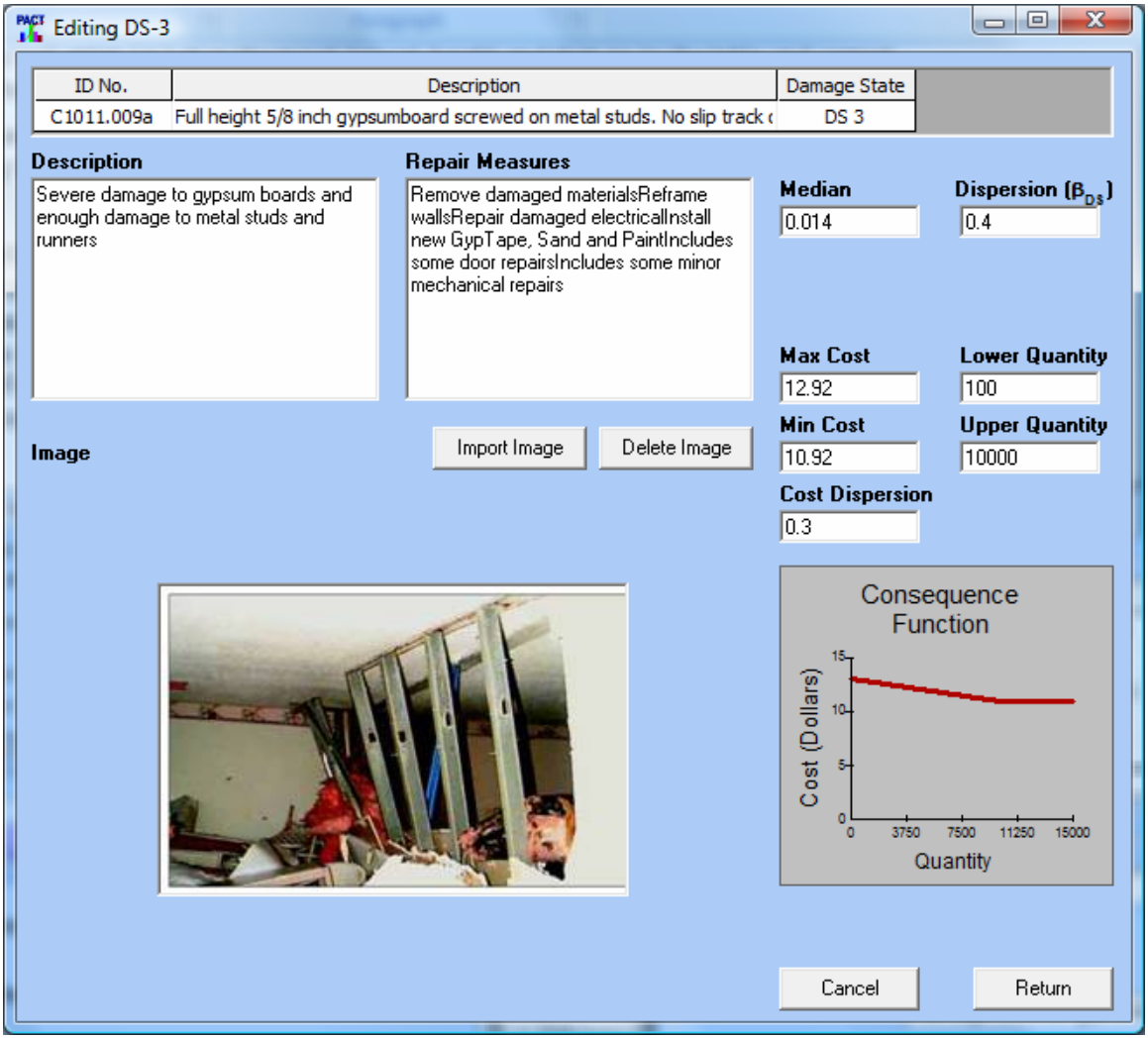


Fragility functions are listed in the table at the upper portion of this form. Selecting a fragility function displays the assigned damage states, corresponding description, associated median and dispersion values and a graph of the fragility function for the defined damage states. Clicking the graph changes the presentation of fragilities from cumulative to discrete probabilities and vice versa.

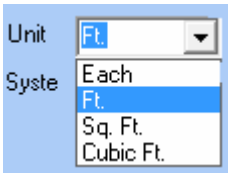
Each fragility function is defined as either drift sensitive or acceleration sensitive. It is also classified as being directional or non-

directional. Currently drift sensitive fragilities are all considered to be directional and acceleration sensitive fragilities are all considered to be non-directional.

If you click *Edit* corresponding to a damage state you will see a more detailed description of that damage state, a representative photo and the cost consequence function defined for the damage state. All these, of course can be changed by the user.

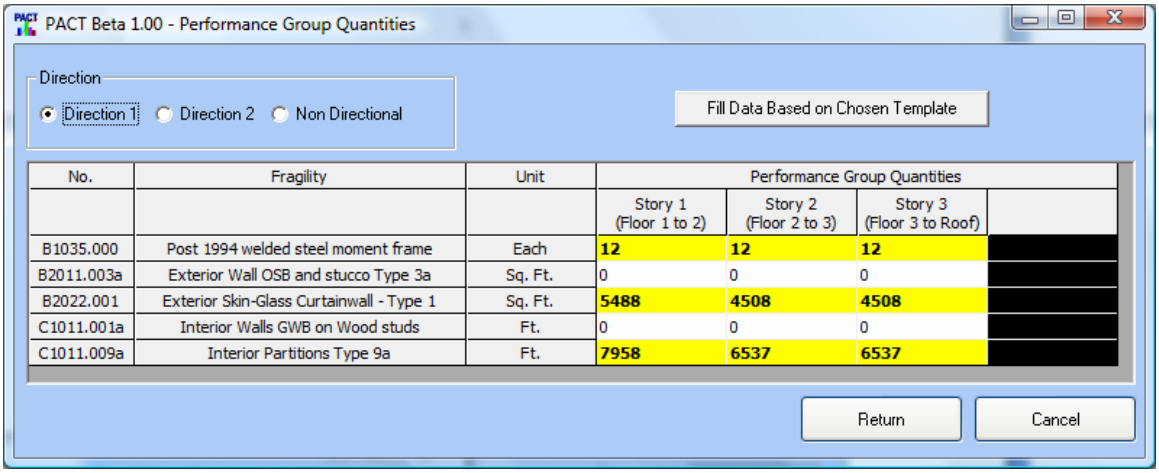


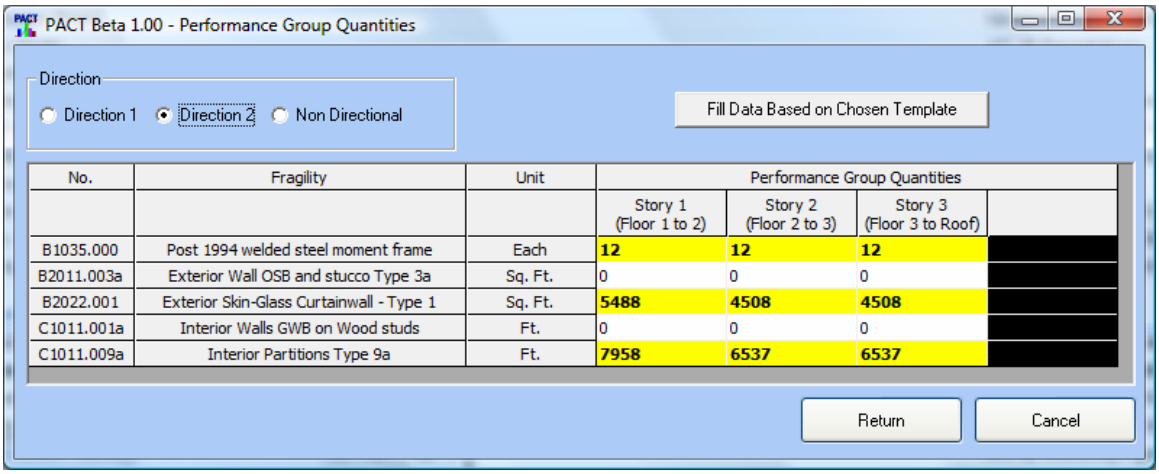
The unit associated with each cost function is defined as either “each”, “linear feet”, “square feet”, or “cubic feet.”

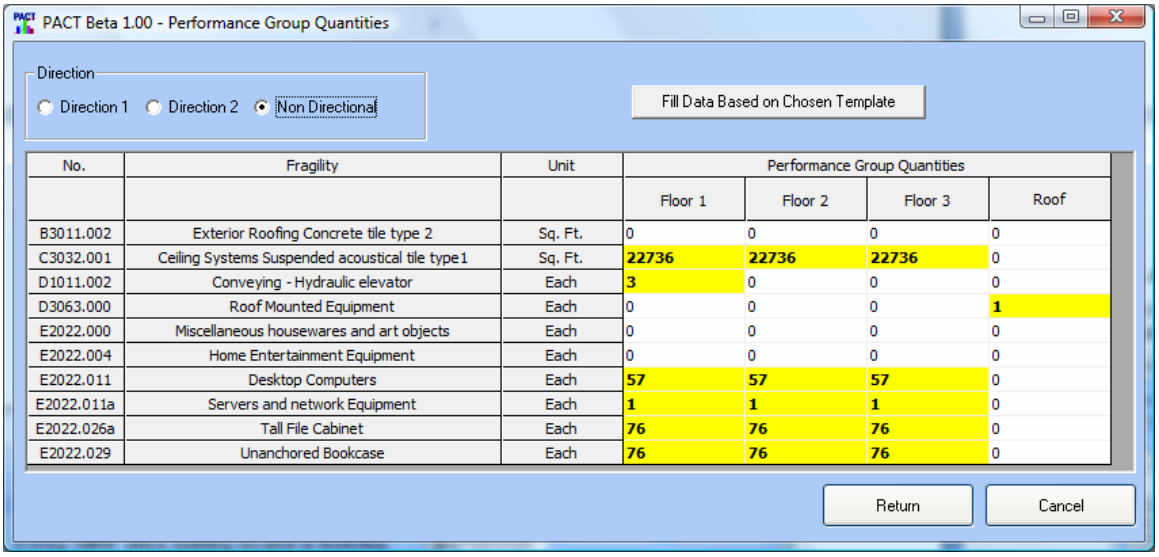


4.1.4 Edit Performance Groups

You need to use this button to associate fragility functions to various components and contents of your building. Please note that there are three tables that need to be filled one for each horizontal direction and one for non-directional items.



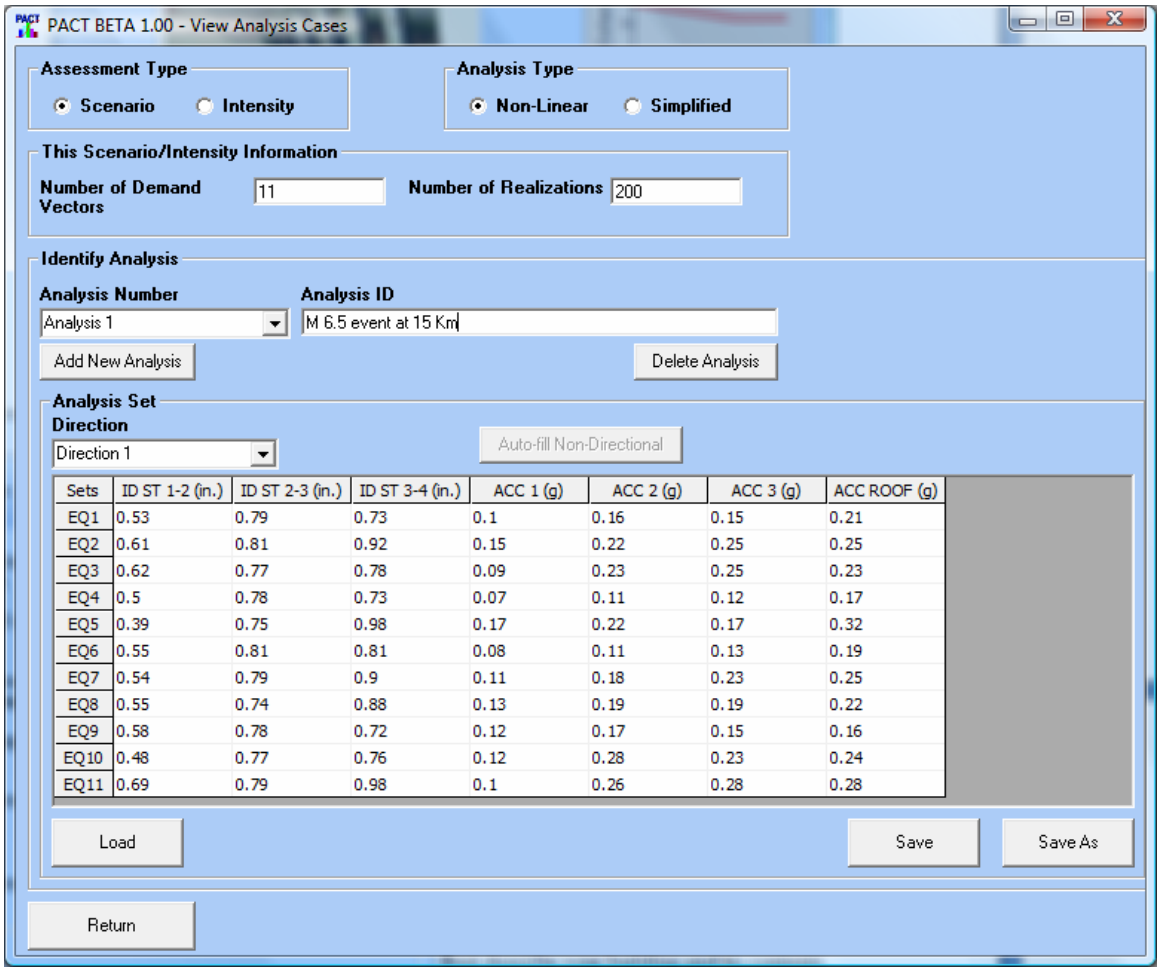




The cells that are entered will be highlighted with a yellow background. You can either directly fill-up these tables, cut and paste from an Excel or Word table, or have PACT fill them up based on the occupancy category you choose. No matter what method you use to fill up these tables, you can always modify the values shown either directly or by cutting and pasting to represent the final values that best describe your building and its contents.

4.1.5 Import Analysis Results

You will use this function to import the results of various analyses you have performed into PACT for loss analyses. You can import results of all your analyses regardless of whether they are scenario-based, intensity-based, or time-based and have PACT process them all at once. YOU CANNOT, HOWEVER, MIX THE RESULTS OF NONLINEAR ANALYSES WITH THOSE OF SIMPLIFIED ANALYSES.

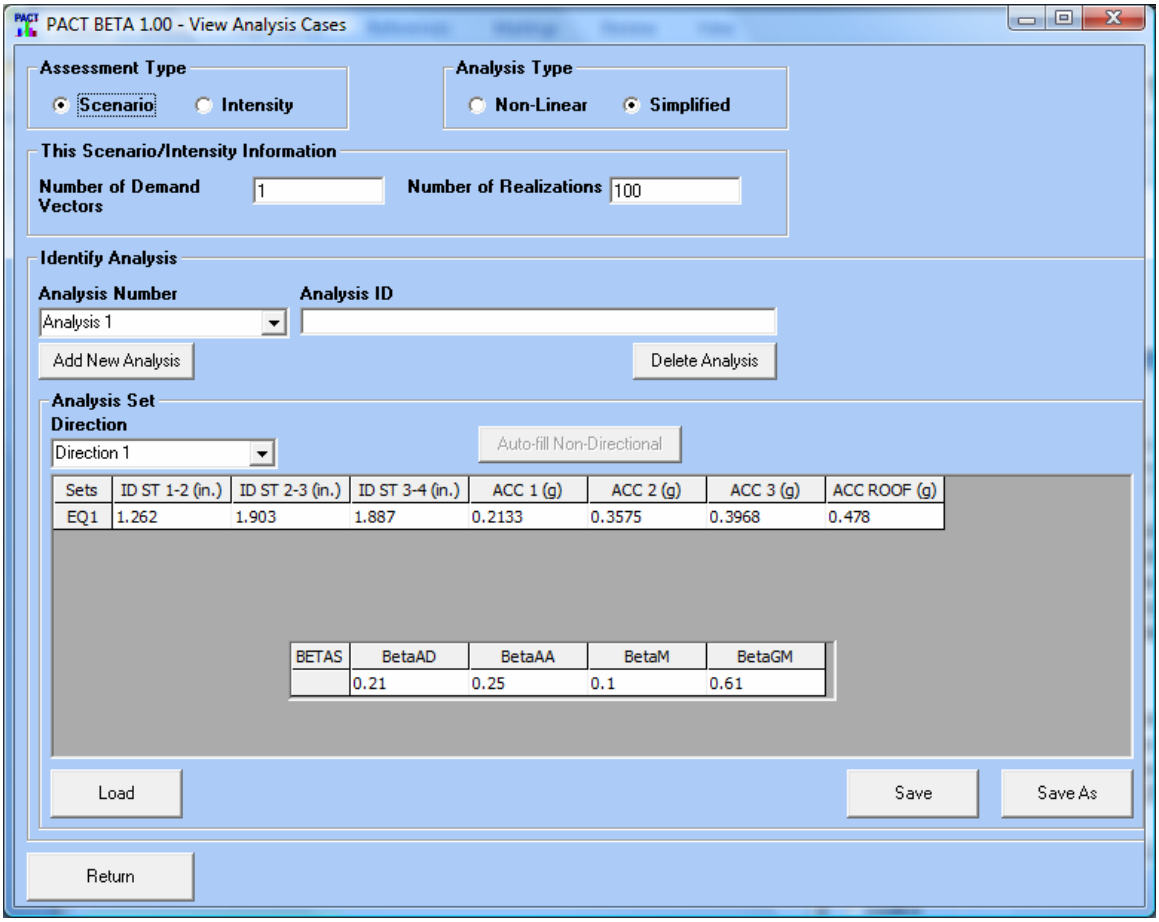


Sets	ID ST 1-2 (in.)	ID ST 2-3 (in.)	ID ST 3-4 (in.)	ACC 1 (g)	ACC 2 (g)	ACC 3 (g)	ACC ROOF (g)
EQ1	0.53	0.79	0.73	0.1	0.16	0.15	0.21
EQ2	0.61	0.81	0.92	0.15	0.22	0.25	0.25
EQ3	0.62	0.77	0.78	0.09	0.23	0.25	0.23
EQ4	0.5	0.78	0.73	0.07	0.11	0.12	0.17
EQ5	0.39	0.75	0.98	0.17	0.22	0.17	0.32
EQ6	0.55	0.81	0.81	0.08	0.11	0.13	0.19
EQ7	0.54	0.79	0.9	0.11	0.18	0.23	0.25
EQ8	0.55	0.74	0.88	0.13	0.19	0.19	0.22
EQ9	0.58	0.78	0.72	0.12	0.17	0.15	0.16
EQ10	0.48	0.77	0.76	0.12	0.28	0.23	0.24
EQ11	0.69	0.79	0.98	0.1	0.26	0.28	0.28

Although it is possible to directly enter the values on this form, the best way to supply this information is to prepare tables containing the information needed using Word ot Excel and cut and paste them into the table.

Please note that each assessment is classified as *Scenario*, or *Intensity* type and analysis type has to be identified as *Nonlinear* or *Simplified*.

For Nonlinear analyses results you need to specify the number of demand vectors and the number of realizations. For the Simplified analyses the number of demand vectors for each analysis is set to one and you need to supply the number of realizations and the necessary dispersion values.

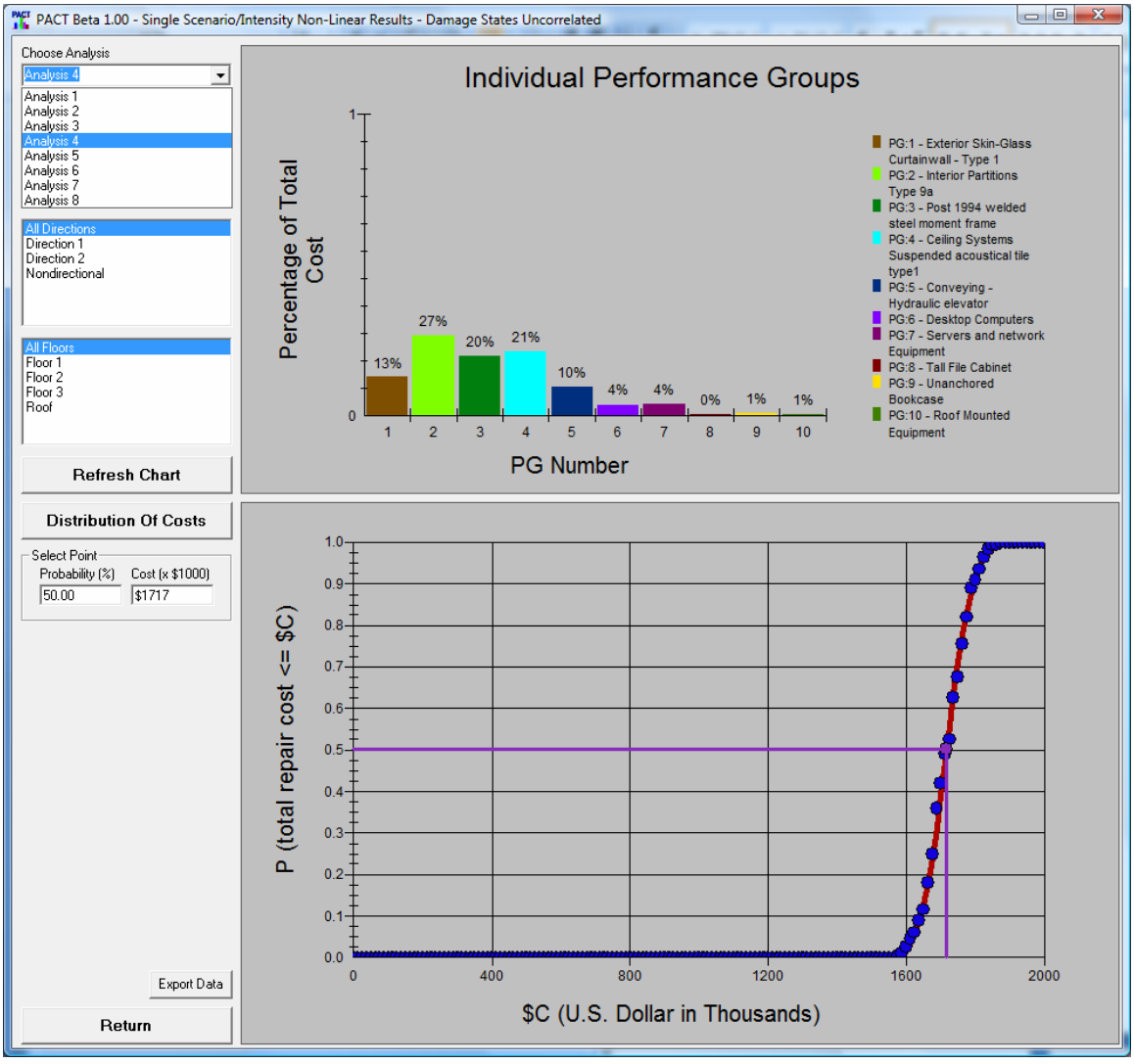


Note that for each analysis there are three tables to be filled. One associated with each direction and one for non-directional items. You may, however, have PACT fill in your non-directional table by placing the maximum values obtained from directional tables in each corresponding non-directional cell.

You can define as many number of analyses as you want. If you intend to perform a time-based assessment later, you need a minimum of three sets of analyses for the PACT time-based performance assessment to work..

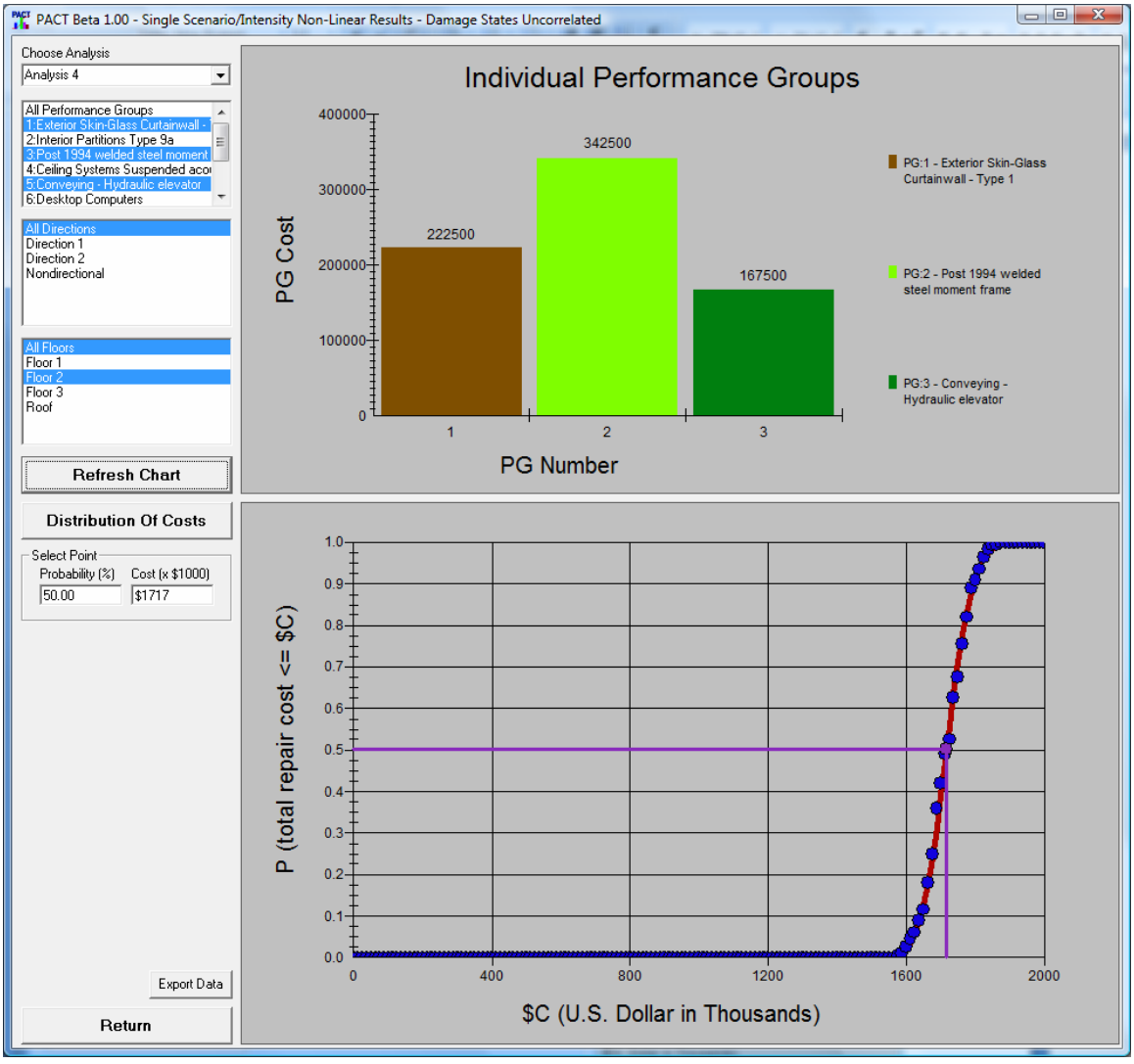
4.1.6 Perform Scenario or Intensity-based Assessments

Click this button for PACT to start performing its computations. Depending on the speed of your computer, PACT computations may take anywhere from a few seconds to several minutes. Once PACT has performed its computations the loss assessment results are presented in terms of a graph and a bar chart. You can select the results of the particular analysis you are interested in from the drop-down menu at the left top corner of the form.



The graph at the bottom of the form depicts the loss curve associated with the selected analysis for all performance groups in all directions and throughout the height of the building. By default the cursor on the graph is placed at the median value. However, you can click anywhere on the curve to examine losses at various probabilities. Note that the values corresponding to the selected point on the curve are displayed on the text boxes to the left of the curve. Instead of clicking the cursor on the curve, you can enter either a cost or probability in the text box and the corresponding value will be shown in the other text box and the cursor will move to the corresponding location on the curve.

The bar chart on the top depicts the segregation of losses among various performance groups. Note that when you change cost or probability on the loss curves the distribution of costs among performance groups shown on the bar chart changes. You may select a particular direction or a number of floors and a subset of performance groups (by holding down CTRL while clicking selected items) to further drill down the losses corresponding to various entities.



You may also use the *Export Data* button export the data represented on the bar chart and the loss curve to a delimited text file that you can easily import into Excel to perform your own evaluations. Click *Return* to go back to PACT Control Panel.

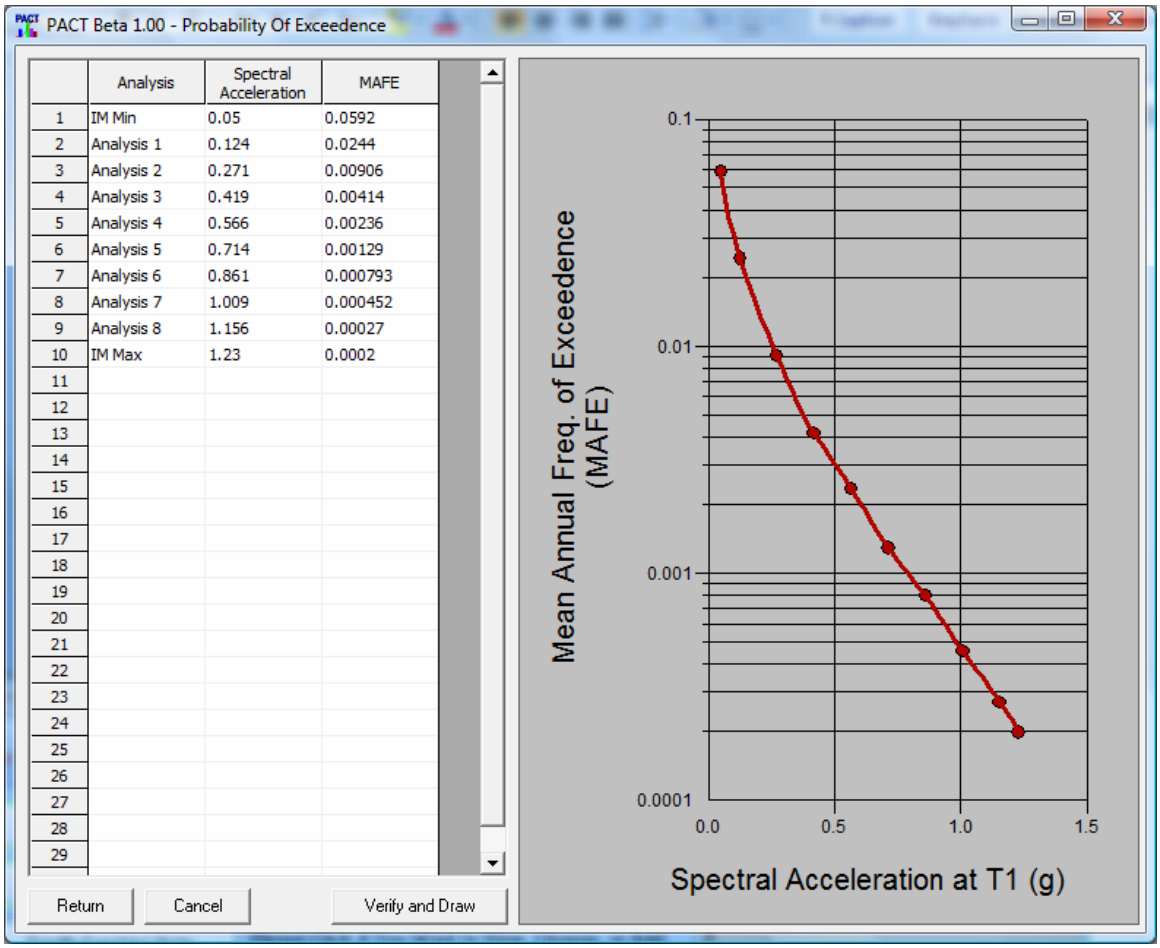
4.1.7 Perform Time-Based Analyses

In order to perform time-based analyses you need to already have performed a number of intensity based analyses (minimum of three) and you need to have the information necessary to construct the hazard curve.

4.1.7.1Define Hazard Curve

Click *Define Hazard Curve and …* on the PACT Control Panel and enter or cut and paste the coordinates of the points on the hazard curve on the second and third columns of the table.

On the first column of the table identify the points of the curve that correspond to each intensity analysis using the drop-down menu provided. Also identify the end points on the curve and any other point on the curve not associated with an analysis as merely a curve point. Click *Verify and Draw* to see how you hazard curve looks like and make any adjustments necessary. Click *Return* when you are done.



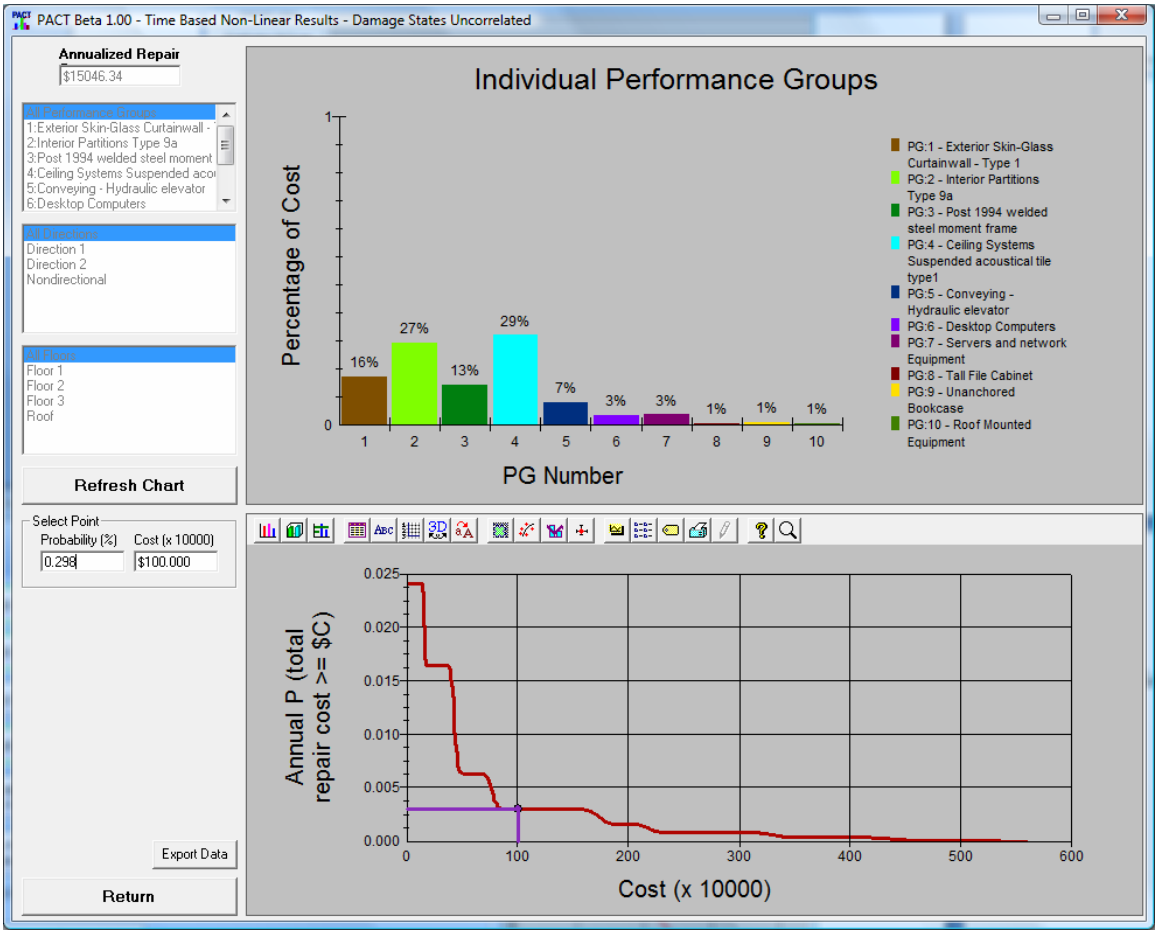
4.1.7.2Perform Time-Based Calculations

Click *Perform Time-Based Assessments …* on the PACT Control Panel for PACT to start performing its computations. Depending on the speed of your computer, PACT computations may take anywhere from a few seconds to several minutes. Once PACT has performed its computations the loss assessment results are presented in terms of a graph and a bar chart similar to those presented for the scenario and time-based assessments.

At the top left corner of the form the annualized repair cost is displayed. This number is represents the area of the loss curve shown below.

Selecting a particular dollar amount or probability on the loss curve (either by clicking a point or entering a value into one of the text boxes to the left of the graph will update the bar graph to depict the distribution of corresponding loss dollar amount between various performance groups.

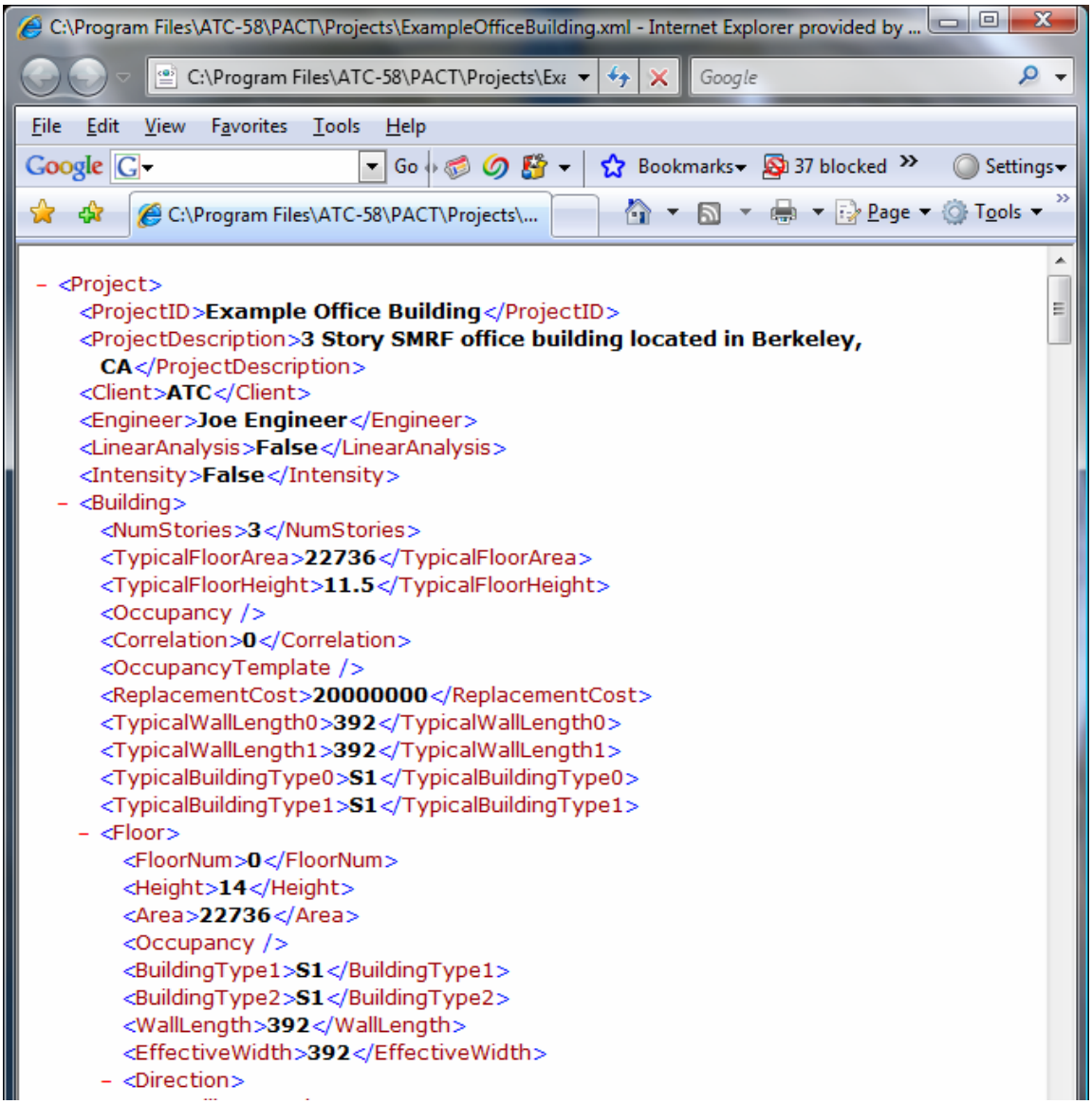
As before you can use the *Export Data* button export the data represented on the bar chart and the loss curve to a delimited text file that you can easily import into Excel to perform your own evaluations. Click *Return* to go back to PACT Control Panel and exit from PACT when you are done. Make sure to save your project prior to exiting PACT.



5 A Look under the Hood

5.1 Project Files

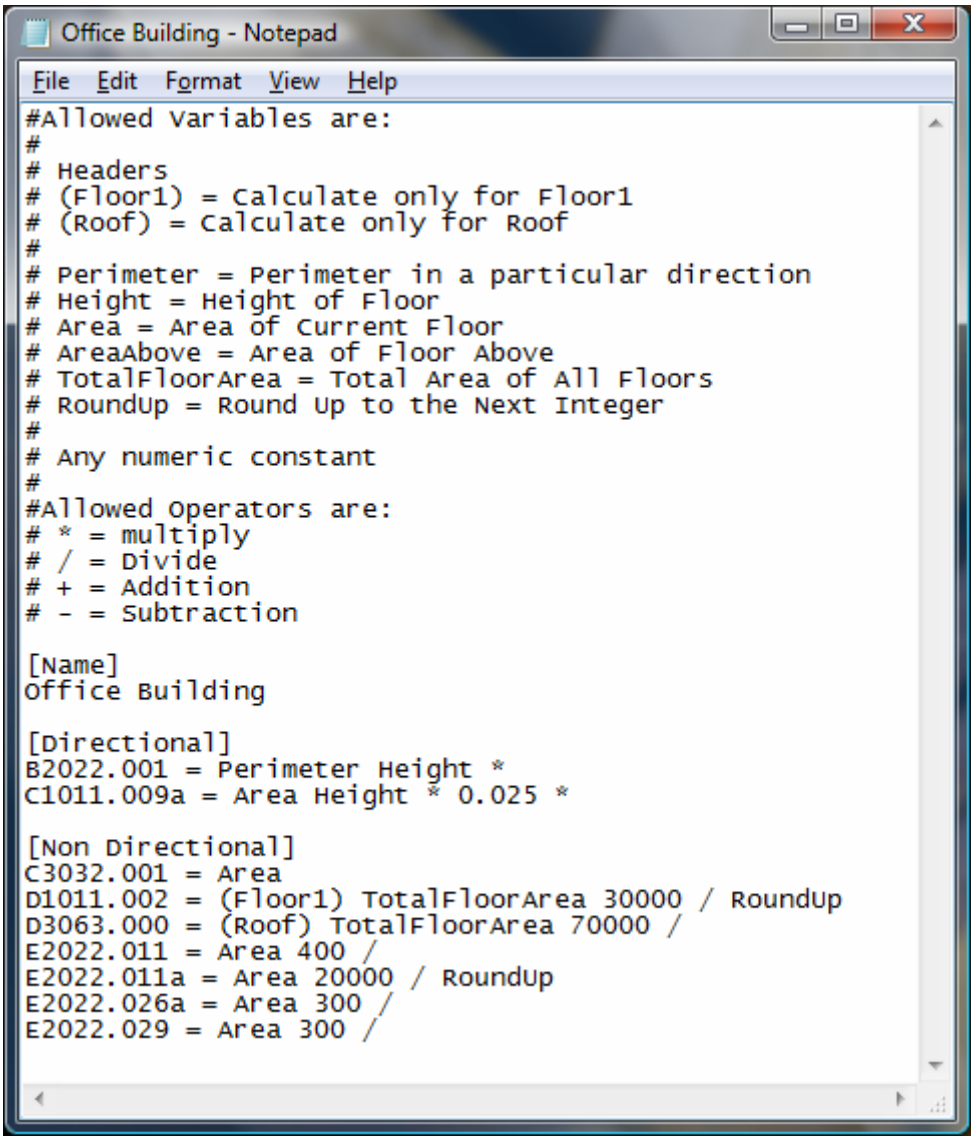
All information corresponding to a particular project (input and output) are saved in a single XML file with the project name in the Projects sub-folder under the folder that you installed PACT at. If you used the default path for installing PACT, the project files may be found at "C:\Program Files\ATC-58\PACT\Projects." Although XML files are text files that can be viewed and changed using any text or word processor you should be extremely careful if you want to manipulate these files as even minor manual changes may render a project file unusable. You can of course copy a project file for transportation to another computer or for archival purposes with no adverse effects.



5.2 Occupancy Template Files

Occupancy files are simple text files stored in a subfolder under the folder that you installed PACT at. If you used the default path for installing PACT, the template files may be found at "C:\Program Files\ATC-58\PACTTemplates." PACT will show any text file stored in that sub-folder as an Occupancy Template when displaying available templates. Currently there are two such files present in this sub-folder one for SMRF office buildings and the other for residential wood-frame buildings.

The structure of templates is rather simple and operations are defined in terms of RPN (Reverse Polish Notation).



Lines beginning with "#" are comment lines. There are eight headers such as *Floor1*, *Area*, etc. The name of the template is contained in the line following the [Name] identifier. Identifiers are marked by square brackets and a blank line separates one from the other. The fragility specifications that are directional or non-directional are listed

under the corresponding identifier. The rules of application of fragility specification to the building follow the equal sign. For example:

```
B2022.001 = perimeter Height *
```

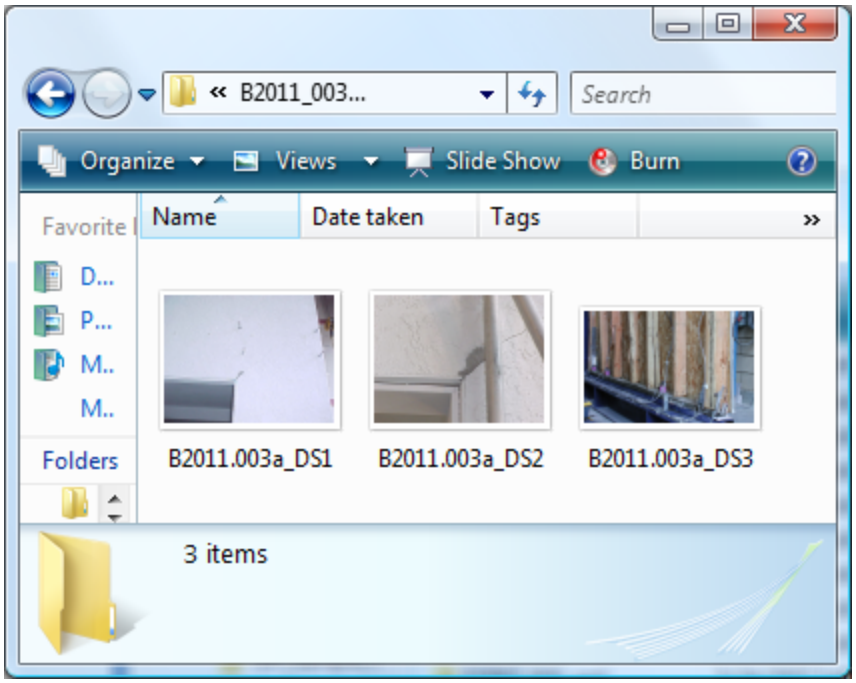
means for the B2022.001 fragility specification take the perimeter length of the floor in the direction under consideration multiplied by the floor height and place it in the corresponding quantity cell of the performance group table. Similarly

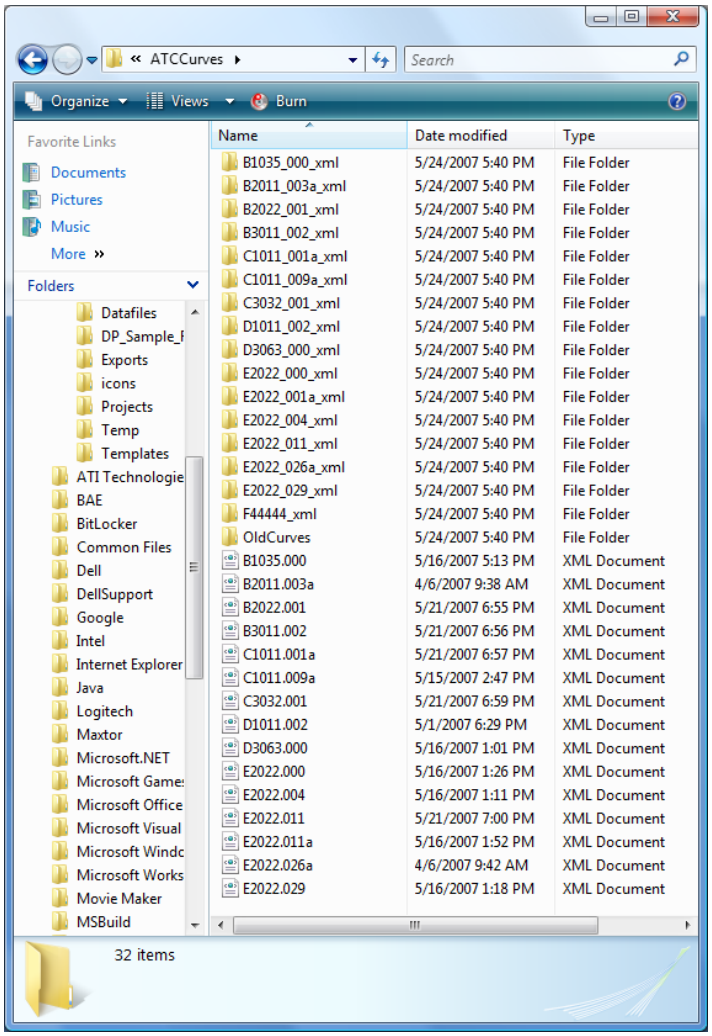
```
D1011.002 = (Floor1) TotalFloorArea 30000 / Roundup
```

means for the D1011.002 fragility specification take the total floor area of all floors, divide it by 30,000, round it up to the next integer and place it only at the first floor of the building in the corresponding non-directional cell of the performance group table.

5.3 Fragility Specification Files

Fragility specification files are XML files that bear the same identifier as the fragility specification they represent. For each fragility specification, there is an XML file and a folder with the same name that contains the representative photos of the damage states associated with the fragility function. These file are stored in a subfolder under the folder that you installed PACT at. If you used the default path for installing PACT, these files may be found at “C:\Program Files\ATC-58\ATCCurves.” PACT will show any proper fragility specification stored in this subfolder.





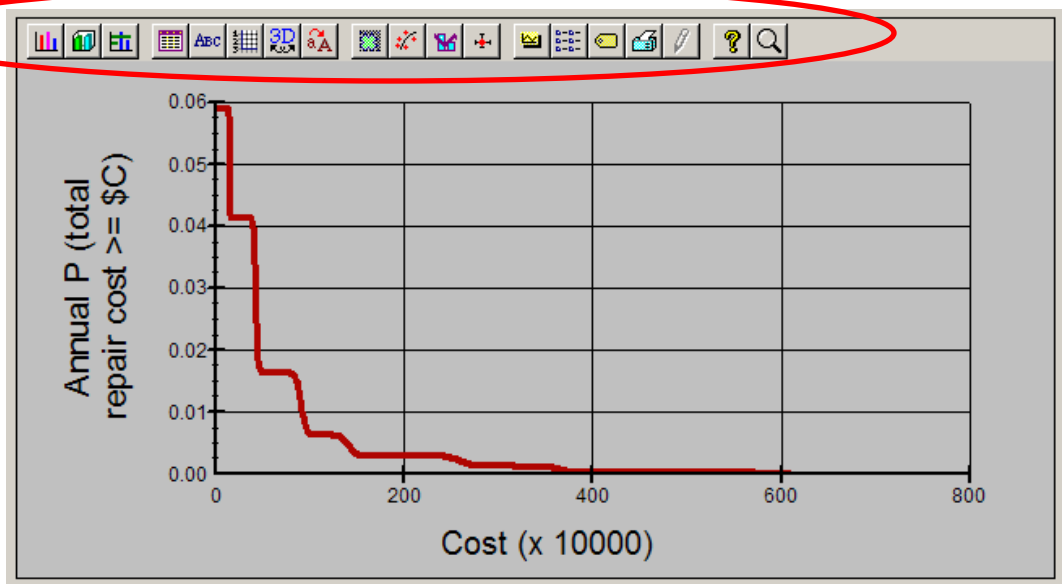
5.4 Programming Notes

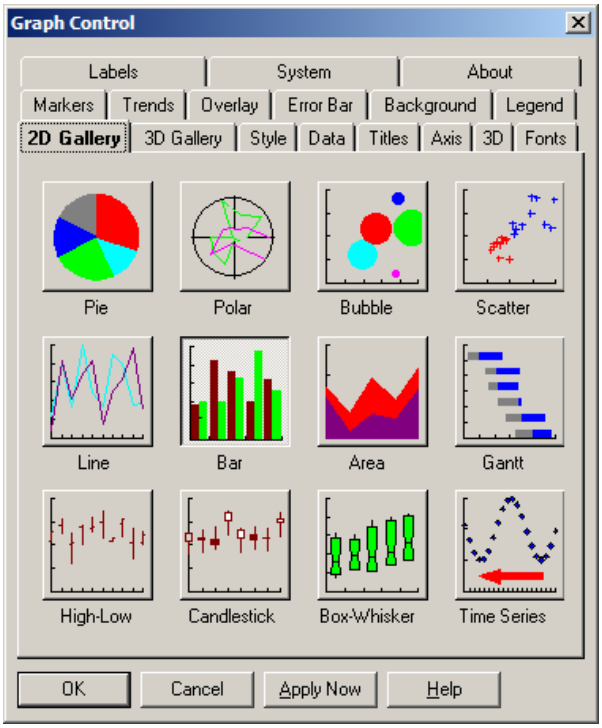
PACT is coded using Microsoft Visual Studio and VB 6.0 programming language. Certain engine routines are coded in Digital Visual Fortran. Besides the functions and utilities contained in the above two platforms the following third-party controls and libraries have been used.

Control Name	Vendor	Link
Graphics Server 6.0	Graphics Server Technologies	www.graphicsserver.com
Entisoft Tools 2.0	Entisoft	www.entisoft.com/
Arcadia PowerButton	Arcadia Software Development	hwww.arcadiahome.com

6 Advanced Use of PACT Graphs

Either right clicking the mouse or clicking the toolbar on the top of a graph (if shown) provides you with powerful tools for customizing and exporting PACT graphs. Using either method the Graph Control Panel will be displayed



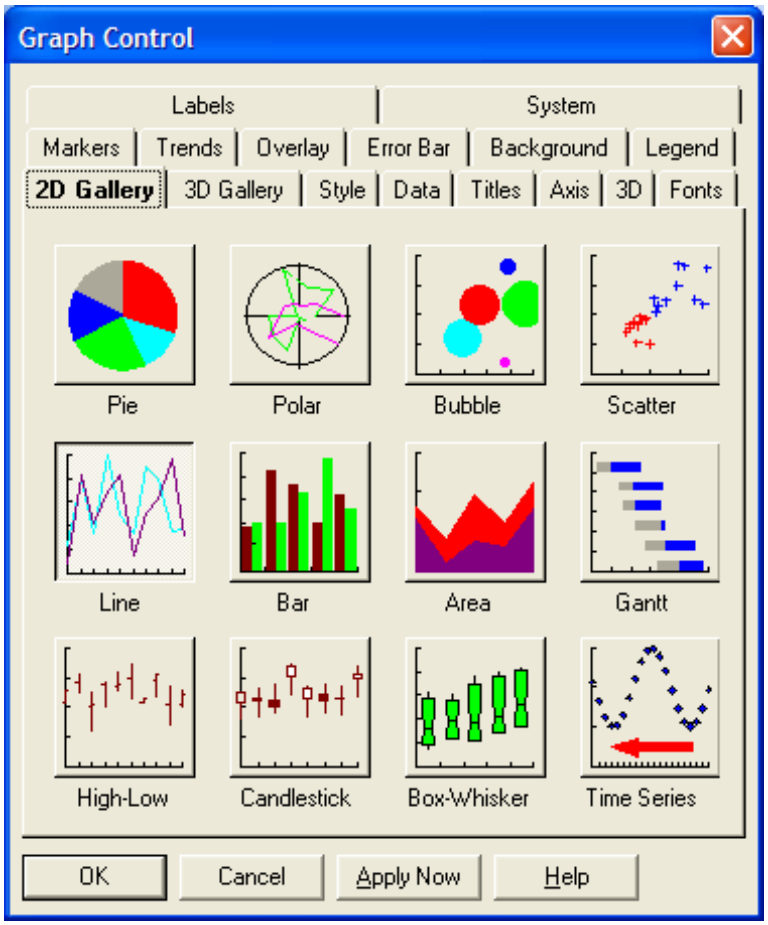


If you move your mouse over a toolbar icon, a short description of the icon appears. You may select a toolbar icon by clicking it.

6.1 Customizing PACT Graphs

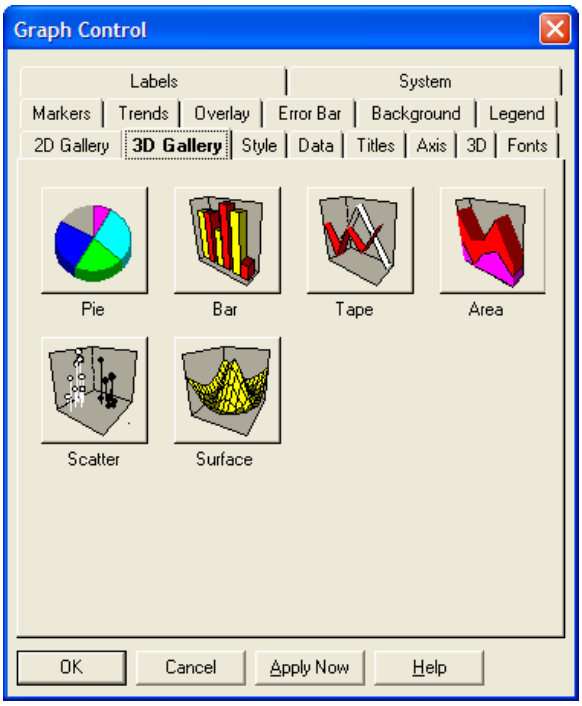
6.1.1 2D Gallery

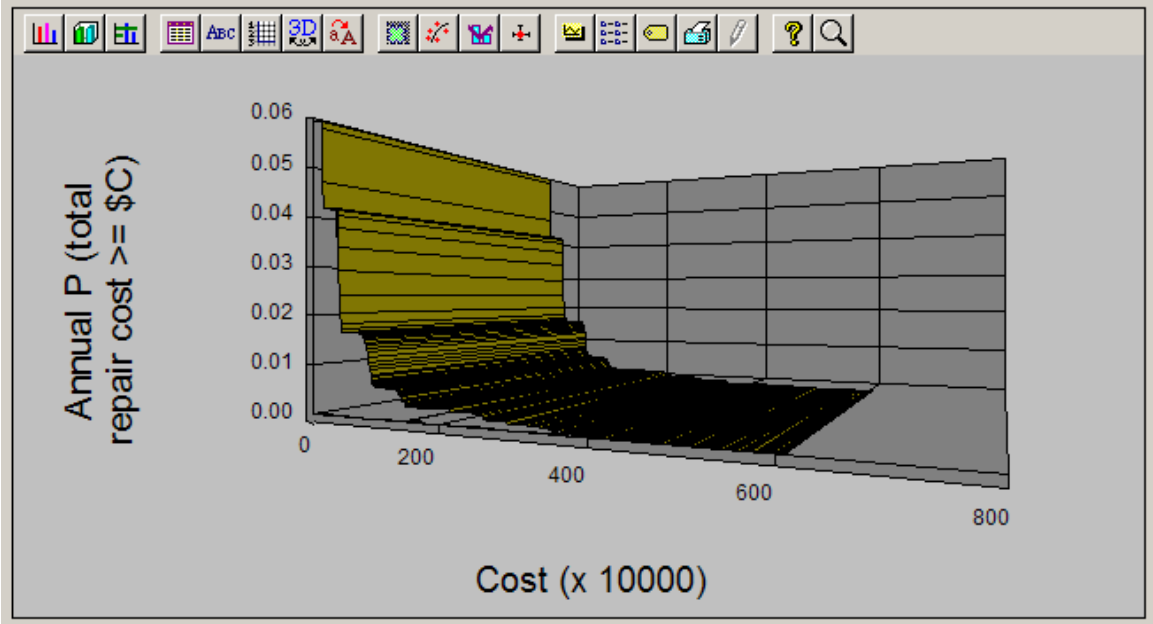
2D Gallery lets you change the type of two dimensional graph displayed. You may choose from several options including bar harts, scatter charts, area charts, etc. Most of the two dimensional graphs displayed on PACT are drawn using the line chart option, but you can change the type of chart displayed. Not all chart types produce meaningful graphs in every occasion, so you have to experiment with them and select the one that fits your purpose.



6.1.2 3D Gallery

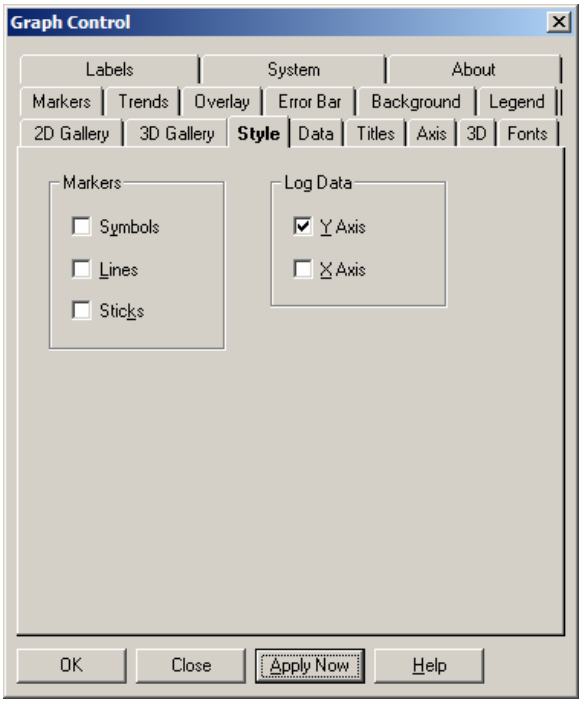
3D Gallery lets you give a three dimensional appearance to the displayed chart. Again, there are several options to choose from. For example, displaying a lateral displacement graph in a *tape chart* format results in a view like the one showed at the bottom of the page.

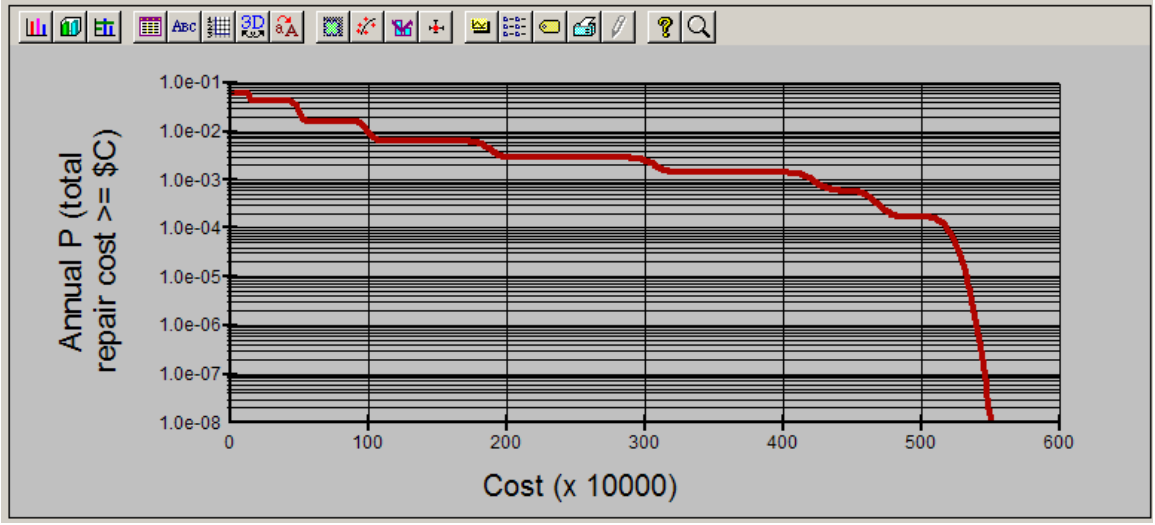




6.1.3 Style

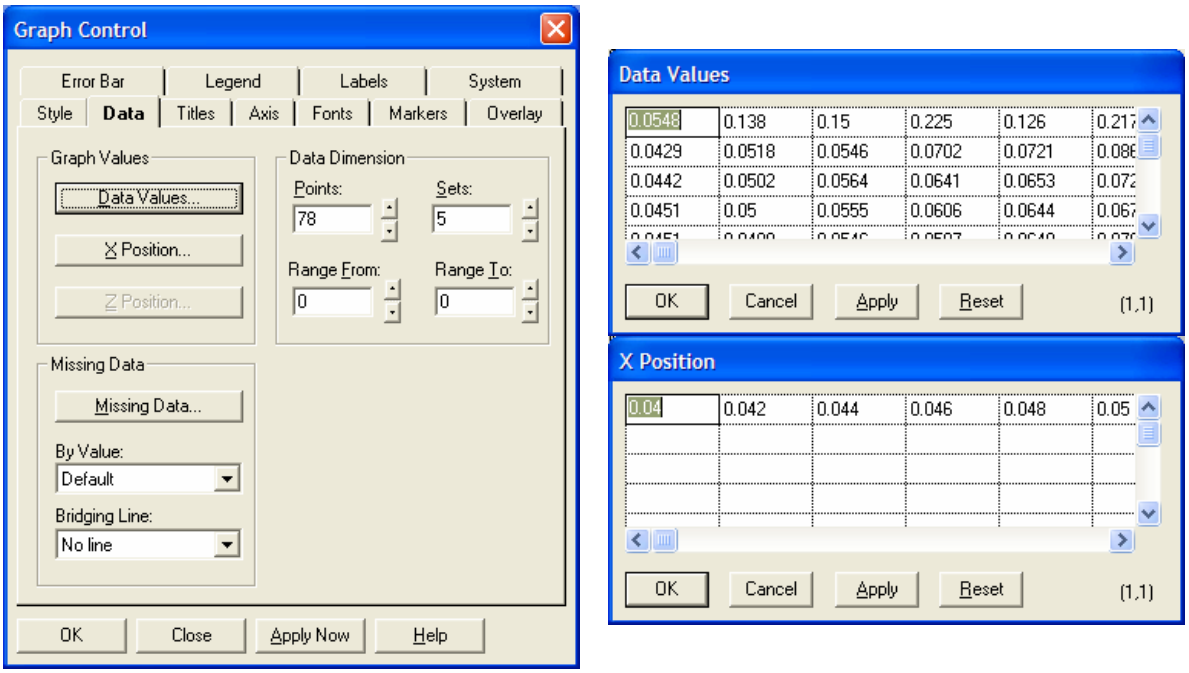
Style lets you select logarithmic scales for the graph axes and to mark data points by markers. For example, you can check the *Y Axis* under *Log Data* to display the annual loss probability curve.





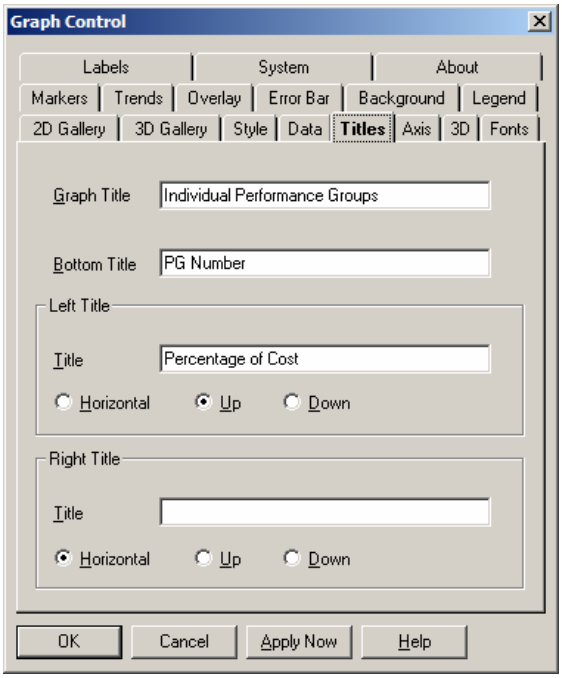
6.1.4 Data

Data permits you to examine the values of data displayed on the graph. For example, for the velocity spectra shown on the previous page, *Data* indicates that there are five sets of graphs on display each consisting of 78 data points. Clicking *Data Values* displays the data values (Y coordinates) for the five sets. Clicking *X Position* displays the X coordinates of data points. In this example you notice that one set of x coordinates is assigned to all five data sets.



6.1.5 Titles

Titles displays the current titles displayed on the graph and gives you the option to change the titles and the way they are displayed on the graph.



6.1.6 Axis

Axis lets you change the position of the axes on the graph, change the limits, select the type of grids to be shown on the graph and how tick marks are displayed on the graph.

6.1.7 3D

3D lets you rotate a three-dimensional graph and change the viewing angles.

6.1.8 Fonts

Fonts permits changing the font types and font sizes and font colors applied to graph titles, labels and legends.

6.1.9 Markers

Markers lets you mark various data points on the graph.

6.1.10 Trends

Trends lets you mark a graph with statistical indicators such as mean values and standard deviations.

6.1.11 Overlay

Overlay lets you change the overlay marks applied to a graph. Many PACT graphs use overlay to superimpose data bins on the lognormal approximation curve.

6.1.12 Error Bar

Error Bar lets you display various statistical indicators such as standard deviation, standard error, and user defined measures on multiple graph charts.

6.1.13 Legend

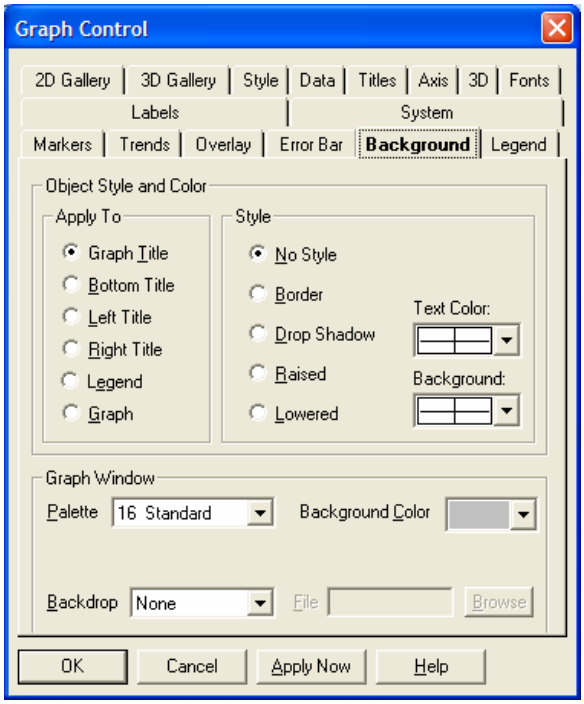
Legend permits you to change the location of graph legends and their associated text and font size.

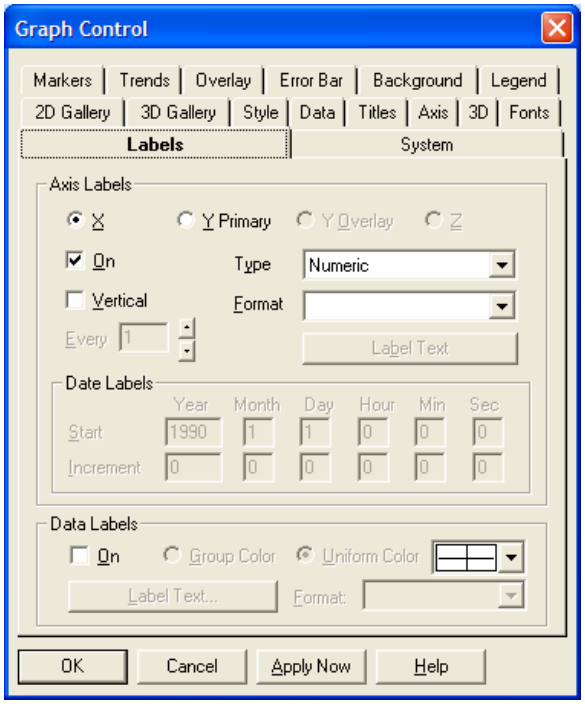
6.1.14 Background

Background lets you change the color schemes used to display the graph, its axes, background and titles.

6.1.15 Labels

Labels permits you to apply labels to selected data points.





6.2 Exporting and Printing PACT Graphs

In addition to using the button provided next to most of PACT graphs to export X-Y data of the graph, you can use *System* from the graph toolbar for exporting and printing PACT generated graphs. PACT graphs may be exported and to more than a dozen commonly used graphic file formats. Prints may be produced in color or black and white.