Training Guide

λPREDICT

Version 3

ReliaSoft®

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Lambda Predict Training Guide

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1.1 About this Training Guide

This training guide is intended to provide you with many examples to demonstrate the use of Lambda Predict. It begins with step-by-step examples and then proceeds into more advanced examples and questions.

Some of the examples in this training guide require you to access files that have been shipped with the Lambda Predict software. These files are located in the Training Guide folder in your application directory (*e.g.* C:\Program Files\ReliaSoft\LambdaPredict3\Training Guide).

1.2 Lambda Predict Documentation

Like all of ReliaSoft's standard software products, Lambda Predict is shipped with detailed printed documentation on the product (*Lambda Predict User's Guide*). This training guide is intended to be a supplement to that reference.

1.3 Minimum System Requirements

Lambda Predict 3 is compiled and designed for Microsoft Windows XP and Vista and takes advantage of the features available in these platforms.

Minimum system requirements:

- Windows XP or Vista.
- Microsoft Excel® 2003 or higher for automated report generation.
- 433 MHz Pentium class, AMD Opteron, AMD Athlon64 or AMD Athlon XP processor with 256 MB of RAM (512 MB or more is recommended), SVGA display and at least 125 MB of hard disk space.

Please note that if you have set your computer to use large fonts, you will need to set your screen display to 1024x768 in order for all windows to display correctly.

1.4 Contacting ReliaSoft

ReliaSoft can be reached at:

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For up-to-date product information, visit our Web site at:
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Features Summary 2

The examples in this training guide have been designed to introduce you to the features available in Lambda Predict. This section presents a brief summary of these features. If you are already familiar with Lambda Predict's features, you can proceed to the next chapter, First Steps.

2.1 Lambda Predict Supports Major Reliability Prediction Standards

Lambda Predict can be used to perform standards based reliability prediction analyses according to any of the following major published standards:

- **MIL-HDBK-217:** *Reliability Prediction of Electronic Equipment* (MIL-HDBK-217F), issued by the U.S. Department of Defense in December, 1991. Lambda Predict supports both the Part Stress and Parts Count calculation methods for electronic components in commercial and military applications.
- **Bellcore/Telcordia:** *Reliability Prediction Procedure for Electronic Equipment* (SR-332 Issue 2), issued by Telcordia Technologies in September, 2006. This standard provides reliability prediction models for electronic components in commercial applications. Lambda Predict also supports two previous versions of the standard (TR-332 Issue 6, issued by Bell Communications Research in 1997 and SR-332 Issue 1, issued by Telcordia Technologies in 2001).
- **NSWC (Mechanical):** *The Handbook of Reliability Prediction Procedures for Mechanical Equipment* (NSWC-07), issued by Naval Surface Warfare Center Carderock Division on July 31, 2007. This standard was originally released in the 1980s. It provides reliability prediction models for mechanical components, such as seals, springs, pumps, valves, brakes and more.

2.1.1 A Note about Licensing

Your copy of Lambda Predict is limited to the reliability prediction standard(s) that you purchased with your license. If you receive a file that contains systems that use standards that are not included in your license:

- You will be able to open the database file. You will see a notification upon opening the file that it contains systems based on standards not included in your license.
- You will be able to open all predictions in the project. You will, however, see only those systems that are based on standards included in your license.
- You will be able to open any and all stored plots in the project, and all original data will be displayed in the plots. If you refresh a plot (or make a change that causes an automatic refresh), however, the new plot will not include any items that are based on standards not included in your license. You will see a warning prior to the plot being redrawn.

2.2 Derating Standards

The following derating standards are available for use in Lambda Predict:

- **NAVSEA-TE000-AB-GTP-010**: *Parts Derating Requirements and Application Manual for Navy Electronic Equipment* (Rev. 1 with Change A), issued by the Naval Sea Systems Command in March 1991. This standard provides derating curves for ten electrical and electronic parts.
- **MIL-STD-975M**: *NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List*, issued by the U.S. National Aeronautics and Space Administration in 1994. This standard provides part selection information and derating curves for electronic parts, materials and processes for space and launch vehicles.
- **MIL-STD-1547A**: *Electronic Parts, Materials, and Processes for Space and Launch Vehicles*, issued by the U.S. Department of Defense in November 1998. This standard provides part selection information and derating curves for electrical, electronic and electromechanical parts used in the design and construction of space flight hardware in space missions as well as essential ground support equipment (GSE).
- **Naval Air System Command AS-4613**: *General Specification for Application and Derating Requirements for Electronic Components*, issued by the U.S. Naval Air Systems Command in 1976. This standard provides derating curves for three classes of electronic and electromechanical parts.
- **ECSS-Q-30-11-A**: *Space Product Assurance*, issued by the European Cooperation for Space Standardization in April, 2006. This standard provides derating requirements for electronic, electrical and electromechanical components used for space projects and applications.

For MIL-HDBK-217F or Bellcore/Telcordia systems in Lambda Predict, you can choose a derating standard to use for the components of the system. Once a standard has been chosen, each component indicates if its current stress levels are within the derating standard or not. Graphical displays of the situation are available for ease in identifying problem areas. Parametric displays are also available to show the temperature vs. stress situation of the component.

You can also define your own derating requirements, giving you the ability to combine any of the published standards with your own.

2.3 Work with Multiple Predictions and Systems Simultaneously

The first step to perform a standards based reliability prediction analysis in Lambda Predict is to create a database file (*.lp3) and a prediction. Systems can be created within the prediction according to any of the reliability prediction standards that are enabled for your copy of the software (*i.e.* MIL-HDBK-217F, Bellcore/Telcordia or NSWC-07). The options available for defining the system configuration and component properties, as well as the analysis results, will vary depending on the standard that you are using.

Each file can contain multiple predictions (with the failure rate and other metrics calculated at the prediction level based on the calculations for the systems it contains). You can work with multiple predictions simultaneously, which provides an easy way to copy information among predictions or compare alternate designs.

2.4 Calculated Results

Lambda Predict provides several ways to obtain calculated results for your analyses. Failure Rates, MTBFs, Pi Factors and other metrics can be displayed in the System Hierarchy and Properties panels. Results are available for individual components, higher level assemblies and systems.

2.5 Graphical Plots/Charts

Lambda Predict provides a complete array of plots/charts to demonstrate your analysis graphically. This includes plots for Failure Rate, MTBF, Mission Time and Unavailability (displayed independently and versus Temperature, Environment, Stress, etc.).

You can customize your plots using the Plot Setup. The Plot Setup gives you full control over the settings used both for individual plots and as default settings for all new plots.

2.6 Reports

Lambda Predict gives you the ability to generate template-based reports for your predictions. Reports are generated in Microsoft Excel®, which provides maximum flexibility for additional post-generation customization and distribution. You can customize the appearance of all predefined reports and also build and manage your own custom report templates to include information about Failure Rates, Application Parameters, Physical Parameters, Pi Factors, etc.

2.7 Flexible Data Management (Import and Export)

Lambda Predict's flexible data management options include the ability to import and export data from other Lambda Predict 3 files as well as importing from Excel spreadsheets and delimited text files.

2.8 Libraries

Lambda Predict's libraries provide pre-configured components that you can copy and paste into your project. You can create your own libraries, use the libraries included with the application or take advantage of the collection of parts libraries available on ReliaSoft’s Web portal at http://www.PartLibraries.org, which contains the data found in the installed part libraries and will also be continually updated with the most current commercial components.

2.9 Allocations

The Allocations utility provides five allocation models that can be used to logically apportion the product design reliability into lower level design criteria such that the cumulative reliability still meets the requirements. The available models are: Equal Allocation, AGREE Allocation, Feasibility of Objective Allocation, ARINC Apportionment Technique and Repairable Systems Allocation.

2.10 Intuitive, Flexible and Customizable Work Environment

The powerful and flexible interface allows you to keep all related analyses and information together in a single database file. Using the “Project Explorer” approach that is employed in many of ReliaSoft’s other applications (*e.g.* Weibull++, ALTA and BlockSim, among others), Lambda Predict provides an intuitive, hierarchical (tree) structure to allow you to view and manage maintain multiple predictions, plots and attachments within a project.

Lambda Predict's User Setup allows you to configure the work environment and analysis settings to meet your particular needs. This includes the parameters and results displayed in the System Hierarchy panel, the displayed math precision, etc.

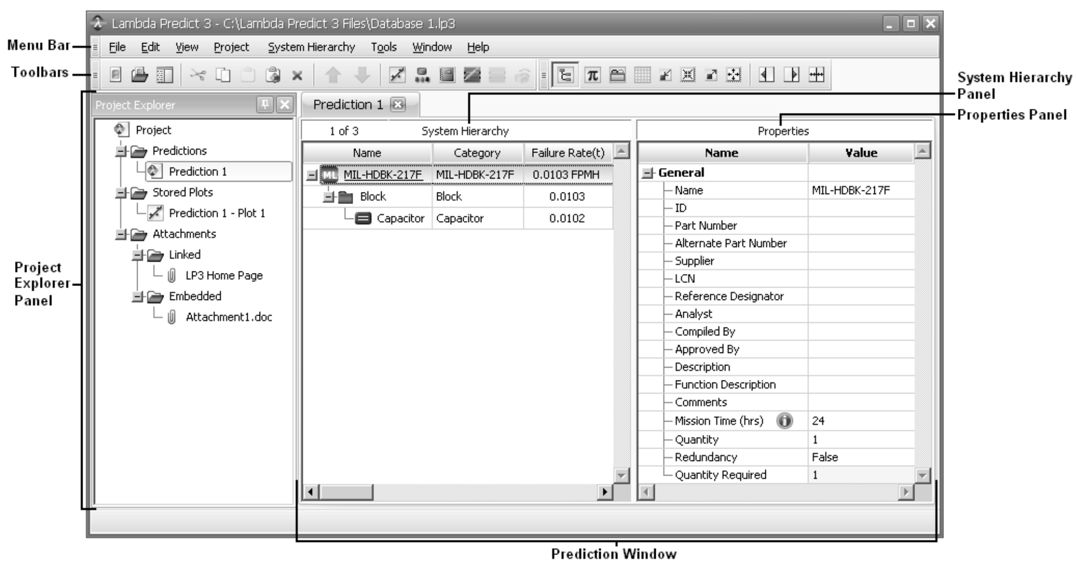
First Steps 3

3.1 Starting Lambda Predict

To start Lambda Predict, from **Start** select **All Programs**, **ReliaSoft Office** and then **Lambda Predict 3**.

3.2 Multiple Document Interface and Data Folio

Lambda Predict's Multiple Document Interface (MDI) is the workspace within which you can create, edit and manage your standards based reliability prediction analyses. The MDI remains open until you close the program and closing the MDI terminates the program. The next figure displays the Lambda Predict MDI and its default components.



The Project Explorer panel presents all of the items associated with the current project in a hierarchical tree structure. The project name is displayed at the top of the tree structure. The folders that contain the predictions, stored plots and attachments are displayed below the project name.

The System Hierarchy panel displays the system hierarchy, which includes all systems, blocks and components that have been defined in the prediction.

The Properties panel allows you to view and edit the properties of the system, block or component that is currently selected in the System Hierarchy panel.

3.3 Getting Help in the Lambda Predict Environment

ReliaSoft's Lambda Predict includes complete on-line help documentation. This help can be obtained at any time by pressing **F1** or by choosing **Help > Contents**.

3.4 First Steps Example

This example has been designed to familiarize you with Lambda Predict's interface and tools. It uses a sample data set for demonstration purposes that is not intended to be realistic. You will:

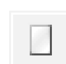
- Create a new database/project, including a new prediction with a MIL-HDBK-217F system.
- Build a hierarchical system configuration using the blocks and components that are available for the MIL-HDBK-217F standard.
- Modify general properties of the system, block and components.
- Plot the data for the system.

3.4.1 Create a New Database and Project

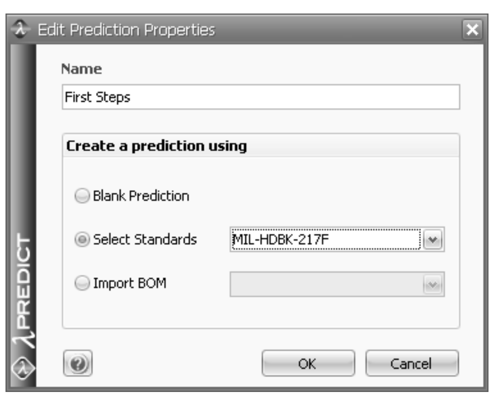
The first step in performing a standards based reliability prediction analysis in Lambda Predict is to create a database file (*.lp3) with an associated project and the next step is to add a prediction. The prediction can contain one or more individual systems, analyzed according to one of the reliability prediction standards supported by Lambda Predict (*i.e.* MIL-HDBK-217F, Bellcore TR-332 Issue 6, Telcordia SR-332 Issue 1, Telcordia SR-332 Issue 2 or NSWC-07). Although the basic procedures are the same, the options available for defining the system configuration and component properties, as well as the analysis results, will vary depending on the standard that you are using.

At this time, we assume that you have started the application.

- Create a new Lambda Predict database by choosing **File > New Database** or by clicking the **New Database** icon.[1]

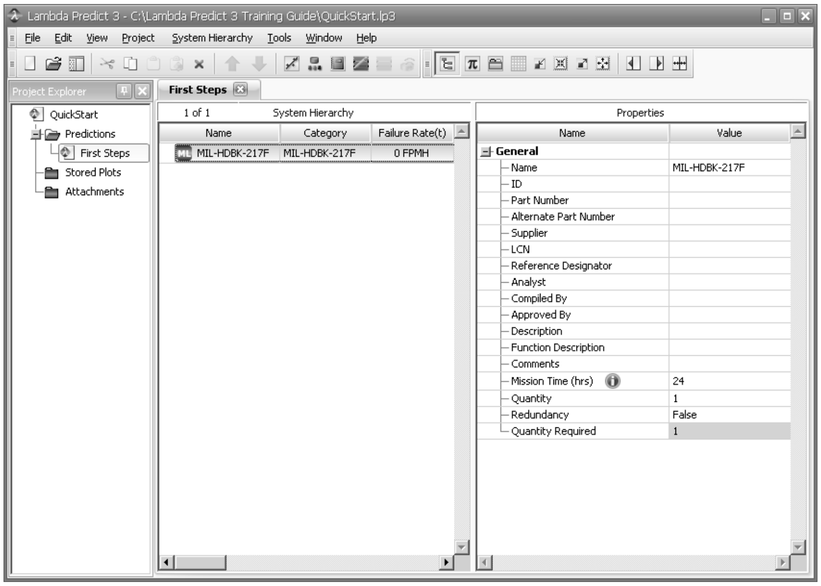


- In the Create New Database window, browse to the desired location for the database, type the name **QuickStart** and click **Save** to continue.
- In the Edit Prediction Properties window that appears next, do the following:
  - In the **Name** field, type **First Steps**.
  - Select the **Select Standards** option. In the list that becomes available, select **MIL-HDBK-217F** and click **OK**. The Edit Prediction Properties window will look like the one shown next.



1. If you have just started Lambda Predict and the initial window is displaying, you can click **Create New Database**.

- Click **OK** to create the new prediction and system. The MDI will look like the one shown next.



3.4.2 A Note about Terminology

When working in the System Hierarchy panel in Lambda Predict, you should be aware of how the following terms are used:

- **Systems** are analyzed according to one of the reliability prediction standards supported by Lambda Predict (*e.g.* MIL-HDBK-217F, Telcordia SR-332 Issue 2, etc.). Such systems are made up of blocks and components.
  - Lambda Predict also offers a Generic system, which has no analysis properties of its own and cannot have blocks or components. Generic systems can only contain other systems, and they serve purely as a way to roll up failure rates from their subsystems.

  A system is always the first item added to a prediction.
- A **block** represents a group of blocks and/or components in the next lower level of the system configuration. Lambda Predict uses the block properties (based on the applicable reliability prediction standard) together with the calculations for the blocks and components in the next lower level to determine the failure rate, MTBF and other results for the subassembly that the block represents.
- A **component** represents an individual item (such as a fuse, capacitor, valve, spring, etc.) with properties based on the applicable reliability prediction standard that are used to calculate the item's failure rate, MTBF and other results. Components always represent the lowest level within a branch of the hierarchy. In other words, you cannot place another block or component below an existing component.

> **Note:** It is recommended that you always use a block as the parent of components, rather than adding components directly to a system. This allows you to more accurately represent connections (if applicable, as in MIL-HDBK-217F systems) and facilitates more advanced analysis.

On the System Hierarchy menu, Lambda Predict uses the following terminology:

- **Top Level Item:** When you add a Top Level Item, you add a system to the prediction. The Generic system is always available; the availability of the other system types depends on the standards that you purchased.

- **Same Level Item:** When you add a Same Level Item, you add an item at the same level of the system hierarchy as that of the item you currently have selected:
  - If a system is selected, select **Add Same Level Item** to add a new system as the current system.
  - If a block or component is selected, select **Add Same Level Item** to add a component, block, or linked block to the system.
- **Next Level Item:** When you add a Next Level Item, you add an item immediately subordinate to the currently selected item:
  - If a generic system is selected, select a **Add Next Level Item** to add a dependent system to the generic system.
  - If any other system type, a block or component is selected, select **Add Next Level Item** to add a component, block, or linked block to the system.

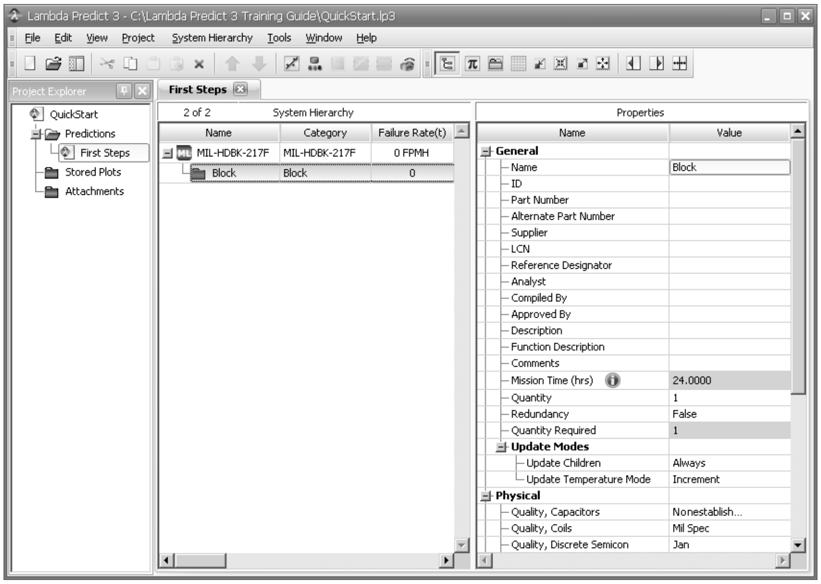
3.4.3 Build the System Configuration

You can build the hierarchical system configuration using the blocks and components that are available for the current standard. In general, blocks are used to represent groups of items within a multilevel system configuration (*e.g.* subsystems, subassemblies, etc.). They can have components and other blocks below them in the hierarchy and Lambda Predict uses the block properties (based on the applicable reliability prediction standard) together with the calculations for the blocks and components in the next lower level to determine the failure rate, MTBF and other results for the subassembly that the block represents. Components (*e.g.* fuses, switches, resistors, pumps) have pre-defined properties based on the selected standard and must be placed at the lowest level within a branch of the hierarchy.

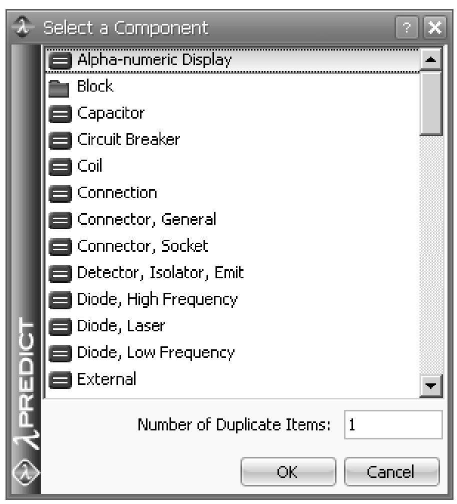
For this example, you will be defining the following configuration (a subassembly that consists of three capacitors):

- Block 10
  - Capacitor 10.1
  - Capacitor 10.2
  - Capacitor 10.3

- To add a block to the system, click the MIL-HDBK-217F system in the System Hierarchy panel (center) and choose **System Hierarchy > Add Next Level Item > Block**. The block will be added to the system, as shown next.



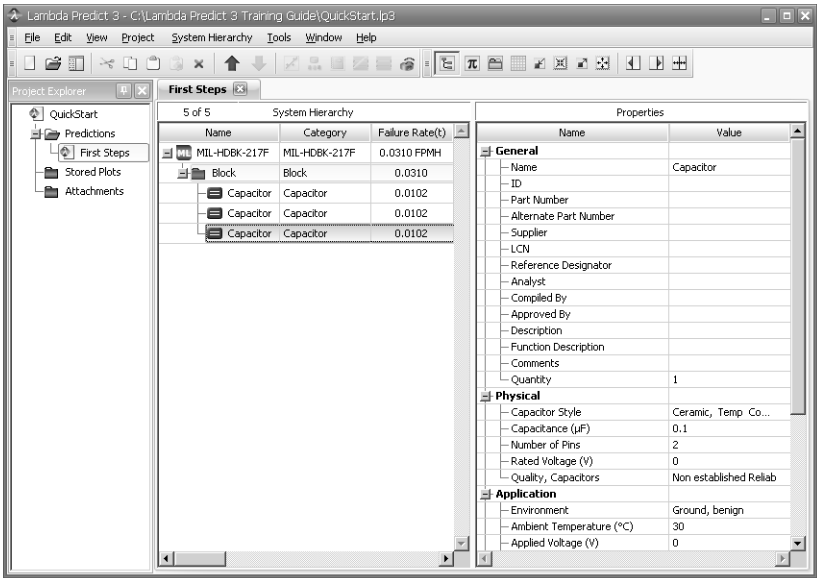
- Now add components to the block. To do this, right-click the block and choose **Add Next Level Item > Component/Block** from the shortcut menu. The Select a Component window will appear, as shown next.



Note: The simplest way to add 3 capacitors to the system at one time is to type 3 in the **Number of Duplicate Items** field and click **OK**. However, to demonstrate some of the other techniques that you can use in Lambda Predict when building systems, this example uses several other methods to add the capacitors to the system.

- You can either double-click **Capacitor** in the list or click it once and click **OK** to add it to the block.
- Add another capacitor by copying the first one you added and pasting it to the block. To do this, right-click the capacitor and select **Copy** from the shortcut menu. Next, right-click the block and select **Paste As Next Level** from the shortcut menu. The pasted capacitor will appear on the level beneath the block, along with the original capacitor.

- To add the third capacitor, right-click the first capacitor and select **Copy** from the shortcut menu. Next, right-click the original capacitor and select **Paste As Same Level** from the shortcut menu.
- Once you have finished adding the three components, the MDI will look like the one shown next.



3.4.4 Explore Additional Views

By default, the first time you open Lambda Predict, the Tree view is used in the Properties panel. The Tree view organizes item properties into a hierarchical structure. The appearance of the Tree view will vary depending on the type of record that is currently selected in the System Hierarchy panel and the type of analysis that is being performed.

Lambda Predict also includes three additional view types: Pi Factor, Tab and Grid.

- The **Pi Factor** view displays the item properties based on the Pi factor(s) that they contribute to. Pi factors account for the effects of various factors such as environment, stress, quality, etc. on the part's expected failure rate, which is the product of the part’s base failure rate and each Pi factor (or acceleration factor) that quantifies the effect of a particular factor's variance from baseline. This means that all Pi factors for a part operating under baseline conditions will be equal to 1, while if the part is operating under conditions other than baseline, one or more Pi factors will greater than or less than 1.
- The **Tab** view displays the item properties grouped on separate tabs, rather than in a hierarchical tree structure.
- The **Grid** view displays each item property as a column.[2]

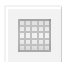
[2] By default, only the “general” properties are displayed in the Grid view. To change the columns that are displayed and/or the order in which they are displayed, right-click in any column header and choose **Customize**.

To change the Properties panel view, choose **View** > **Select Properties View** and then choose the desired view or click the appropriate icon in the View toolbar.

 Tree View

 Pi Factor View

 Tab View

 Grid View

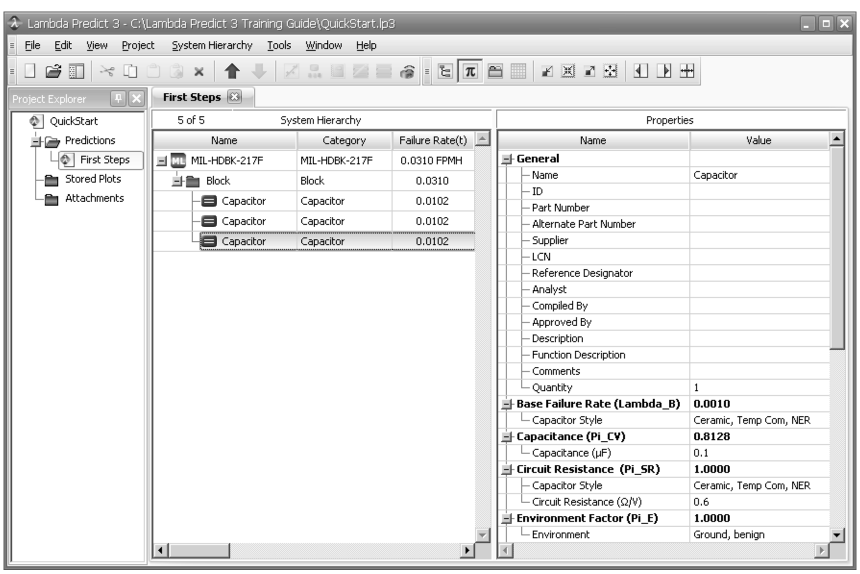
The properties that are shown and the way in which they are displayed and/or edited will vary depending on the view that you are using.

In all views, the following tips apply:

- Fields that cannot be edited are displayed with a grey background.
- In the Tab and Grid views, when you point to a numeric parameter, a tooltip will appear that displays the maximum and minimum allowable values for that field. In the Tree and Pi Factor views, the tooltip displays when you click inside the field.
- Additional information is available for certain parameters. These parameters have an Information icon that you can click to display the information in a tooltip.

For example, to view the First Steps data in the Pi Factor view, with the third capacitor selected, do the following:

- Choose **View** > **Select Properties View** and then choose **Pi Factor View**. The MDI will look like the following.



- You can take some time to look the other views, if desired. When you are finished, return to the Tree view.

3.4.5 Modify General Properties of the System, Block and Components

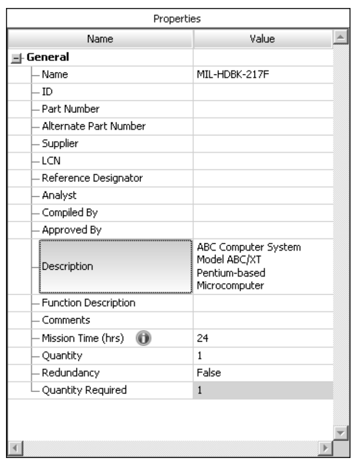
You can use the Properties panel on the right side of the MDI to view and modify the properties of the system, block or component that is currently selected.

Before modifying the properties choose **View > Wrap Text**. The enables Lambda Predict's text wrap functionality, which allows row heights to be expanded and text wrapped to fit within the viewable area where necessary.

- Select the system in the System Hierarchy panel (called "MIL-HDBK-217F") to display the properties in the Properties panel.
- Notice that some of the fields have already been filled out for the system by default. You can change any of these properties but for this example, we will use the defaults. Enter the following additional information into the corresponding field for the system.

Description:	ABC Computer System Model ABC/XT Pentium-based Microcomputer

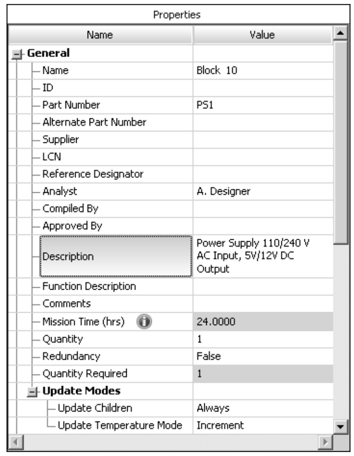
- Press **ENTER** or click outside the **Description** field to accept your input.
- The Properties panel for the system will look like the one shown next.



- Next, select the block that you added to the system. In the **General** properties area of the Properties panel, enter the following information:

Name:	Block 10
Part Number:	PS1
Analyst:	A. Designer
Description:	Power Supply 110/240 V AC Input, 5V/12V DC Output

- The Properties panel for the block (now named “Block 10”) will look like the one shown next.

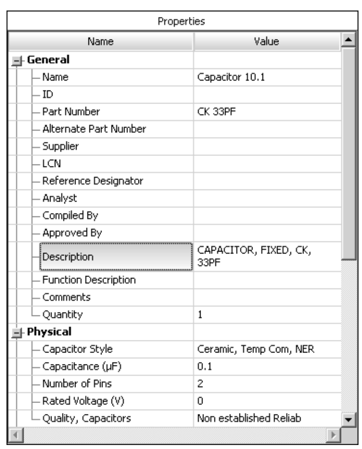


- Scroll down through the Properties panel and notice the Application properties. The Application properties contain some of the MIL-217 parameters required for the failure rate calculation, including parameters that specify information about the environment in which the item is being used. Notice that the application parameters are already set for the block. For this example, we will use the default settings.

- Now select the first capacitor in the System Hierarchy panel and enter the following information into the **General** properties area of the Properties panel.

Name:	Capacitor 10.1
Part Number:	CK 33PF
Description:	CAPACITOR, FIXED, CK, 33PF

- The Properties panel for the first capacitor (Capacitor 10.1) will look like the one shown next.



- You can view the physical parameters for the capacitor by scrolling down through the Properties panel to the Physical properties section. The Physical properties include parameters that specify information about the component itself, which are also required for the failure rate calculation. Notice that the physical parameters are already set for the capacitor. You can also scroll down to the Application properties section to view those parameters. For this example, we will use the default settings for all physical and application parameters.

You can use the Grid view to quickly enter information for multiple items at the same time.

- In the System Hierarchy panel, select Block 10. Choose **View > Select Properties View** and then choose **Grid View**. (Note that only the immediately selected item in the System Hierarchy panel and its children are shown in the Grid view.)
- Now enter the following information for the second and third capacitors.

Capacitor 2	
Name:	Capacitor 10.2
Part Number:	CQ-10NF
Description:	CAPACITOR, FIXED, POLYESTER, 10nF
Comments:	These capacitors are rated at 24 Volts and being used at 20V. If this causes a problem upgrade to 40V devices.

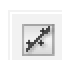
Capacitor 3	
Name:	Capacitor 10.3
Part Number:	0805 COG
Description:	CAPACITOR, FIXED, CERAMIC CHIP, 220 pF

- After entering the data, return to the Tree View.
- You can take the time to view the default physical and application parameters for these two capacitors, if desired.

Looking at the System Hierarchy panel will show that the value for the system in the Failure Rate(t) column is 0.0310 FPMH. In other words, at the default mission time (24 hours, specified in the **Mission Time** field in the system's general properties), the expected failure rate is 0.0310 failures per million hours.

3.4.6 Plot the System Data

- Select the system in the System Hierarchy panel and then choose **Tools > Plot** or click the **Plot** icon.

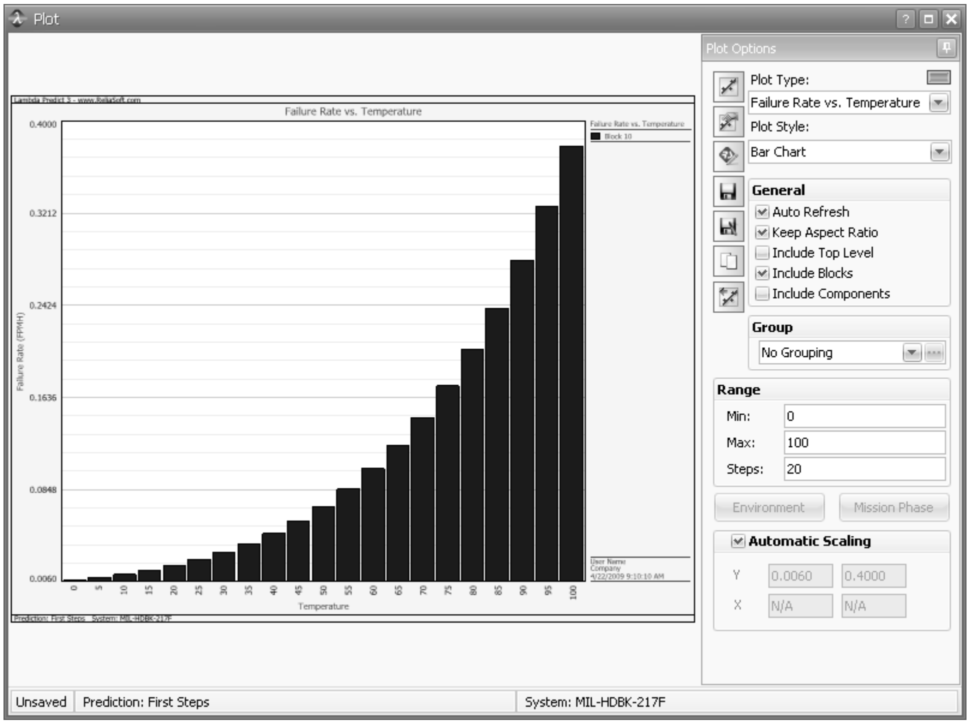


The Plot window will appear.

- By default, the last plot type that was selected will automatically be plotted when you open the Plot window. For this example, choose **Failure Rate vs. Temperature** from the **Plot Type** list in the Control Panel on the right side of the Plot window. If the **Auto Refresh** option is not selected, you will have to click the **Refresh** icon to refresh the plot with the new plot type.

- In the **Range** area, enter **0** for the minimum temperature (**Min**), **100** for the maximum temperature (**Max**) and **20** for the number of intervals (**Steps**). Also make sure that the **Include Blocks** option is selected and that the **Include Top Level** and **Include Components** options are not selected.

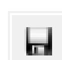
The Failure Rate vs. Temperature plot is shown next.



The data in the plot are based on the system that you selected in the System Hierarchy panel for use as the top level item. Systems or blocks can be used as top level items.

You can generate other plots by choosing different types in the **Plot Type** list. Remember that if the **Auto Refresh** option is not selected, then you will have to click the **Refresh** icon to refresh the plot with the new plot type.

- Click the **Save** icon to save the plot in the current project.



- You will be prompted to enter a name for the plot so that it can be saved to the project's Stored Plots folder in the Project Explorer. Accept the default name, **First Steps - Plot 1**, and click **OK**.
- Close the plot by clicking the **Close (x)** button in the upper right corner of the window.

This feature allows you to save the plot together with the project file so you can access it again (with the same data set and settings) in the future. If you do not save the plot, you can re-create it in the future but you will need to make all selections again.

Lambda Predict also allows you to create plots from within the Project Explorer by choosing **Project > Add Plot** or right-clicking the project's Stored Plots folder in the Project Explorer and choosing **Add Plot** on the shortcut menu. Plots created in this way can have multiple top level items. Closing a plot created in this way causes Lambda Predict to prompt you for a name for the plot so that it can be saved to the project's Stored Plots folder in the Project Explorer.

For more information about plots, refer to Example 8 on page 53.

3.4.7 Close the Database

You have completed the First Steps example. You can now close the Lambda Predict database. Lambda Predict saves each change to the database as it is made, so there is no need to save prior to closing the file.

If you do not close the database, it will be closed automatically when you create a new database for the next example or open an existing database.

- To close the database, choose **File > Close Database**.
- Proceed to the Step-by-Step Examples in Chapter 4.

Step-by-Step Examples 4

4.1 List of Examples

This chapter provides the following step-by-step examples, designed to introduce you to the features of the Lambda Predict software:

- Example 1 - Working with Component Properties - page 19
- Example 2 - Working with Parts Outside the Standard - page 26
- Example 3 - Using Libraries - page 32
- Example 4 - Importing Data From Excel - page 36
- Example 5 - Further Analysis - page 42
- Example 6 - Advanced Analysis: Allocation - page 45
- Example 7 - Advanced Analysis: Derating - page 50
- Example 8 - Information Reporting - page 53

4.2 Example 1 - Working with Component Properties

This example will demonstrate more advanced features of working with component properties in Lambda Predict. It uses a sample data set for demonstration purposes that is not intended to be realistic. You will:

- Create a new prediction and copy a system from an existing prediction.
- Work with default component properties.
- Change component properties.
- Reset the default component properties.
- Change block properties.
- Change connection types for your analysis, including changing a custom connection type.

4.2.1 Opening a Database

For this example, you will be working with the QuickStart.lp3 database that you created in the First Steps example in Chapter 3.

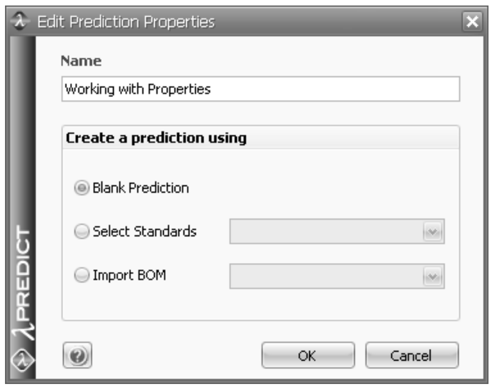
- Open the database by choosing **File > Open Database** or by clicking the **Open Database** icon.

- In the Open Database window, browse to the location of the database, click the **QuickStart.lp3** file and click **Open** to continue.

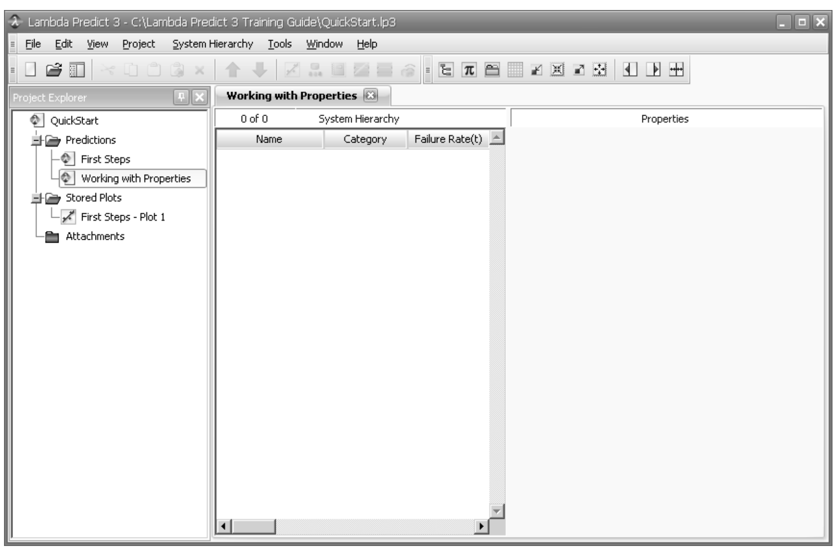
4.2.2 Create a New Prediction

For this example, you will create a new prediction without any standards initially selected.

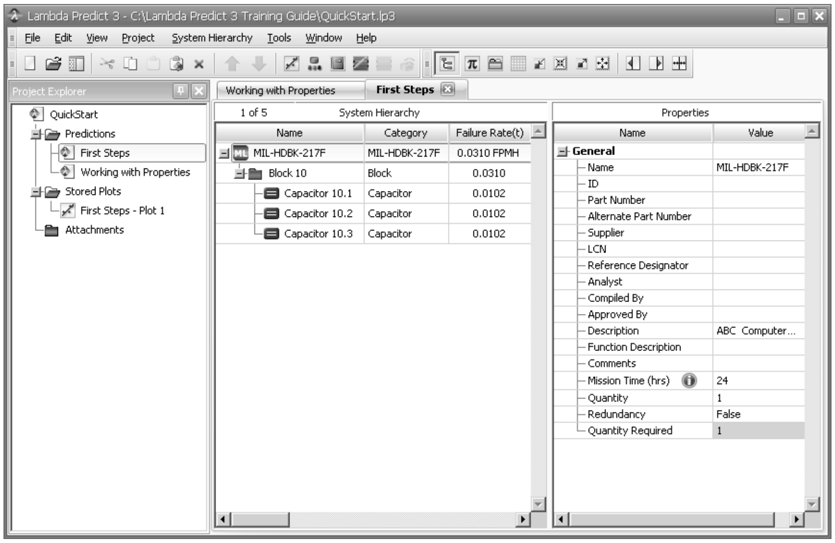
- To create a new prediction, choose **Project > Add Prediction** or right-click the **Predictions** folder in the Project Explorer and choose **Add Prediction** from the shortcut menu.
- In the Edit Prediction Properties window that appears, do the following:
  - In the **Name** field, type **Working with Properties**. The Edit Prediction Properties window will look like the one shown next.



- Click **OK** to create the new prediction. The MDI will look like the one shown next.



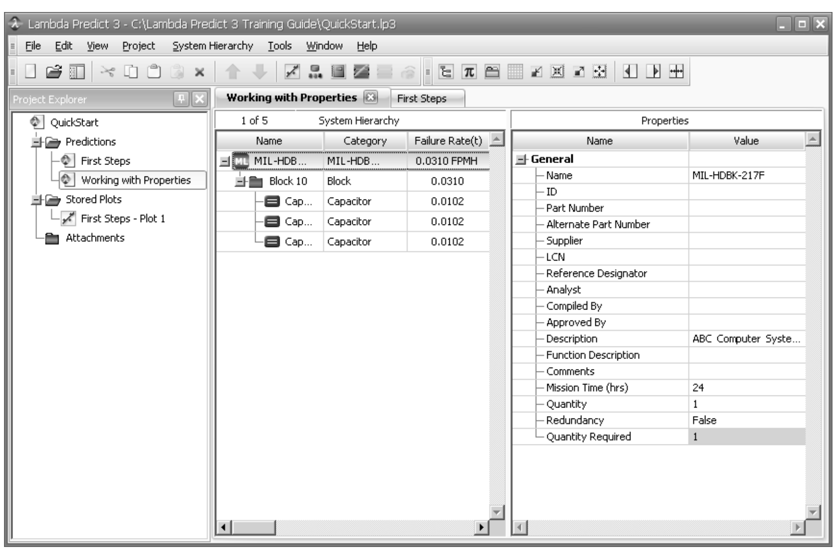
- In the Project Explorer, double-click the **First Steps** prediction to open it. The MDI will look like the one shown next.



- In the System Hierarchy panel, click the **MIL-HDBK-217F** system and choose **Edit > Copy**. You can also click the **Copy** icon or right-click the system and choose **Copy** from the shortcut menu.

- To bring the focus to the Working with Properties prediction, click the **Working with Properties** tab.
- To add the copied system to the prediction, you can click in the System Hierarchy panel and choose **Edit > Paste As Same Level** or click the **Paste As Same Level** icon or right-click in the System Hierarchy panel and select **Paste As Same Level** from the shortcut menu.

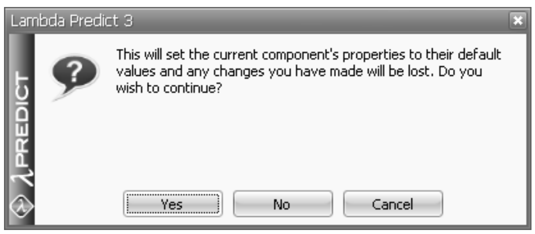
The pasted system, its block and its components will appear in the System Hierarchy panel. The MDI will look like the one shown next.



4.2.3 Changing and Resetting Properties

Each block or component that you add to a system has default properties that are pre-defined based on the type of analysis that you are working with (*i.e.* MIL-HDBK-217, Bellcore, etc.). If you have changed the settings for an item, you can change them back to the default settings.

- In the System Hierarchy panel, click the capacitor named **Capacitor 10.3**. Note that the Properties panel displays its properties.
- In the Properties panel, in the capacitor's Application properties, change the value of the **Voltage Stress** field to **0.5**.
- Press **ENTER** or click outside the **Voltage Stress** field to accept your input. Note that in the System Hierarchy panel, the failure rate of the capacitor has changed. In addition, the failure rates of the block and the system have changed.
- Click **Capacitor 10.3** and then choose **Tools > Reset Component to Default**. A dialog box like the one shown next will appear, asking you to confirm that you want to set the values of the selected component back to the default values.

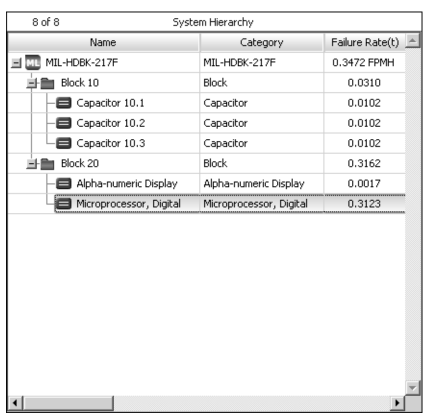


- Click **Yes**. The failure rates of the capacitors now matches the other capacitors.

4.2.4 Changing the Failure Rate by Changing the Connection Type

Notice that the failure rates displayed for the components in the block do not add up to the failure rate displayed for the block. This is because for MIL-HDBK-217F systems, Lambda Predict takes the connections between components into account when calculating the block's failure rate.

- For example, add a new block to the system and change its name to **Block 20**, then add an alpha-numeric display component and a microprocessor, digital component to the block, as shown next.



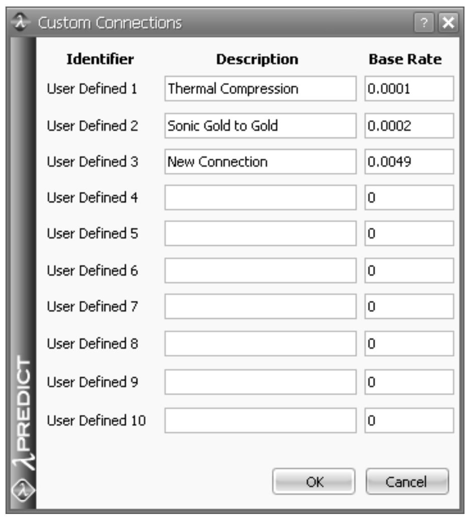
Note: When using the Select a Component window, you can select multiple items by clicking the first item and then pressing **CTRL** and clicking additional items or by clicking the first item and then pressing **SHIFT** and clicking another item to select all items between and including the two.

Note that the failure rate of the alphanumeric display (0.0017 FPHM) and the failure rate of the microprocessor, digital (0.3123 FPMH) add up to 0.3140 FPHM, while the failure rate of the block is 0.3162 FPMH. For each component in a block, the connection type failure rate per pin is multiplied by the value in the **Number of Pins** field in the component's physical properties. The resulting value is added into the parent block's failure rate along with the component's failure rate.

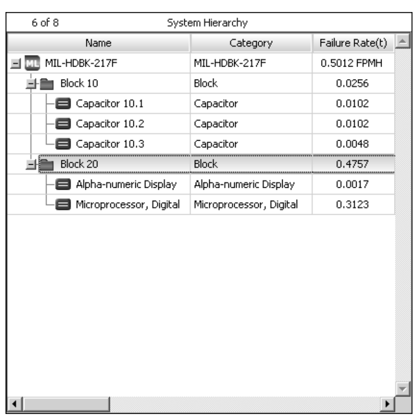
In MIL-HDBK-217F analyses, you also have the ability to define your own connection types. The connections you create will be saved in the database and will be available to you at a later date, or to other users who open the database.

For this example, you have changed your connection method to use a method that is not defined elsewhere. Based on your research, you know that the base failure rate of your method is 0.0049 FPMH per pin.

- Choose **Tools > Custom Connections**. The Custom Connections window will appear. You will see that two additional connection types have been pre-defined.
- In the **Description** field for User Defined 3, type **New Connection**. Enter **0.0049** in the Base Rate field and click **OK**.



- In the System Hierarchy panel, click **Block 20** and change its connection type to **User defined 3 (New Connection: 0.0049)** in the Application properties. Click any other block or component in the System Hierarchy panel to refresh. Note that the Failure Rate of Block 20 is now 0.4757, as shown next.

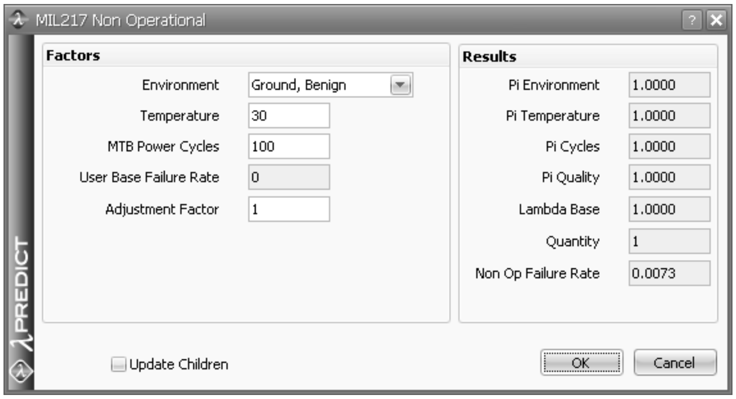


This shows that since there is 1 pin for the alphanumeric display and 32 pins for the digital microprocessor that the connection failure rate for the block is (1 pin + 32 pins) x (0.0049 FMPH/pin) = 0.1617 FMPH, which is what is added to the components failure rates to obtain the block failure rate.

4.2.5 Setting the Non-Operational Failure Rate

For blocks and/or components in MIL-HDBK-217F systems, you can specify separate parameters to be used during a non-operational phase. For example, an item in long-term storage may be in a different environment, at different temperatures, etc, from its normal operating conditions; such changes will affect its failure rate.

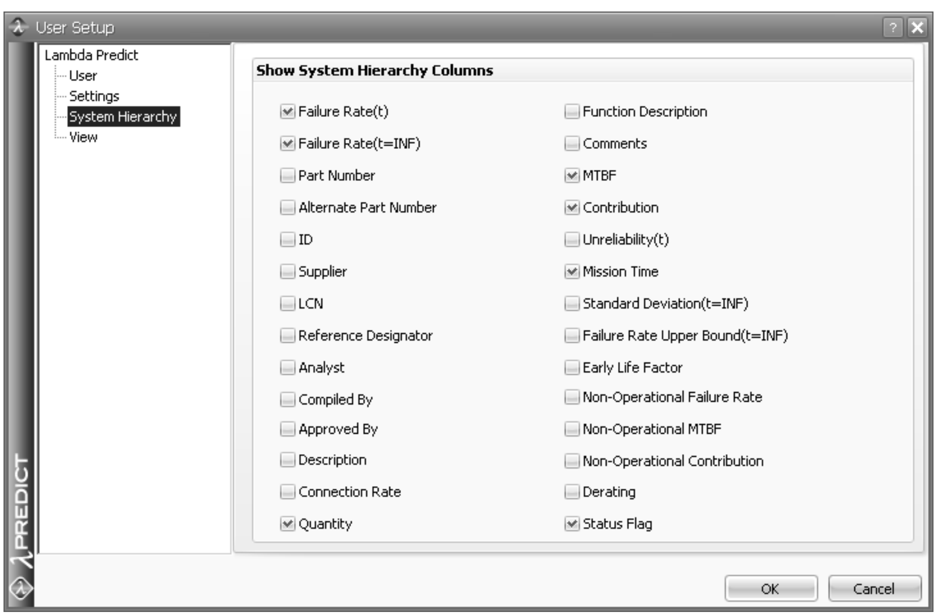
- In the System Hierarchy panel, click **Block 20** and then choose **Tools > Non Operational**. The Non Operational window will appear.



- In the **Environment** field, choose **Ground, Fixed** and enter **10** in the Temperature field.
- Select the **Update Children** check box and then click **OK**. This updates the non-operational parameters for the sub-items associated with the block so that they also use the environment, temperature and MTB (Mean Time Between) power cycles parameters defined in the window.

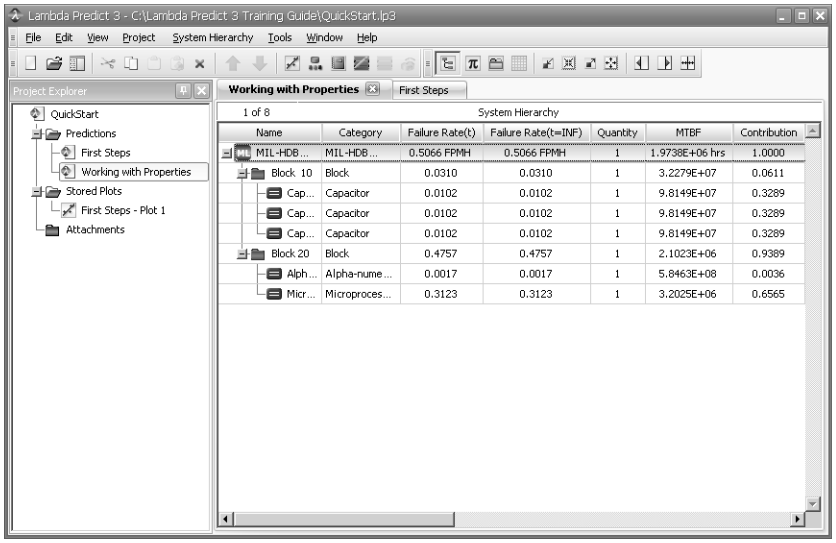
You can view other calculated results in the System Hierarchy panel. Note that to view the non-operational failure rate, you must first enable it on the System Hierarchy page of the User Setup window.

- Choose **File > User Setup**. The User Setup window displays.
- In the navigation area on the left of the User Setup window, click **System Hierarchy**. The System Hierarchy page displays.



- On the System Hierarchy panel, select the **Non-Operational Failure Rate** option, then click **OK**.
- In the System Hierarchy panel, click the **MIL-HDBK-217F** system and choose **View > Splitter Right**. You can also click the **Splitter Right** icon.

The MDI will look like the one shown next.

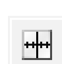


Notice the additional columns that appear. In particular, the following two columns present some useful information:

  - **MTBF** displays the mean time between failures, expressed in hours.
  - **Contribution** displays the contribution made by the item to the failure rate of its direct parent. For example, Capacitor 10.3 contributes 32.89% of the failure rate of its direct parent, Block 10.[1].

Note: For blocks in MIL-HDBK-217F systems, Lambda Predict takes into account the connections between components when calculating the contributions so the contributions made by items may not add up to 1.

- Scroll to the right and notice that the non-operational failure rate for Block 20 is 0.0073.
- Right-click the Status Flag cell for **Block 20** and choose **Complete**. This adds a green flag to the cell, which indicates that you have completed your work with Block 20.[2]
- You can take the time to view the other calculated results, if desired.
- To return the System Hierarchy to the default look, choose **View > Splitter Center**. You can also click the **Splitter Center** icon.



[1] The MTBF and Contribution columns display by default. You can view other results as well. For more information about how to view them, refer to the *Lambda Predict 3 User's Guide*.

[2] The Status Flag is displayed in the System Hierarchy panel only and does not affect reports. You can use it to provide a visual indication of the status of a given item.

4.2.6 Close the Database

You have completed this example. You can now close the Lambda Predict database. Lambda Predict saves each change to the database as it is made, so there is no need to save prior to closing the file.

- To close the database, choose **File > Close Databas**e.[3]

4.3 Example 2 - Working with Parts Outside the Standard

There may be times when you are modeling a system using a particular reliability prediction standard and you find that a given component or subsystem either cannot or should not be modeled using that standard. Consider, for example, a transducer assembly that includes both mechanical and electronic components in the following configuration:

- Transducer Assembly
  - Spring
  - Sensing Elements
    - Primary Coil
    - Secondary Coil
    - Secondary Coil

This example will guide you through the following ways to combine results from different sources and standards to model such a configuration. You will:

- Create a new database.
- Import a prediction from an existing database.
- Use an external component to model the data for an item.
- Use a generic system to encompass data from two subsystems using separate reliability prediction standards.
- Use a linked block to incorporate data from a system that uses a different reliability prediction standard.

4.3.1 Create a New Database/Project

- Create a new database file by choosing **File > New Database** or clicking the **New Database** icon.

- Browse to the desired location for the database, name the database **Parts Outside the Standard** and then click **Save**.
- In the Edit Prediction Properties window that appears, click **Cancel**. This will create the database with no predictions.

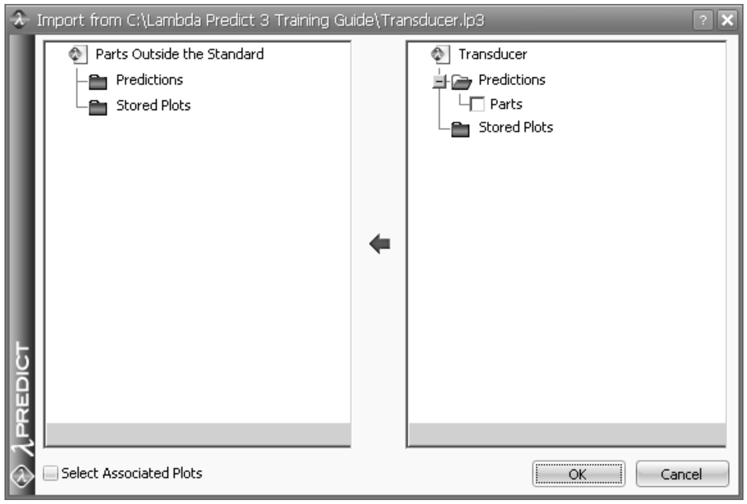
4.3.2 Import a New Prediction

For this example, you will import a prediction from another database. This prediction contains the blocks and components that will be used in the following steps of this example to model the transducer assembly.

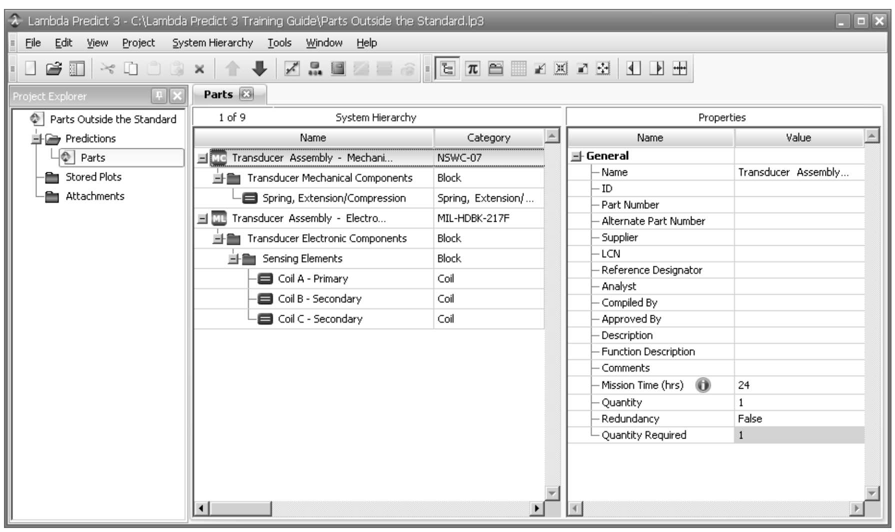
---

3. If you do not close the database, it will be closed automatically when you create a new database for the next example or open an existing database.

- Choose **Project > Import Prediction(s)**. In the window that appears, navigate to the Transducer.lp3 file, which is located in the Training Guide folder within your application directory (*e.g.* C:\Program Files\ReliaSoft\LambdaPredict3\Training Guide) and click **Open** to select the file. The Import window displays, as shown next.



- Select the **Parts** prediction check box and then click **OK**. The Parts prediction is added to your database.
- In the Project Explorer, double-click the **Parts** prediction to open it. The MDI will look like the one shown next.



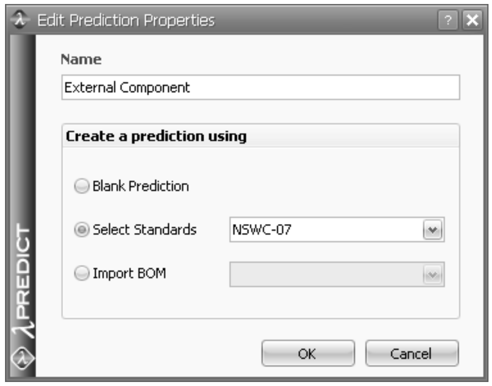
4.3.3 Option 1: Using an External Component

If a component or subsystem cannot be modeled using the current reliability prediction standard but you have information about its failure rate, one way to incorporate that information is to represent the component or subsystem with an external component.

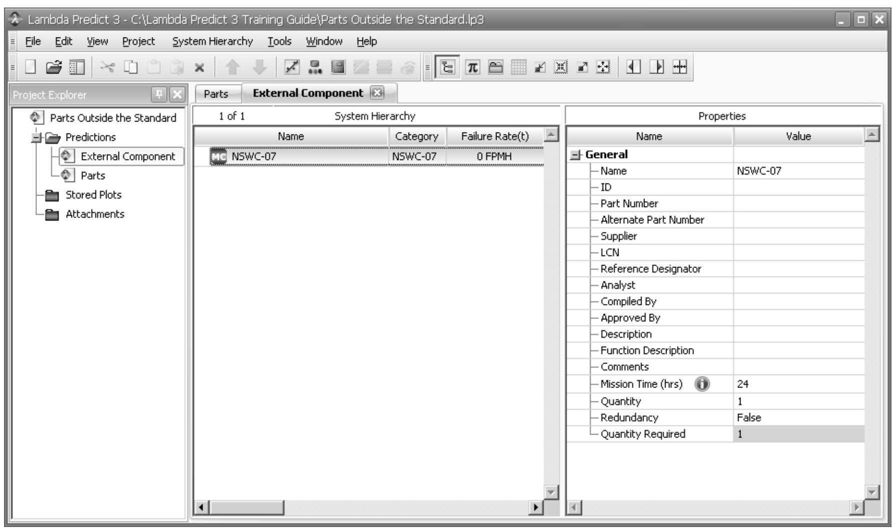
To practice this approach, you will first create another prediction.

- Choose **Project > Add Prediction** or right-click the project's **Predictions** folder in the Project Explorer and choose **Add Prediction** from the shortcut menu.

- In the Edit Prediction Properties window that appears, do the following:
    - In the **Name** field, type **External Component**.
    - Select the **Select Standards** option. In the list that becomes available, select **NSWC-07** and click **OK**. The Edit Prediction Properties window will look like the one shown next.



- Click **OK** to create the new prediction and system. The MDI will look like the one shown next.



- Click the **NSWC-07** system and then, in the Properties panel, in the **Name** field, change the name to **Transducer Assembly**. Press **ENTER** or click outside the Name field to save the change.
- Return to the **Parts** prediction by clicking the tab or double-clicking the name in the Project Explorer.
- In the System Hierarchy panel, under the **Transducer Assembly Mechanical Components** system, right-click the **Transducer Mechanical Components** block and click **Copy** on the shortcut menu that appears.
- Return to the **External Component** prediction. In the System Hierarchy panel, right-click the **Transducer Assembly** system and choose **Paste As Next Level** on the shortcut menu that appears.

You can now add an external component to the system, which will represent the failure rate of the electronic components that cannot be analyzed with the NSWC standard.

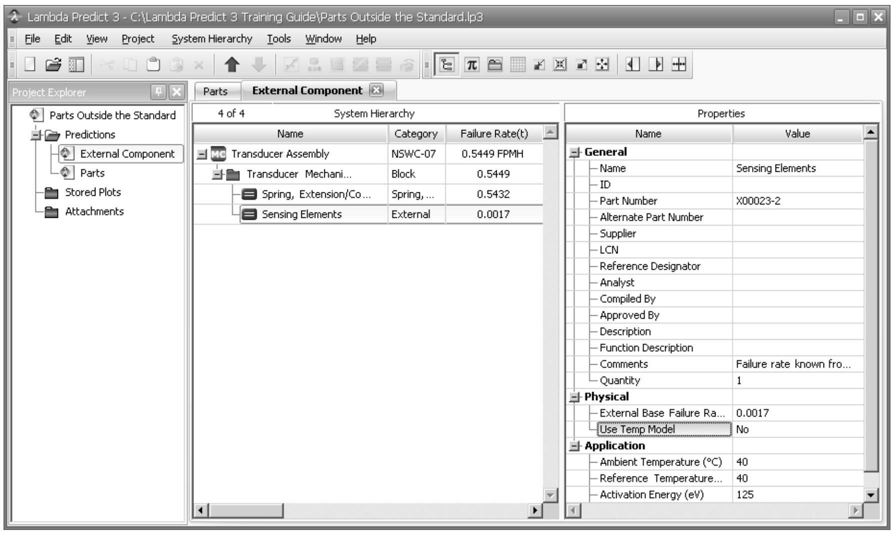
- Right-click the **Transducer Mechanical Components** block and choose **Add Next Level Item > Component/Block** from the shortcut menu.
- In the Select a Component window, click the **External** component and then click **OK**.

- Now select the external component in the System Hierarchy panel and enter the following information into the Properties panel.

Name:	Sensing Elements
Part Number:	X00023-2
Comments:	Failure rate known from previous testing.

From prior testing, you know that the sensing elements have a failure rate of 0.0017 FPMH.

- Click the **External Base Failure Rate (FMPH)** field and type **0.0017** and then press **ENTER** or click outside the field. The MDI will look like the one shown next.



Note that the failure rate of the system, as shown in the Failure Rate(t) column, is 0.5449 FMPH.

4.3.4 Option 2: Using a Generic System

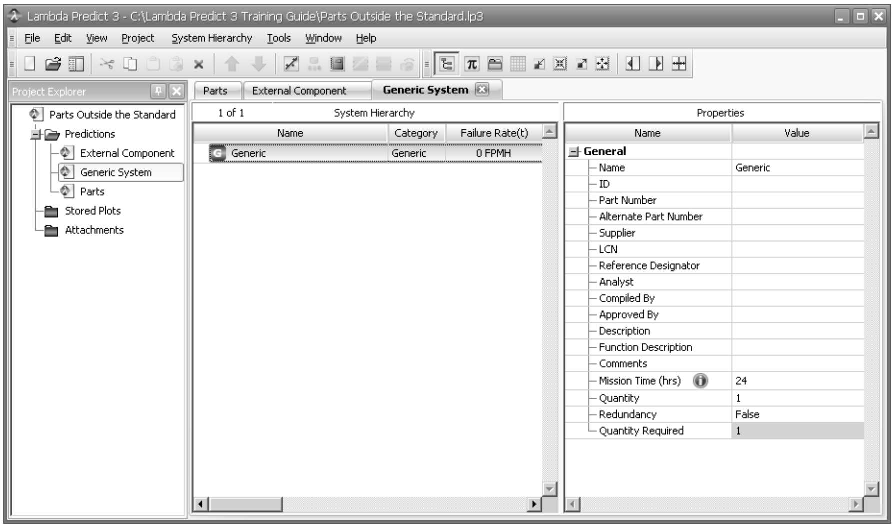
If you are able to model the component or subsystem using a different reliability prediction standard and the resulting failure rates can be combined by simple summation (*i.e.* a series configuration is assumed and that subsystems are not physically connected or the failure rate due to connections is considered negligible), then you can model the main system using a “Generic” system.[4]

To practice this approach, you will first create another prediction.

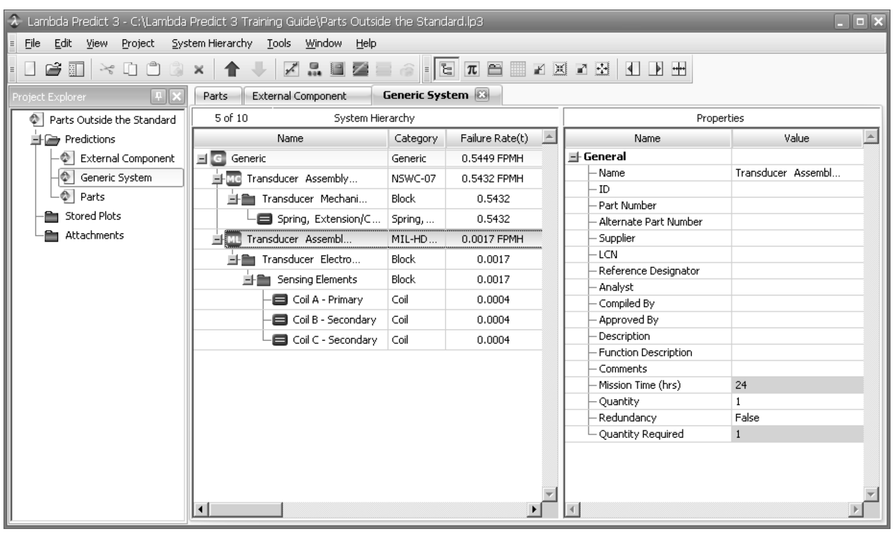
- Choose **Project > Add Prediction** or right-click the project’s **Predictions** folder in the Project Explorer and choose **Add Prediction** on the shortcut menu.
- In the Edit Prediction Properties window, do the following:
  - In the **Name** field, type **Generic System**.
  - Select the **Select Standards** option. In the list that becomes available, select **Generic** and click **OK**.

4. Note that for MIL-HDBK-217F systems, Lambda Predict takes into account the fact that components are connected to each other; the **Connection Type** field (in the Application properties of components and blocks) allows the user to specify how each item is connected. Each connection type is associated with its own failure rate, and this contributes to the failure rates of higher-level and top-level items. Thus, if the main system you are working with is a MIL-HDBK-217F system, the generic system method given in this section may not be an appropriate choice.

- Click **OK** to create the new prediction and system. The MDI will look like the one shown next.



- Return to the **Parts** prediction by clicking the tab or double-clicking the name in the Project Explorer.
- In the System Hierarchy panel, right-click the **Transducer Assembly - Mechanical Components** system and choose **Copy** on the shortcut menu that appears.
- Return to the **Generic System** prediction.
- In the System Hierarchy panel, right-click the **Generic** system and choose **Paste As Next Level** from the shortcut menu that appears.
- Repeat the above steps to copy the **Transducer Assembly - Electronic Components** system from the **Parts** prediction to the **Generic System** prediction. The MDI will look like the one shown next, with one NSWC-07 system and one MIL-HDBK-217F system combined together under the "Generic" system.



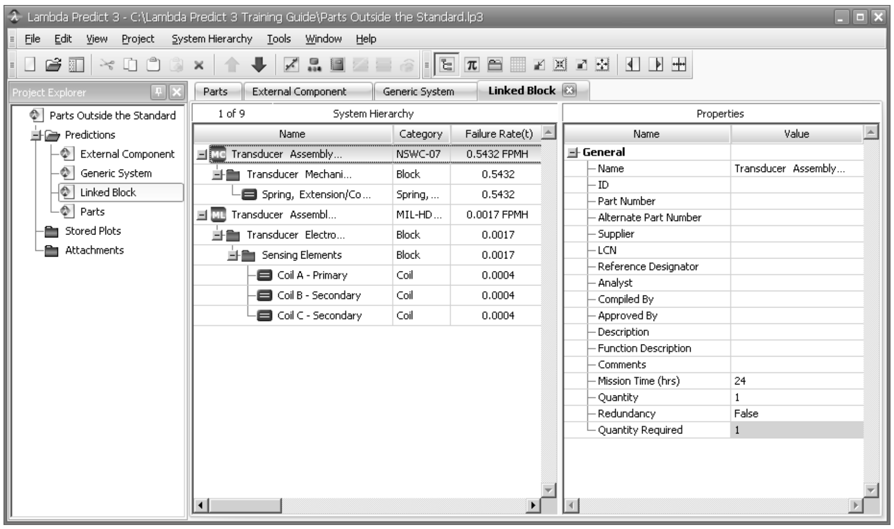
Note that the failure rate of the generic system is 0.5449 FMPH. This is the sum of the failure rate for the mechanical components (as analyzed with NSWC-07) and the failure rate of the electronic components (as analyzed with MIL-HDBK-217F).

4.3.5 Option 3: Using a Linked Block

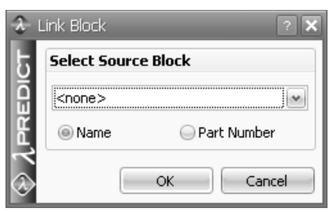
If you are able to model the component or subsystem using a different reliability prediction standard, another way to model the main system is to use a linked block.

To practice this approach, you will first create another prediction.

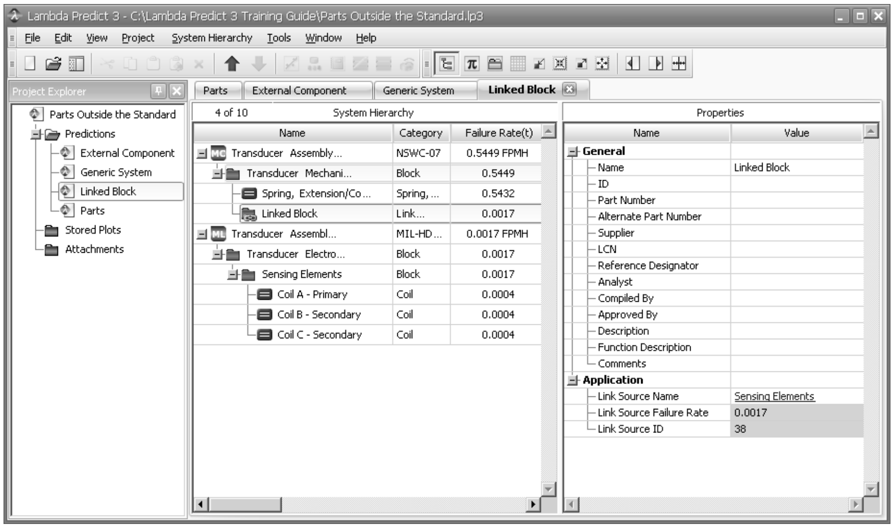
- Create a new blank prediction, called **Linked Block**.
- Copy the **Transducer Assembly - Mechanical Components** and **Transducer Assembly - Electronic Components** systems from the Parts prediction and paste them in the Linked Block prediction. (You can select the first system and then press **CTRL** and select the second system so that you can copy both systems at the same time.) The MDI will look like the one shown next.



- In the NSWC system, right-click the **Transducer Mechanical Components** block and choose **Add Next Level Item > Linked Block** from the shortcut menu. The Link Block window appears.



- Choose **Sensing Elements** as the source for the linked block and then click **OK**. When you are done, the MDI will look like the one shown next.



Note that the failure rate for the NSWC system, which now represents both the mechanical components and, by linked block, the electronic components, is 0.5449 FMPH.

- Close the database and proceed to the next example.

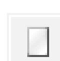
4.4 Example 3 - Using Libraries

Lambda Predict 3 allows you to use part libraries to store pre-configured system elements for use in your predictions. This example will guide you through the basic techniques for adding components from a library to your system hierarchy and adding components from your system hierarchy to a library. You will:

- Create a new database/project and prediction.
- Create a system and import components from a library to the system.
- Create a new library file and add parts to it.

4.4.1 Create a New Database/Project

- Create a new database file and its associated project by choosing **File > New Database** or clicking the **New Database** icon.



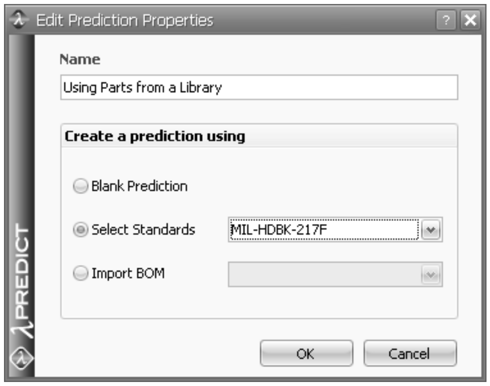
- Browse to the desired location for the database, name the database **Using Libraries** and then click **Save**.

4.4.2 Create a New Prediction

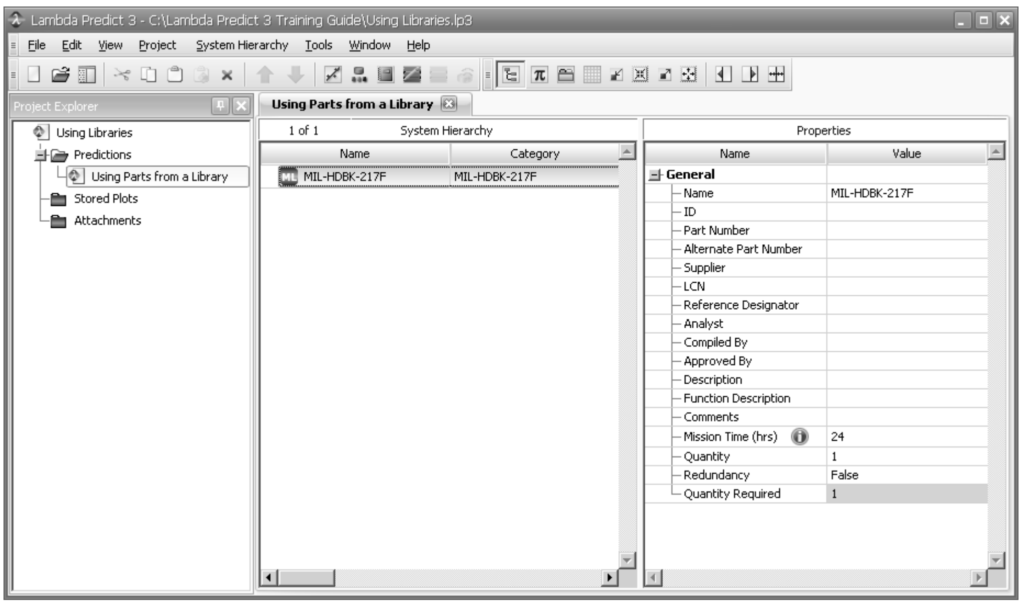
You will be prompted to create a prediction.

- In the Edit Prediction Properties window that appears, type **Using Parts from a Library** in the **Name** field.

- Select the **Select Standards** option and choose **MIL-HDBKF-217F** in the drop-down list and click **OK**, as shown next.



- Click **OK** to create the prediction and system. The MDI will look like the one shown next.

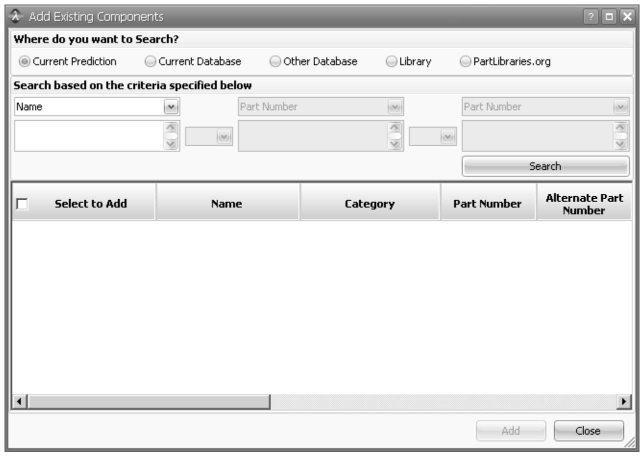


4.4.3 Build the System Configuration

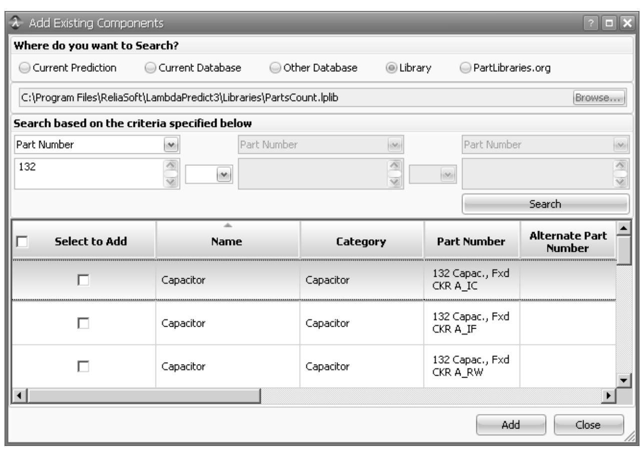
- To add a block to the system, click the system in the System Hierarchy panel and choose **System Hierarchy > Add Next Level Item > Block**. The block will be added to the system.

Next, you will add three components from an existing library file to your system.

- To do this, right-click the block and choose **Add Next Level Item > Existing Components** from the shortcut menu. The Add Existing Components window displays.



- Select the **Library** option.
- Click the **Browse** button to browse for the PartsCount.lplib file, which is located in the Libraries folder within your application directory (*e.g.* C:\Program Files\ReliaSoft\LambdaPredict3\Libraries) and click **Open**.
- In the first list box, choose **Part Number** and then type **132** in the text field below it.
- Click **Search**. This will return a list of items that match your search criteria. The following picture shows the first three results.



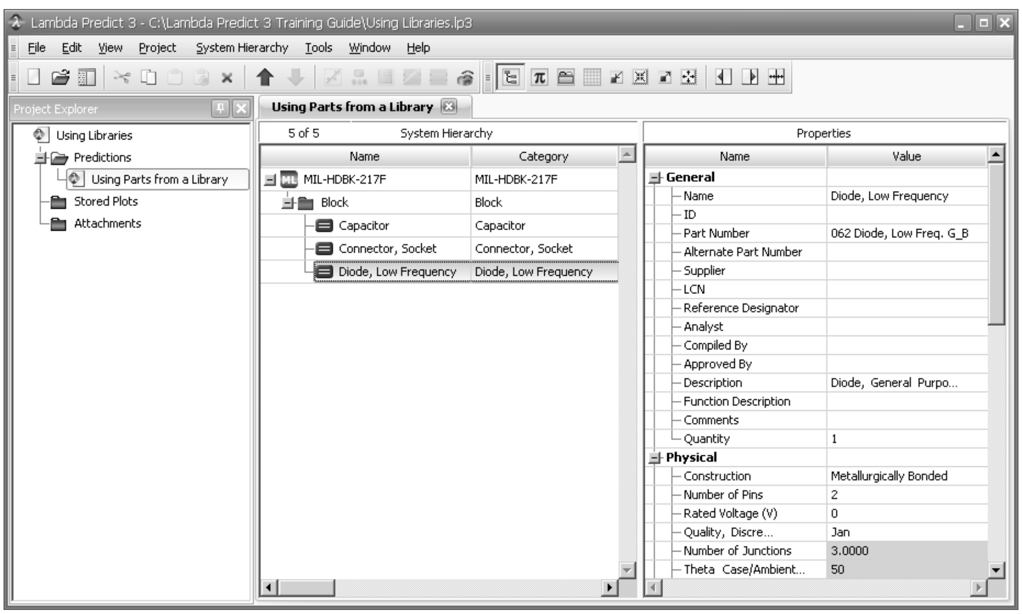
- Scroll through the list until you locate the **132 Capac., Fxd CKR G_B** capacitor and then select its check box.
- Click **Add** to add the capacitor to your system.

You can refine your search by specifying multiple criteria to reduce the number of matches returned.

- In the first list box, choose **Description** and then type **Socket** in the text field below it.
- Choose **And** in the field next to the text field.
- In the second list box, choose **Part Number** and then type **G_B** in the text field below it.
- Click **Search**. A list of items that match your search criteria display.
- Click the check box next to the **188 Connector G_B** socket connector and then click **Add** to add it to your system.

Lambda Predict can also search for partial matches and the search is not case-sensitive.

- In the first list box, choose **Part Number** and then type **62** in the text field below it.
- Choose **And** in the field next to the text field.
- In the second list box, choose **Part Number** and then type **g_b** in the text field below it.
- Click **Search**. A list of items that match your search criteria display. You will notice that “62” is part of both part numbers and “G_B” was returned as a match even though you typed the criteria with lowercase letters.
- Click the check box next to the **062 Diode, Low Freq. G_B** low frequency diode and then click **Add** to add it to your system.
- Click **Close** to close the window. The MDI will look like the one shown next.



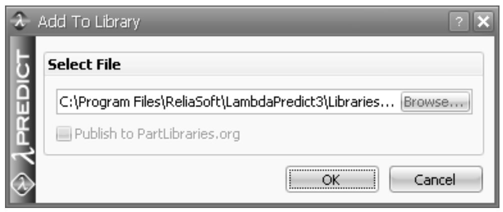
4.4.4 Add Parts to a Library File

Based on your work, you know that you will be using these components again in other projects. You also know that you want to keep a clean copy of the library file that you installed with Lambda Predict as a backup. Therefore, you decide to create your own personalized library file that you can share with coworkers.

> **Important:** ReliaSoft recommends that you do **not** add your own parts to the library files shipped with the software as any changes you make will be lost if you reinstall the software.

You will now add these parts to a new library file.

- Click the MIL-HDBK-217F system and then choose **System Hierarchy** > **Add to Library**. The Add To Library window displays.



- Click **Browse** to display the Open Library window.
- In the File name field, type **My Library** and then click **Save**. You will return to the Add to the Library window.
- Click **OK**. The parts are added to the library file. (To confirm this, you can go back to the Add Existing Components window, browse for the library file you created, and then search for the components you just exported.)
- When you are finished, close the database and proceed to the next example.

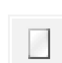
4.5 Example 4 - Importing Data From Excel

This example will guide you through the basic techniques for importing data from a Bill of Materials (BOM) into Lambda Predict. You will:

- Create a new database/project and prediction.
- Import data from a BOM (provided) as part of creating the prediction.

4.5.1 Create a New Database/Project

- Create a new database file and its associated project by choosing **File** > **New Database** or clicking the **New Database** icon.

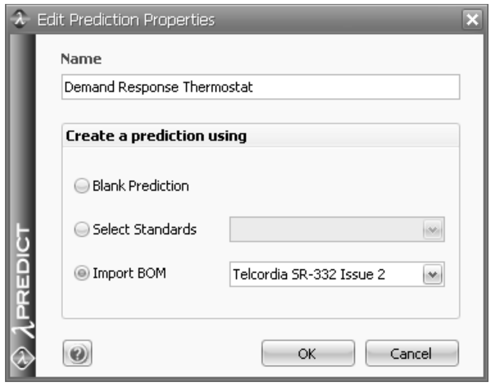


- Browse to the desired location for the database, name the database **Import BOM** and then click **Save**.

4.5.2 Create a New Prediction

You will be prompted to create a prediction.

- In the Edit Prediction Properties window that appears, type **Demand Response Thermostat** in the **Name** field.
- Select the **Import BOM** option and choose **Telcordia SR-332 Issue 2** in the drop-down list that becomes available, as shown next.



- Click **OK** to create the prediction.

4.5.3 Import Data from the BOM

Because you specified that the prediction would contain data imported from a BOM, the Import Wizard will appear automatically once the prediction and top-level Telcordia SR-332 Issue 2 system have been created.

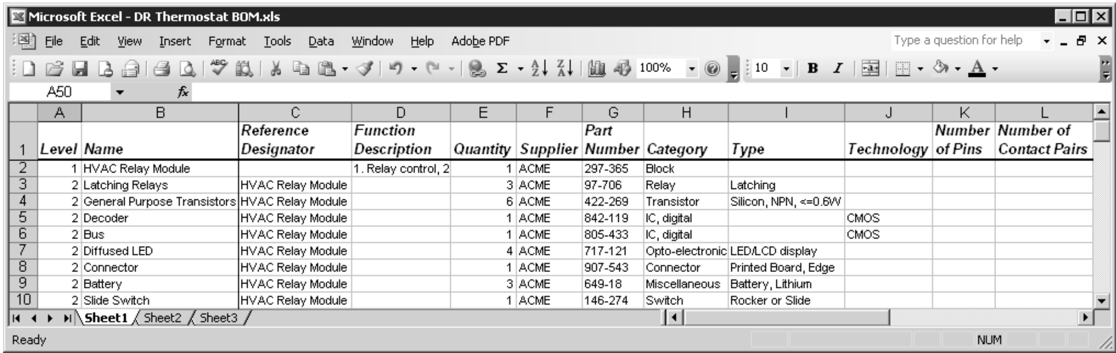
In the Import Wizard, do the following:

- Choose **Excel** in the **Format** field.
- Click the **Browse** button to browse for the DR Thermostat BOM.xls file, which is located in the Training Guide folder within your application directory (*e.g.* C:\Program Files\ReliaSoft\LambdaPredict3 \Training Guide) and click **Open** to select the file for use in the import.
- Choose **Sheet1** in the **Worksheet** field.
- In the **Import Mapping** field, click the **Add Import Mapping** icon.

4.5.3.1 Create a New Import Mapping Template

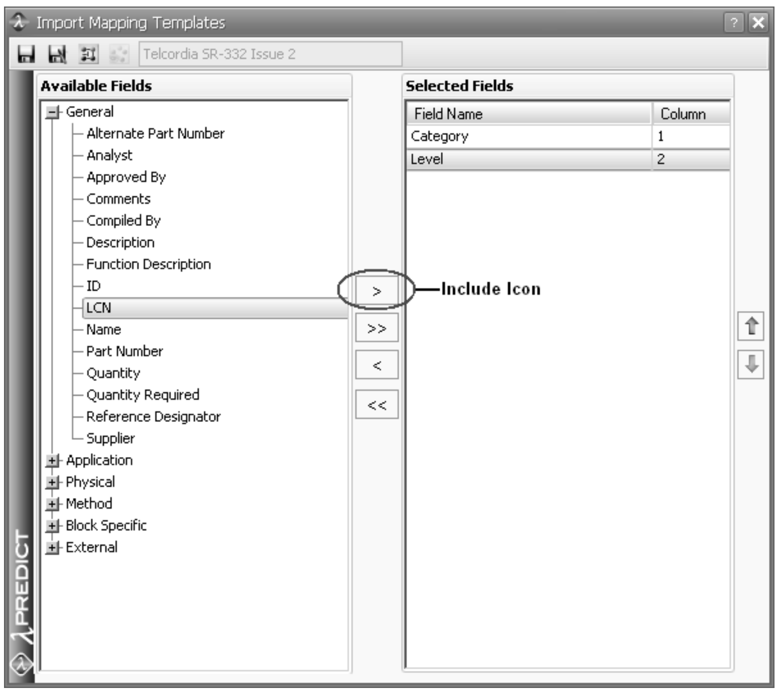
Import mapping templates specify the kinds of information contained in the columns in an Excel file or a delimited text file so that the information can be imported into the correct parameter fields within Lambda Predict. Each import mapping template is associated with a particular standard. When you add a new template, the Import Mapping Templates window is automatically set up to work on a new template for the selected standard (which you have already specified in the Edit Prediction Properties window).

For your reference, the first few rows of the DR Thermostat BOM.xls file are shown next.



Level	Name	Reference Designator	Function Description	Quantity	Supplier	Part Number	Category	Type	Technology	Number of Pins	Number of Contact Pairs
1	HVAC Relay Module		1. Relay control, 2	1	ACME	297-365	Block				
2	Latching Relays	HVAC Relay Module		3	ACME	97-706	Relay	Latching			
2	General Purpose Transistors	HVAC Relay Module		6	ACME	422-269	Transistor	Silicon, NPN, <=0.6W			
2	Decoder	HVAC Relay Module		1	ACME	842-119	IC, digital		CMOS		
2	Bus	HVAC Relay Module		1	ACME	805-433	IC, digital		CMOS		
2	Diffused LED	HVAC Relay Module		4	ACME	717-121	Opto-electronic	LED/LCD display			
2	Connector	HVAC Relay Module		1	ACME	907-543	Connector	Printed Board, Edge			
2	Battery	HVAC Relay Module		3	ACME	649-18	Miscellaneous	Battery, Lithium			
2	Slide Switch	HVAC Relay Module		1	ACME	146-274	Switch	Rocker or Slide			

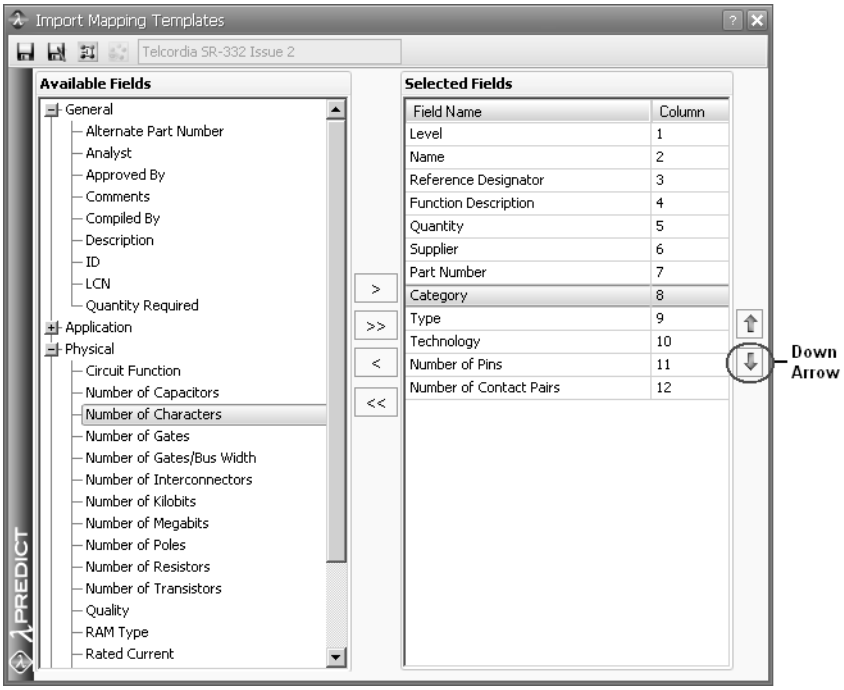
- In the Available Fields area of the Import Mapping Templates window, click the **+** beside **General** to show all of the general fields that are available in Lambda Predict.
- The first column in the Excel spreadsheet is titled "Level." Click the **Level** field and then click the **Include** icon (>) or simply double-click the **Level** field to move it from the Available Fields area to the Selected Fields area, as shown next.



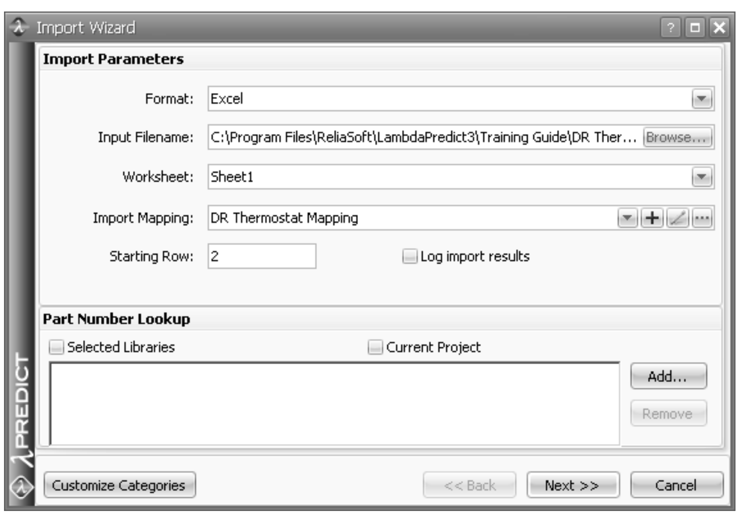
Note: You will notice that the Category field is already included in the Selected Fields area in the first position, as if it were the first field in the Excel spreadsheet. We will change the field order to reflect its actual position in the Excel spreadsheet once all relevant fields have been added.

- Click the **Name** field in the Available Fields area and then click the **Include** icon (>) or simply double-click the **Name** field to move it from the Available Fields area to the Selected Fields area.
- Continue to add fields to the Selected Fields area in this manner, in the order shown in the Excel spreadsheet. You will find the **Type**, **Technology, Number of Pins** and **Number of Contact Pairs** fields under the Physical heading. All other fields are located under the General heading.

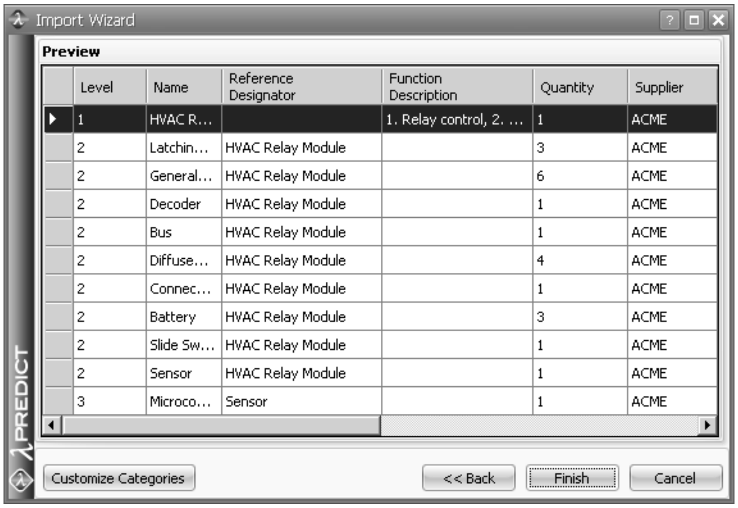
- Once you have added all of the fields, click the **Category** field in the Selected Fields area and use the Down Arrow to move the field below the Part Number field, or simply drag the **Category** field to the desired position, as shown next.



- Click the **Save** icon and save the import mapping template that you have created as **DR Thermostat Mapping.lp3im**. Save it in the default location.
- Close the Import Mapping Template window. You will return to the Import Wizard.
- Choose the **DR Thermostat Mapping** template in the **Import Mapping** field, if it is not already selected.
- Enter **2** in the **Starting Row** field, as shown next, and click **Next**.



- In the Preview that is displayed, make sure that the column headings and data displayed are correct (*i.e.* that they match the Excel file), as shown next.



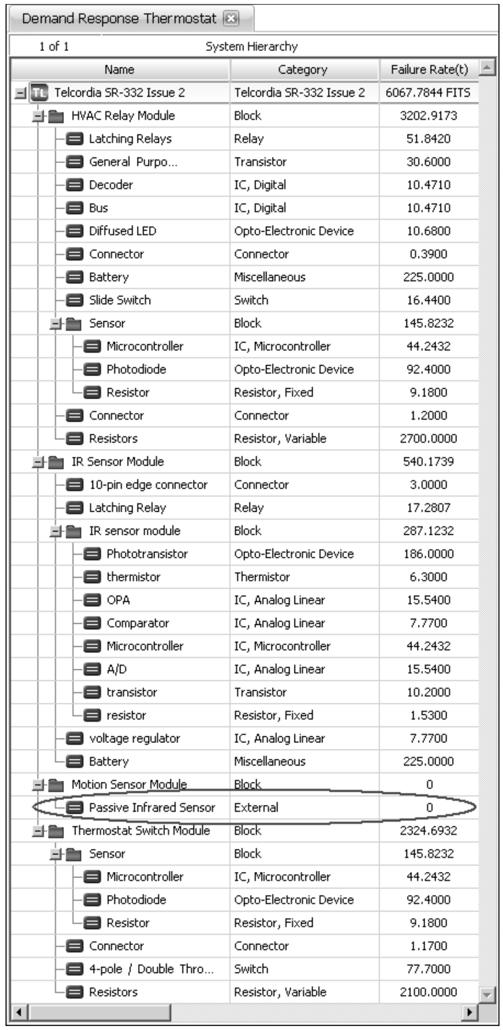
Level	Name	Reference Designator	Function Description	Quantity	Supplier
1	HVAC R...		1. Relay control, 2. ...	1	ACME
2	Latchin...	HVAC Relay Module		3	ACME
2	General...	HVAC Relay Module		6	ACME
2	Decoder	HVAC Relay Module		1	ACME
2	Bus	HVAC Relay Module		1	ACME
2	Diffuse...	HVAC Relay Module		4	ACME
2	Connec...	HVAC Relay Module		1	ACME
2	Battery	HVAC Relay Module		3	ACME
2	Slide Sw...	HVAC Relay Module		1	ACME
2	Sensor	HVAC Relay Module		1	ACME
3	Microco...	Sensor		1	ACME

- If you find errors, click **Back** to return to the Import Parameters page of the Import Wizard and edit your choices and/or import mapping template as necessary. (To edit the mapping you would click the **Edit Import Mapping** icon.

In the Import Mapping Template window, you would make the necessary changes. When you are done, you would save the mapping template and continue with the remaining steps.) If everything is correct, click **Finish**. The Bill of Materials data will be imported to the Telcordia SR-332 Issue 2 system.

4.5.4 Specify the Failure Rate for the External Component

You will notice that the BOM did not contain failure rate information for the external component (called Passive Infrared Sensor and circled in the System Hierarchy panel shown next).



Demand Response Thermostat

1 of 1 — System Hierarchy

Name	Category	Failure Rate(t)
Telcordia SR-332 Issue 2	Telcordia SR-332 Issue 2	6067.7844 FITS
HVAC Relay Module	Block	3202.9173
Latching Relays	Relay	51.8420
General Purpo...	Transistor	30.6000
Decoder	IC, Digital	10.4710
Bus	IC, Digital	10.4710
Diffused LED	Opto-Electronic Device	10.6800
Connector	Connector	0.3900
Battery	Miscellaneous	225.0000
Slide Switch	Switch	16.4400
Sensor	Block	145.8232
Microcontroller	IC, Microcontroller	44.2432
Photodiode	Opto-Electronic Device	92.4000
Resistor	Resistor, Fixed	9.1800
Connector	Connector	1.2000
Resistors	Resistor, Variable	2700.0000
IR Sensor Module	Block	540.1739
10-pin edge connector	Connector	3.0000
Latching Relay	Relay	17.2807
IR sensor module	Block	287.1232
Phototransistor	Opto-Electronic Device	186.0000
thermistor	Thermistor	6.3000
OPA	IC, Analog Linear	15.5400
Comparator	IC, Analog Linear	7.7700
Microcontroller	IC, Microcontroller	44.2432
A/D	IC, Analog Linear	15.5400
transistor	Transistor	10.2000
resistor	Resistor, Fixed	1.5300
voltage regulator	IC, Analog Linear	7.7700
Battery	Miscellaneous	225.0000
Motion Sensor Module	Block	0
Passive Infrared Sensor	External	0
Thermostat Switch Module	Block	2324.6932
Sensor	Block	145.8232
Microcontroller	IC, Microcontroller	44.2432
Photodiode	Opto-Electronic Device	92.4000
Resistor	Resistor, Fixed	9.1800
Connector	Connector	1.1700
4-pole / Double Thro...	Switch	77.7000
Resistors	Resistor, Variable	2100.0000

For this example, we will assume that the base failure rate for a passive infrared sensor of this sort is known to be 127 FITS.

- Click the external component in the System Hierarchy panel.
- In the Physical properties, enter **127** in the **External Base Failure Rate (FIT)** field, then press **ENTER** or click outside the field to accept the input.

You will see that the system failure rate changes to reflect the new information.

4.5.5 View the Failure Rate Upper Bound

Lambda Predict offers upper confidence bounds on failure rates in Telcordia SR-332 Issue 2 systems. To display this information, do the following:

- Choose **File > User Setup**.
- In the navigation area on the left of the User Setup window, click **System Hierarchy**.

- On the System Hierarchy panel, select the **Failure Rate Upper Bound(t=inf)** option, then click **OK**.
- In the System Hierarchy, scroll to the right until the Failure Rate Upper Bound column is visible.

You can see that the system has an expected failure rate of 6194.7844 FITS, with a 90% upper bound of 7359.4555 FITS. This bound is calculated based on the expected failure rate (rolled up from the components' failure rates), the standard deviation (rolled up from the standard deviations of the components) and the **Confidence Level for Upper Bound (%)** field in the Application properties at the system level. The bound calculation will take into consideration the base failure rate for any external components but assumes that external components' failure rates have no associated variability.

- When you are finished, close the database and proceed to the next example.

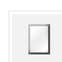
4.6 Example 5 - Further Analysis

This example will show you how to import a prediction from another database and how to perform "what-if" analyses for comparison purposes. For example, you may wish to change one parameter (such as temperature, environment, etc.) to see what impact it will have on the predicted failure rate. You will:

- Import a prediction from an existing database.
- Duplicate the system and change the temperature parameters to compare the results under the different conditions.
- Change a system configuration from series to parallel (*i.e*. use redundancy).

4.6.1 Create a New Database

- Create a new database file by choosing **File > New Database** or clicking the **New Database** icon.



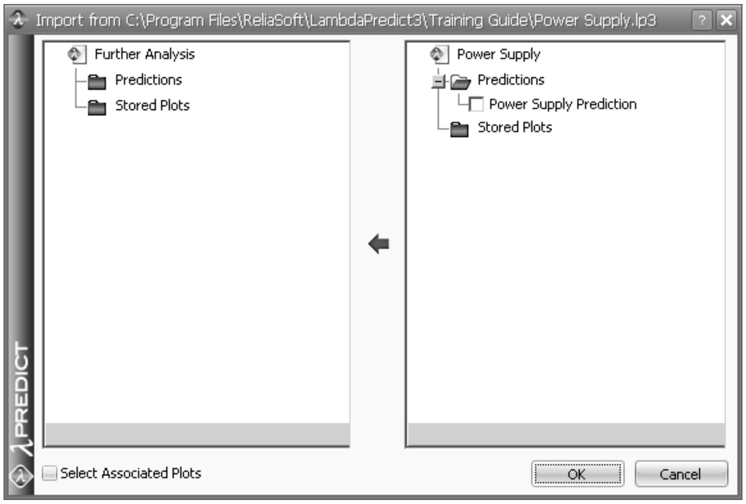
- Browse to the desired location for the database, name the database **Further Analysis** and then click **Save**. You will be prompted to create a prediction.
- In the Edit Prediction Properties window that appears, click **Cancel**. This will create the database with no predictions.

4.6.2 Import a New Prediction

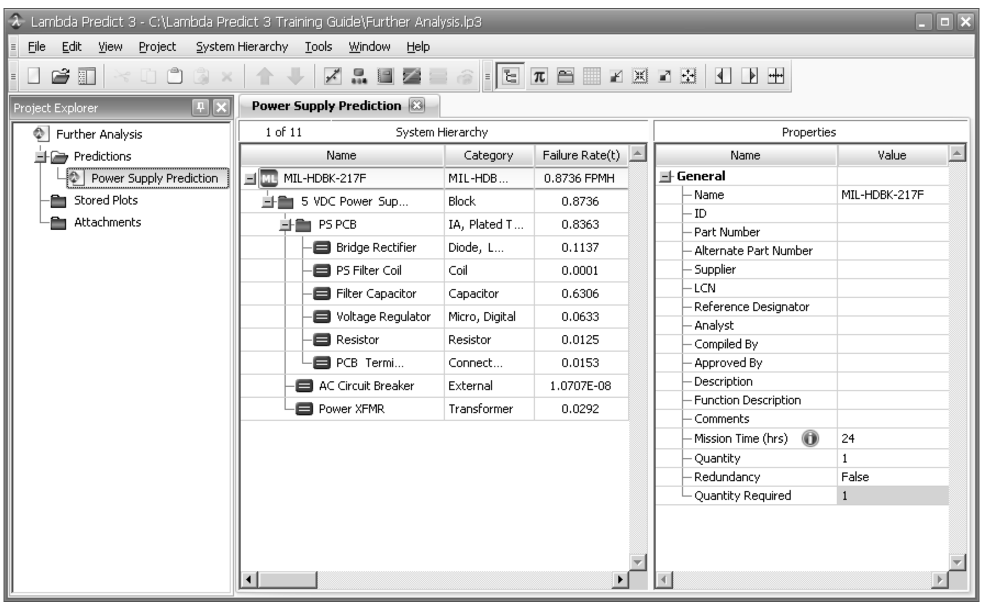
For this example, you will import a prediction and all of its systems, blocks and components from another database.

- Choose **Project > Import Prediction(s)**. In the window that appears, navigate to the Power Supply.lp3 file, which is located in the Training Guide folder within your application directory (*e.g.* C:\Program

Files\ReliaSoft\LambdaPredict3\Training Guide) and click **Open** to select the file. The Import window displays, as shown next.



- Select the **Power Supply Prediction** check box and then click **OK**. The Power Supply prediction is added to your database.
- Open the Power Supply prediction. The MDI will look like the one shown next.

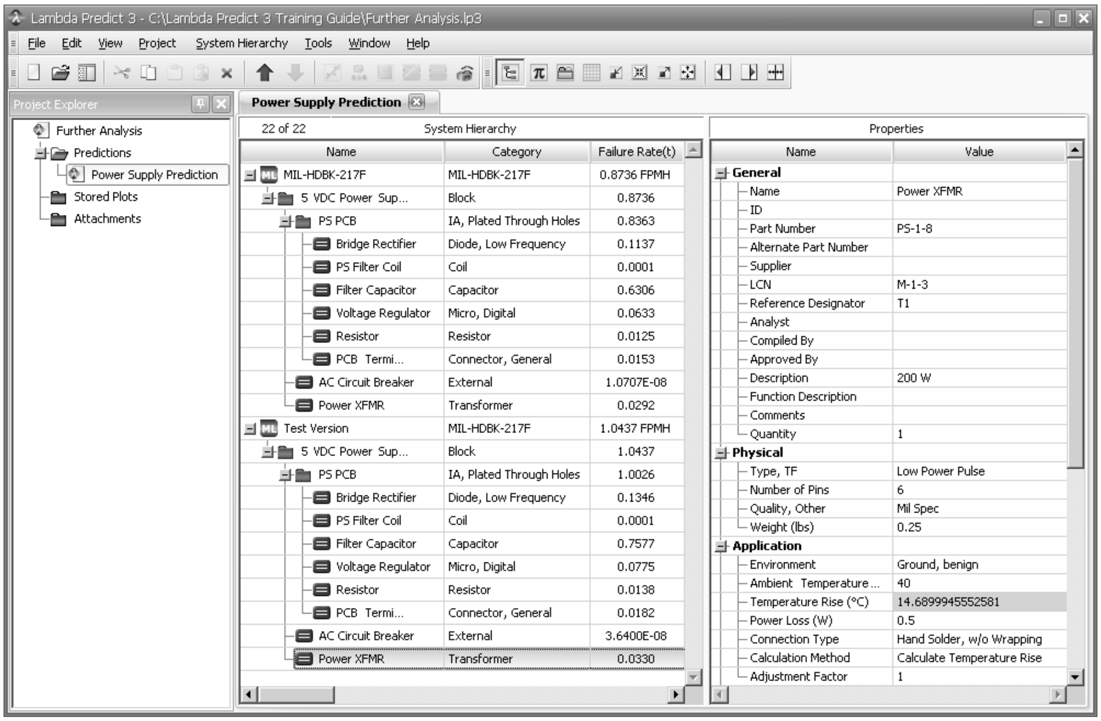


4.6.3 Changing the Ambient Temperature

Lambda Predict's ability to analyze multiple systems within each project allows you to perform "what-if" analyses for comparison purposes. In this case, you will first copy the MIL-HDBK-217F system and then, in the copy, change the ambient temperature at which it operates.

- In the System Hierarchy panel, right-click the **MIL-HDBK-217F** system and select **Copy** from the shortcut menu.
- Right-click the **MIL-HDBK-217F** system and select **Paste As Same Level** from the shortcut menu.
- In the Properties panel, change the **Name** to **Test Version**.

- In the System Hierarchy panel, click the **5 VDC Power Supply Module** block under the Test Version system.
- In the Properties panel, change the value of the **Ambient Temperature** field to **40** and press **ENTER** or click outside the field to accept the change.
- In the System Hierarchy panel, click the **Power XFMR** transformer and, in the Properties panel, note that its **Ambient Temperature** value is now also 40. This is because the 5 VDC Power Supply Module block's Update Children property is set to True and therefore changes to the block's properties affect its children's properties as well.
- Compare the failure rates for the Test Version system to those for the original MIL-HDBK-217F system. Note that the increase in ambient temperature has affected the failure rates throughout the system. The MDI will look like the one shown next.



- Return the **Ambient Temperature** value for the 5 VDC Power Supply Module block to **30**. The failure rates of the two systems now match.

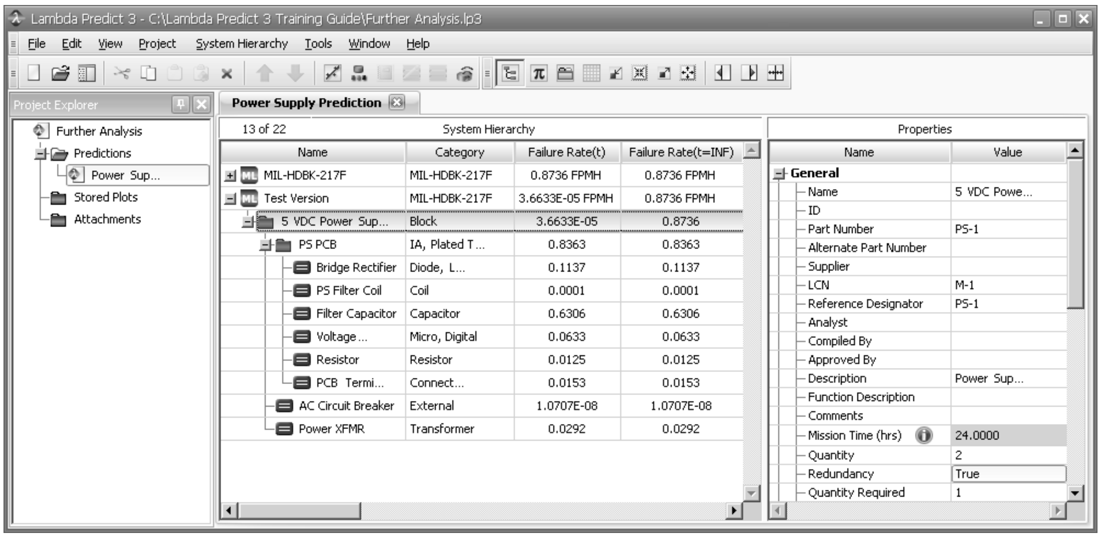
Note: The parent block's **Update Children** and **Update Temperature Mode** properties determine if and how changes to its properties will affect its children. Note that this is a one-way relationship, and that changing a child item's properties will not change the parent block's properties. For more information about updating children, refer to the *Lambda Predict User's Guide*.

4.6.4 Using Redundancy

You can perform other "what-if" tests as well. In this case, you will see what happens when you change a system from a series configuration to a parallel configuration.

- Click the **MIL-HDBK-217F** system. Collapse the system details by clicking the minus sign (-) beside the system name in the System Hierarchy panel, by choosing **View** > **Collapse** or by clicking the **Collapse** icon.

- Click the **5 VDC Power Supply Module** block in the Test Version system. In the Properties panel, change the value of the **Redundancy** field to **True** and change the value of the **Quantity** field to **2**, then press **ENTER** or click outside the Quantity field. The MDI will look like the one shown next.



Changing the **Redundancy** value to **True** means that the system is now in a parallel configuration. There are two of the 5 VDC Power Supply Module blocks present, as indicated in the **Quantity** field, and only one of those two blocks needs to be functioning at any given time in order for the system to be functional.

In the System Hierarchy panel, note that the value of the Failure Rate(t) field has changed to 3.6633E-05 FPMH from the original value of 0.8736 FPMH, while the value of the Failure Rate(t=INF) field remains at 0.8736 FPMH. The Failure Rate(t) field displays the expected failure rate at the mission time, t (hours), specified in the **Mission Time** field in the general properties of the item (in this case, 24 hours). The Failure Rate(t=INF) field displays the expected failure rate when the mission time is equal to infinity (*i.e.* the steady-state failure rate).

- Close the database and proceed to the next example.

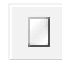
4.7 Example 6 - Advanced Analysis: Allocation

This example will show you how to use the Allocation utility to logically apportion the product design reliability into lower level design criteria such that the cumulative reliability still meets the requirements. You will:

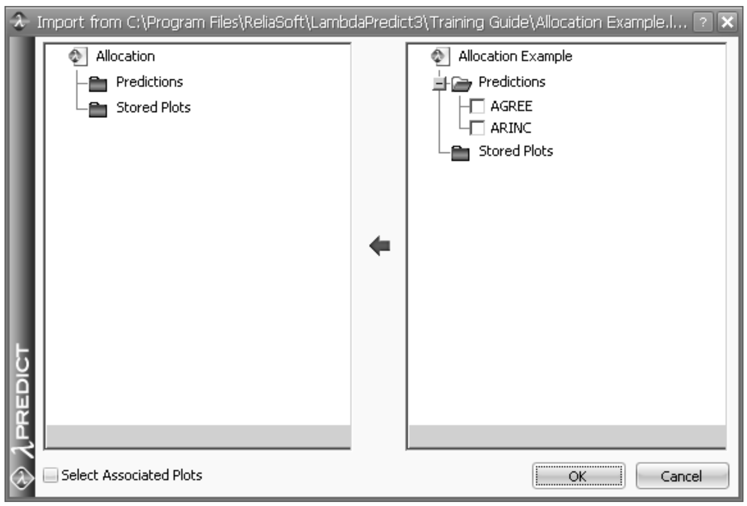
- Import a prediction from an existing database.
- Use the AGREE and ARINC allocation models to apportion the product reliability.
- Plot the allocation results.

4.7.1 Create a New Database and Import Two Predictions

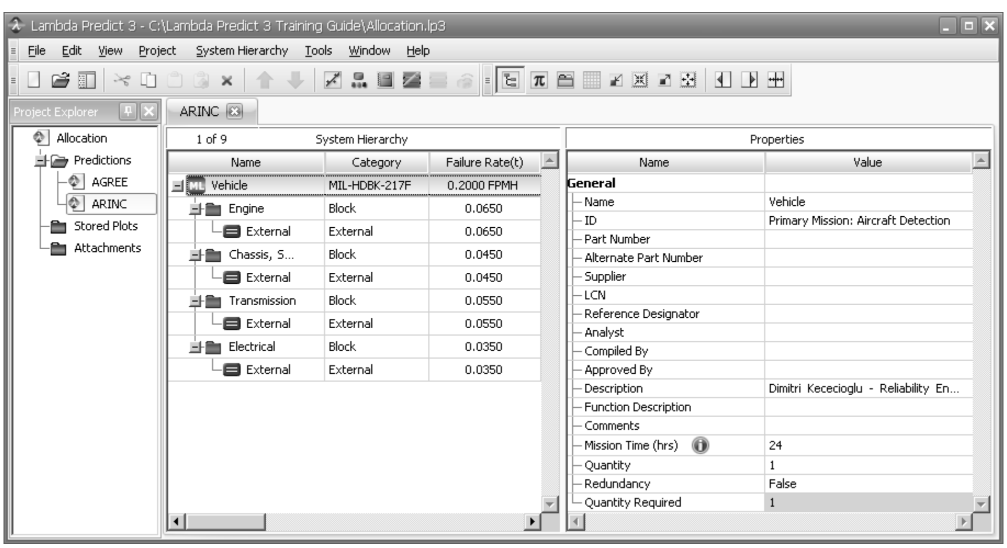
- Create a new database file by choosing **File > New Database** or clicking the **New Database** icon.



- Browse to the desired location for the database, name the database **Allocation** and then click **Save**.
- In the Edit Prediction Properties window that appears, click **Cancel**. This will create the database with no predictions.
- Choose **Project > Import Prediction(s)**. In the window that appears, navigate to the Allocation Example.lp3 file, which is located in the Training Guide folder within your application directory (*e.g.* C:\Program Files\ReliaSoft\LambdaPredict3\Training Guide) and click **Open** to select the file. The Import window displays, as shown next.

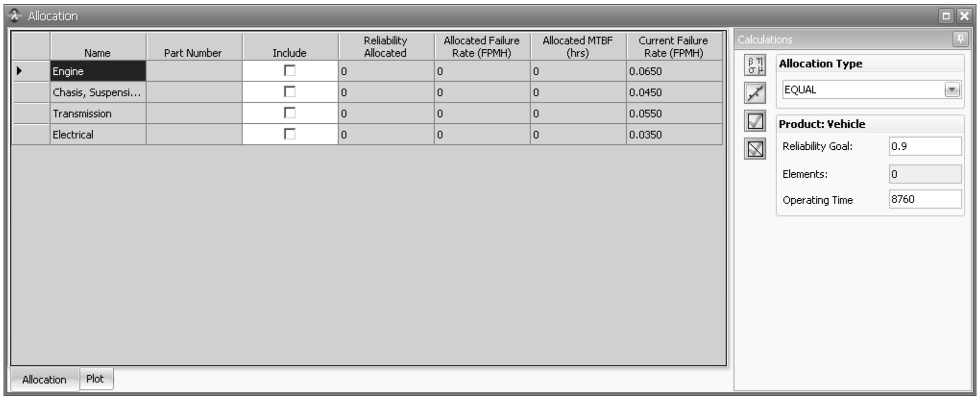


- Select the **AGREE** and **ARINC** prediction check boxes, and then click **OK**. The predictions are added to your database.
- Open the ARINC prediction. The MDI will look like the one shown next.



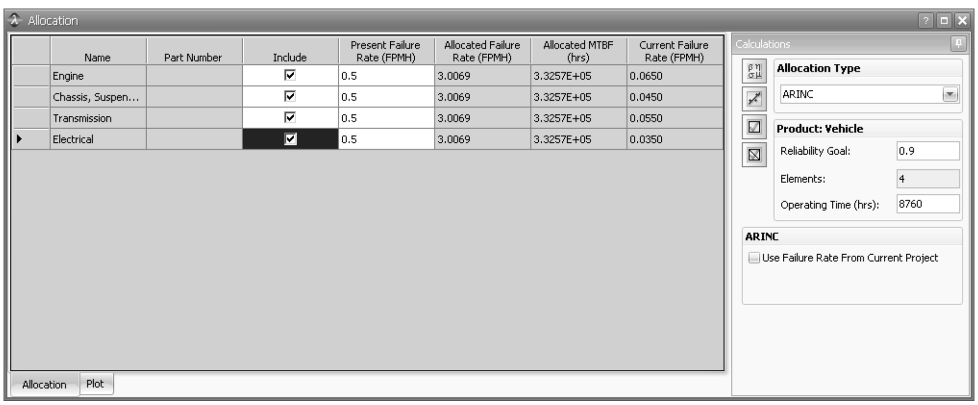
4.7.2 Using the EQUAL and ARINC Models

- Click the **Vehicle** system and choose **Tools > Allocation**. The Allocation window displays, with the EQUAL allocation type displaying by default and a reliability goal of 90% at 8760 hours, as shown next.



The Equal Allocation model apportions reliability equally among all subsystems to meet a user-defined reliability goal for a specified operation time.

- For each component, click the **Include** check box. Note that each component has the same calculated reliability value, in this case 0.9740.
- In the **Allocation Type** field, choose ARINC.
- For each component, click the **Include** check box. The ARINC apportionment looks like the following.

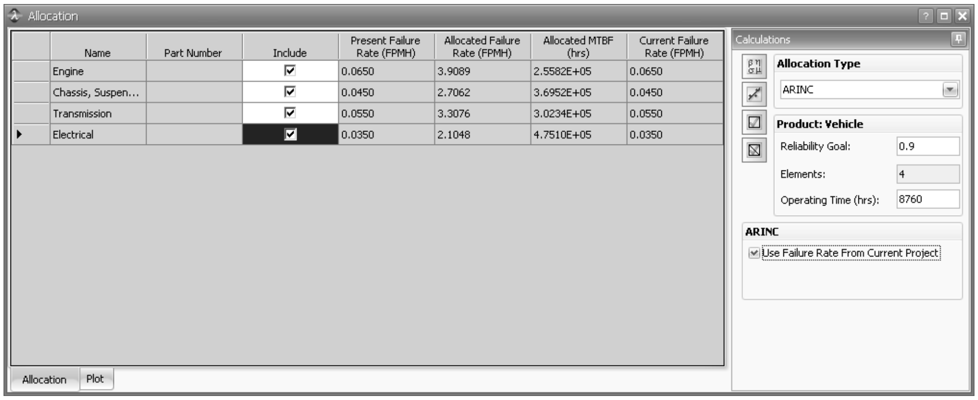


The ARINC Allocation model assumes that all subsystems are in series and have constant failure rates. It meets the defined reliability goal by weighing the individual failure rates of the subsystems based on the current values of subsystem reliability.

By default, the Present Failure Rate column displays in white, which indicates that you can enter the failure rates that determine the weighing factors. This gives you the ability to see how different failure rates affect the system.

As an alternative, you can select the **Use Failure Rate From Current Project** check box in the Control Panel to use the calculated failure rates from the prediction. In this case, the Present Failure Rate column displays in gray, which indicates that you cannot change values in it.

- Click the **Use Failure Rate From Current Project** check box. Notice how the values in the other columns have changed, as shown next.

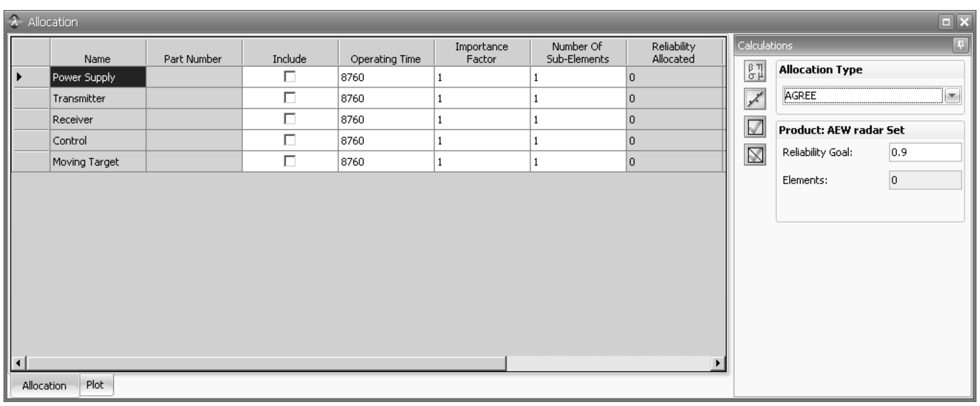


When using the EQUAL Allocation model, each component has an allocated failure rate of 3.0069 FMPH. Similarly, when using the ARINC Allocation model with identical present failure rates, the allocated failure rates are also 3.0069 FMPH. However, when the ARINC Allocation model is used with the unequal present failure rates given in the prediction, the components with the higher present failure rates are allocated higher failure rates.

- Close the Allocation window.

4.7.3 Using the AGREE Model

- Open the AGREE prediction.
- Choose **Tools** > **Allocation**. The Allocation window displays.
- In the **Allocation Type** field, choose **AGREE**. The Allocation window looks like the one shown next.



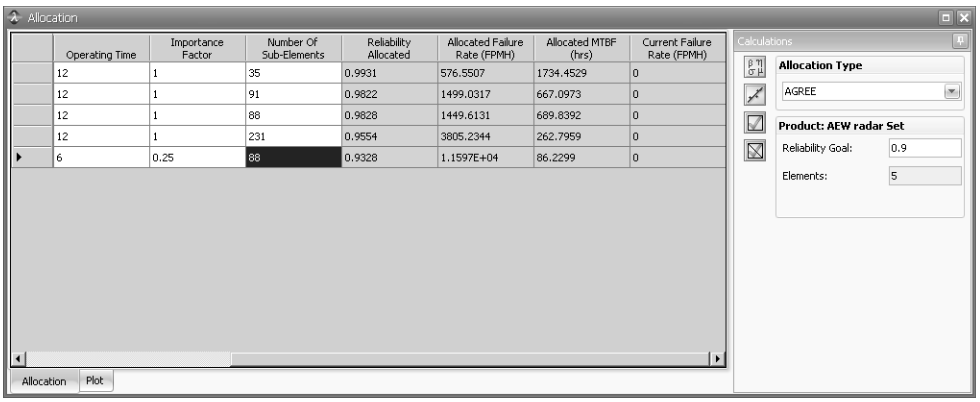
The AGREE model takes into account additional data for each subsystem when calculating subsystem reliability goals, including complexity and importance. The Importance Factor indicates how critical the block is to the overall system operation, expressed as a decimal from 0 to 1, where 0 indicates that the block's failure will not cause any problem for the system and 1 indicates that the block's failure will definitely cause system failure.

- For each component, click the **Include** check box.

- Enter the following values for the components:

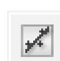
Name	Operating Time	Importance Factor	Number of Subelements
Power Supply	12	1	35
Transmitter	12	1	91
Receiver	12	1	88
Control	12	1	231
Moving Target	6	0.25	88

The values in the Reliability Allocated and other calculated columns (gray background) will be updated based on your inputs, as shown next.

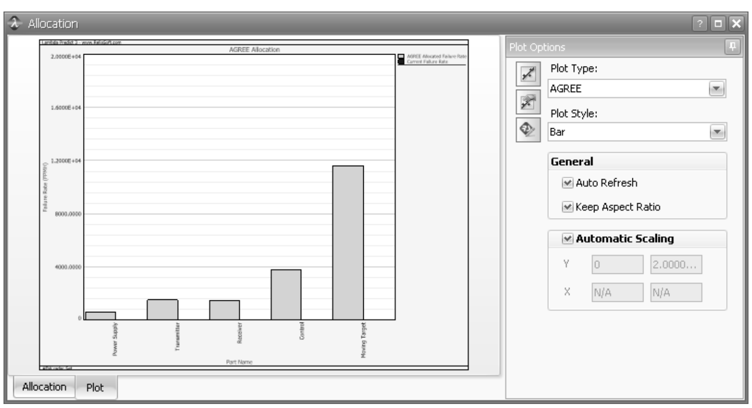


4.7.4 View the Results in a Plot

- Click the **Plot** icon in the Allocation utility Control Panel.



The Allocation window looks like the one shown next:



The plot displays the apportioned failure rate goals that you just calculated in the Allocation utility.

- Close the Allocation window.

- Close the database and proceed to the next example.

4.8 Example 7 - Advanced Analysis: Derating

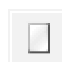
Most equipment failures are precipitated by stress. When the applied stress exceeds the inherent strength of the part, either a serious degradation or a failure will occur. To assure reliability, equipment must be designed to endure stress over time without failure. In addition, design stress parameters must be identified and controlled while parts and materials that can withstand these stresses must be selected. Derating standards are used to help you select and use parts and materials so that the applied stress is less than rated for a specific application.

For this example, imagine that you wish to analyze the effect of ambient temperature on a computer system. You will:

- Import a prediction from an existing database.
- Apply an existing derating standard to the system.
- Change the application parameters to view the effects on derating.

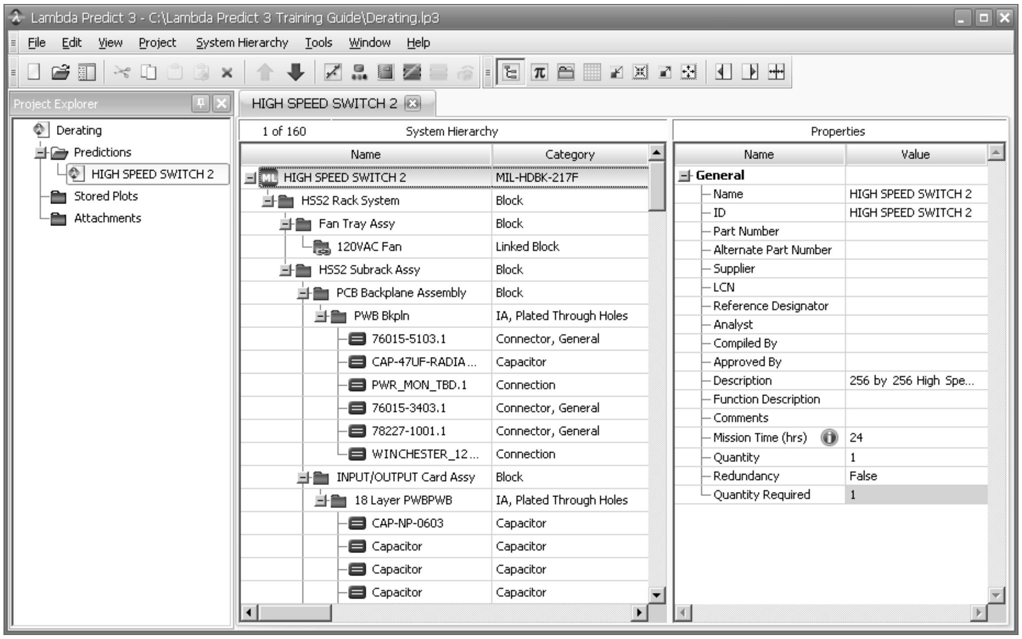
4.8.1 Create a New Database and Import a Prediction

- Create a new database file by choosing **File > New Database** or clicking the **New Database** icon.



- Browse to the desired location for the database, name the database **Derating** and then click **Save**.
- In the Edit Prediction Properties window that appears, click **Cancel**. This will create the database with no predictions.
- Choose **Project > Import Prediction(s)**. In the window that appears, navigate to the MIL Example.lp3 file, which is located in the Training Guide folder within your application directory (*e.g.* C:\Program Files\ReliaSoft\LambdaPredict3\Training Guide) and click **Open** to select the file.
- In the Import window, select the **HIGH SPEED SWITCH 2** prediction check box, and then click **OK**.

- Open the HIGH SPEED SWITCH 2 prediction. The MDI will look like the one shown next.

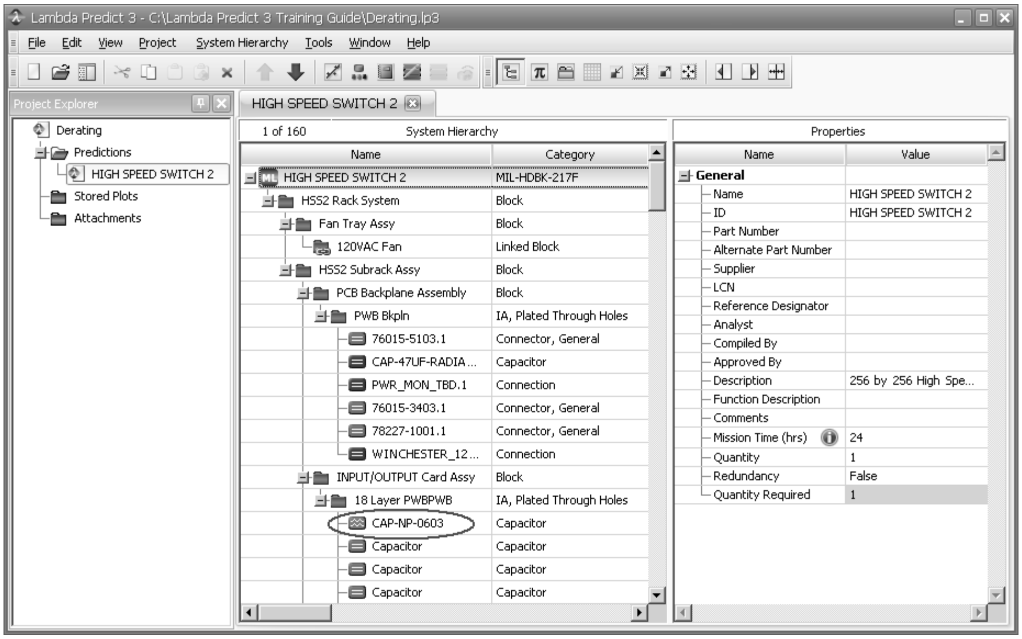


4.8.2 Apply an Existing Derating Standard to a System

When a derating standard is applied to a system, each component in the system is automatically evaluated to determine whether it meets the derating requirements defined for its component type in the standard. Any components of types not specified in the derating standard are not considered in the derating.

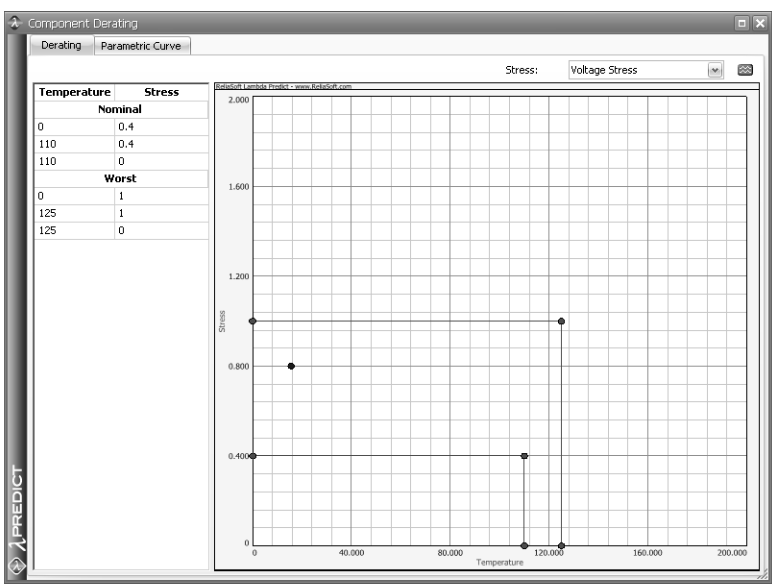
- Choose **Tools** > **Apply Derating Standard**. The Available Standards window displays, as shown next.

- Select the **NAVSEA** standard and then click **OK**. Notice that the icons in the System Hierarchy panel have changed to show the derating status of each component, as shown next.



Components that meet the derating requirements display a green box with two straight lines on the component icon. Components that are not over-stressed but are above the nominal value given in the derating standard are shown with light blue icons with two wavy lines. Components that are over-stressed based on the derating requirements have a red icon with two wavy lines. Components with a plain, dark blue icon with two straight lines are not considered in the derating standard.

- To view the derating analysis for one particular component, select the **CAP-NP-0603** capacitor and then choose **Tools > View Component Derating**. The Component Derating window displays, as shown next.

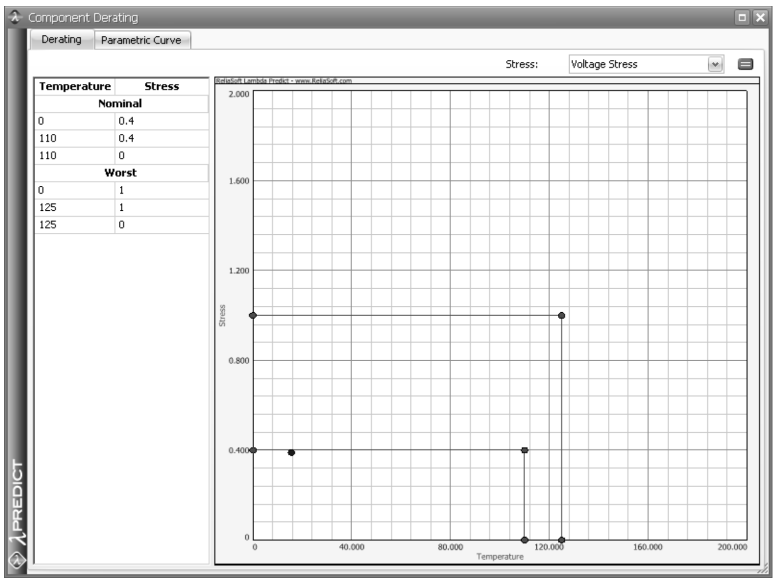


The blue point on the plot shows where the capacitor stands with respect to the requirements of the derating standard. The red line represents the worst case points and the green line represents the nominal points. Note that the capacitor currently falls between the nominal and worst case lines. In other words, it does not meet the derating requirements, but is not actually over-stressed. You can see from the shape of the plot that altering the ambient temperature will not address this problem. Instead, the voltage stress must be reduced.

- Position the cursor at the intersection of the green line and the Y-axis. The location of the cursor, (0, 0.4000), will appear as a tool tip. This gives you an idea of the appropriate voltage stress for this component in the current environment
- Close the window.

4.8.3 Changing a Stress Value

- In the System Hierarchy panel, with the **CAP-NP-0603** capacitor still selected, change the **Voltage Stress** field to **0.39** in the Properties panel.
- Press **ENTER** or click outside the Power Stress field to accept your change. Notice that in the System Hierarchy panel, the CAP-NP-0603 capacitor component's icon has changed to green with two straight lines, indicating that the component now meets the derating requirements.
- Select the CAP-NP-0603 capacitor and then choose **Tools > View Component Derating**. Note the difference in the Component Derating window as compared to the earlier version.



- Close the Component Derating window.
- Close the database and proceed to the next example.

4.9 Example 8 - Information Reporting

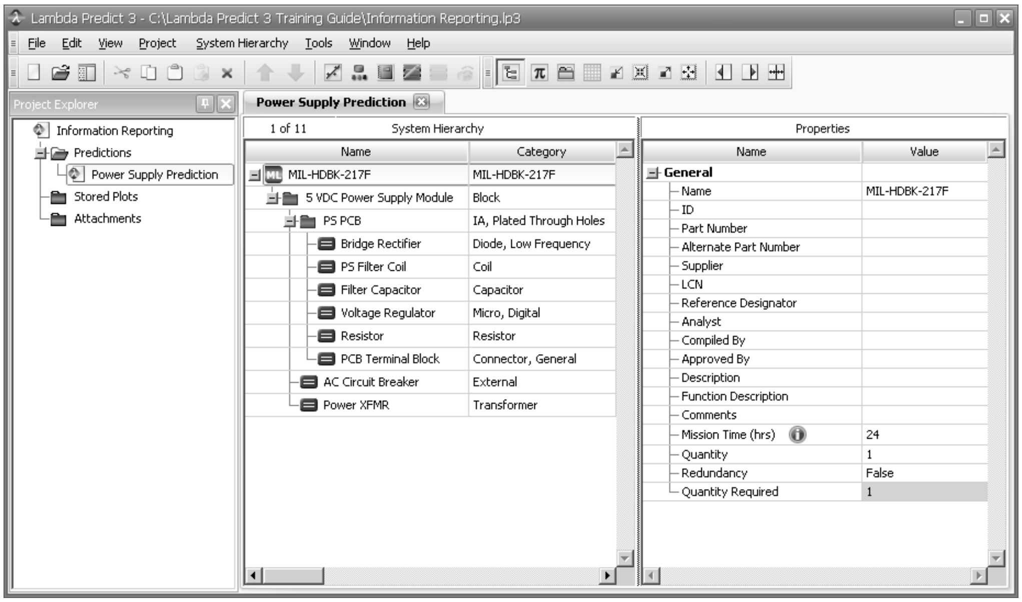
This example will show you how to create and use plots and reports. You will:

- Create a plot "on the fly" (*i.e.* from within the prediction).
- Create a plot from the Project Explorer.
- Customize a plot.
- Create a report template and report.

4.9.1 Create a New Database

- Create a new database file called **Information Reporting**.

- In the Edit Prediction Properties window, click **Cancel** to create the database with no predictions.
- Import the **Power Supply** prediction from the Power Supply.lp3 file, which is located in the Training Guide folder within your application directory (*e.g.* C:\Program Files\ReliaSoft\LambdaPredict3 \Training Guide).
- Open the Power Supply prediction. The MDI will look like the one shown next.



4.9.2 Adding a Plot from the Prediction

Lambda Predict includes two ways of creating plots:

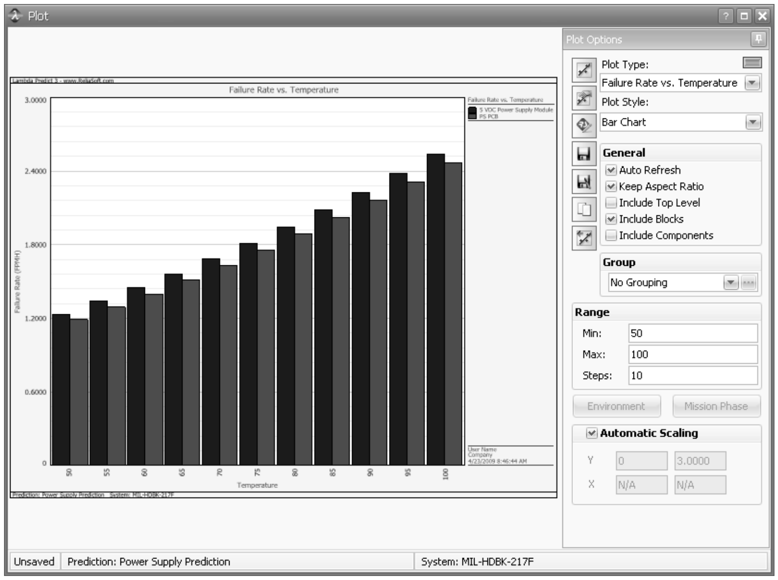
- From the prediction, where you create a plot based on a selected system or block in the System Hierarchy panel. You will not be prompted to save the plots that you create this way, but you can save them, if desired.
- From the Project Explorer, where you can select multiple systems and blocks from any prediction in your database. You will be prompted to save the plots that you create this way.

First you will create a plot from the prediction.

- In the System Hierarchy panel, click the **MIL-HDBK-217F** system.
- Choose **Tools > Plot** or click the **Plot** icon.

By default, the last plot type that was selected will automatically be plotted when you open the Plot Window. For this example, choose **Failure Rate vs. Temperature** from the **Plot Type** drop-down list that appears in the Control Panel on the right side of the Plot Window. If the **Auto Refresh** option is not selected, you will have to click the **Refresh** icon to refresh the plot with the new plot type.

The Failure Rate vs. Temperature plot will appear, as shown next.



If desired, you can take some time now to modify this plot and/or create other plots. For example, you can view this information as a line plot by choosing **Line Plot** in the **Plot Setup** field. You can change the values in the **Range** area to view the results over a different range of temperatures or in more or fewer steps, or see the individual component values by selecting the **Include Components** check box. You can also use the **Plot Type** field to view other types of plots.

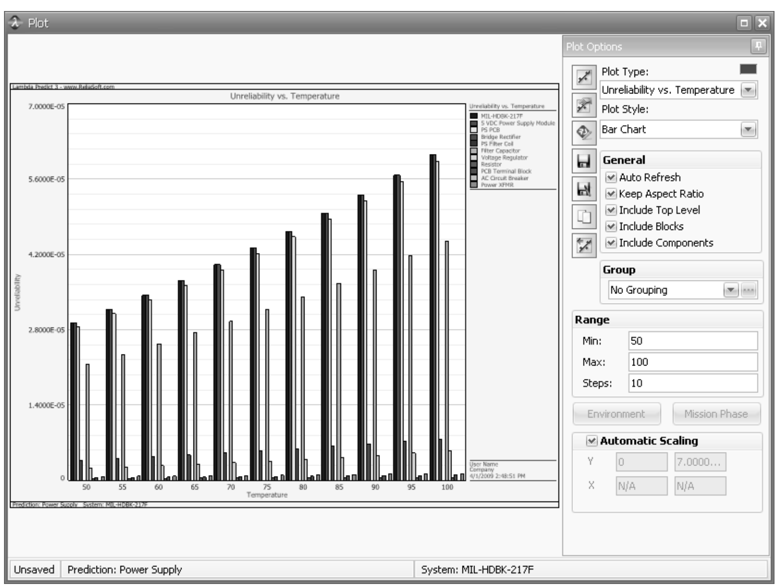
- When you are done, close the plot by clicking the **Close** (x) button in the upper right corner of the window. Note that you are not prompted to save the plot. (If you want to save the plot, click the **Save** icon and use whatever name you want.)

4.9.3 Adding a Plot from the Project Explorer

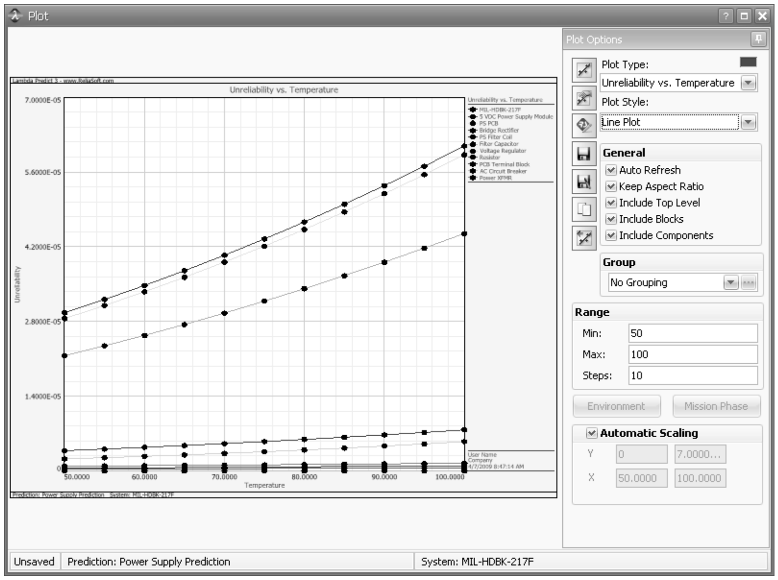
In this case, you will create a plot from the Project Explorer.

- Choose **Project > Add Plot** or right-click the project's **Stored Plots** folder in the Project Explorer and choose **Add Plot** on the shortcut menu that appears. The Select Top Level Items to Plot window will appear.

- Select the check box next to the MIL-HDBK-217F item and then click **OK**.
- For this example, choose **Unreliability vs. Temperature** from the **Plot Type** drop-down menu that appears in the Control Panel on the right side of the Plot window and select the **Include Top Level**, **Include Blocks** and **Include Components** check boxes. The Unreliability vs. Temperature plot will appear, as shown next.



- In the **Plot Style** field select **Line Plot**. Notice how the plot changes, as shown next.

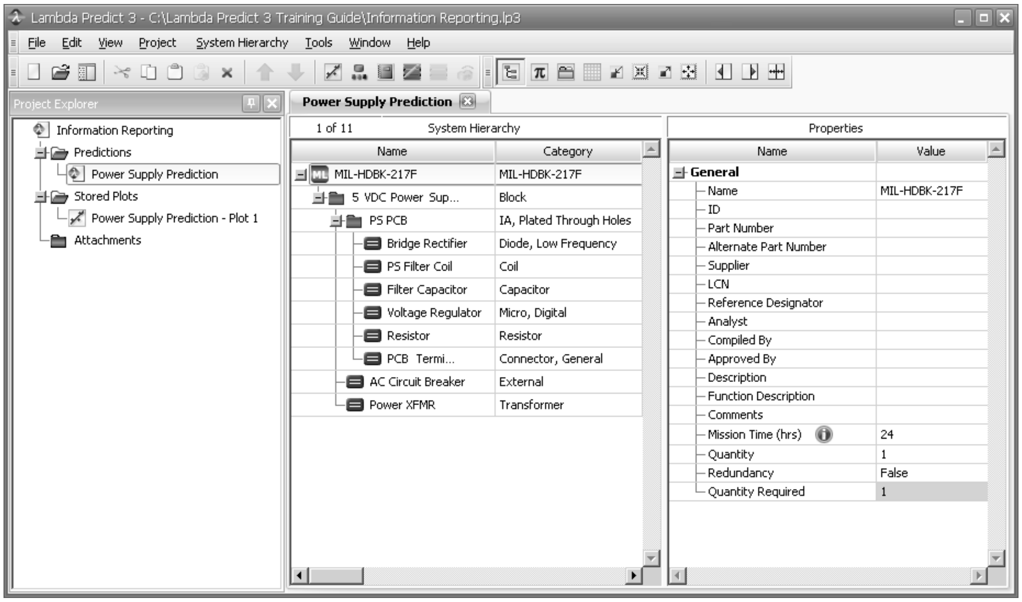


- Click the **Close (x)** button. You will be prompted to save the plot.

  The Save Plot window displays.

- Accept the default name and then click **OK**.

- The MDI now includes the saved plot in the Stored Plots folder in the Project Explorer, as shown next.



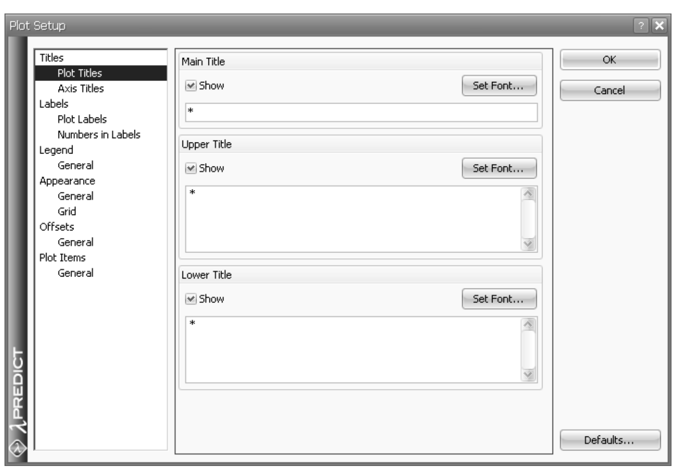
Note that changes to the data in the prediction will not cause the plot to be updated automatically. To have the plot reflect the changed data, you must change the plot settings. If you delete a prediction that is referenced by a stored plot, the plot will remain available, but you will not be able to make any changes to it.

4.9.4 Customizing a Plot

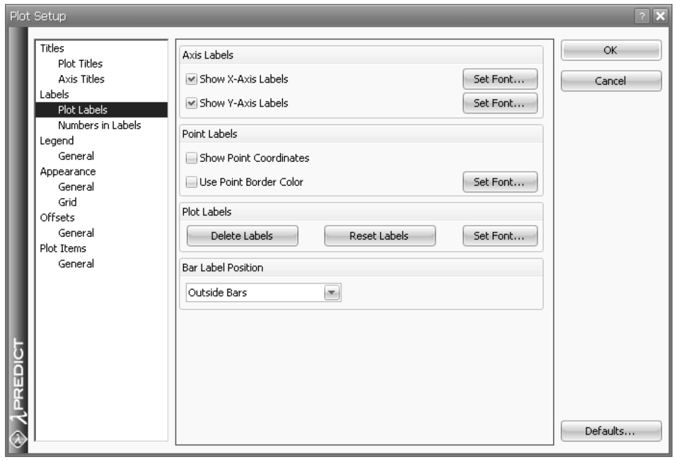
Lambda Predict allows you to customize plots to meet your needs. The Plot Setup window gives you full control over the settings used both for individual plots and as default settings for all new plots. For this example, you will change the default label font size and then add a custom label to the plot.

- In the Project Explorer, open the **Power Supply Prediction - Plot 1** plot.
- Click the **Plot Setup** icon on the Plot Control Panel.

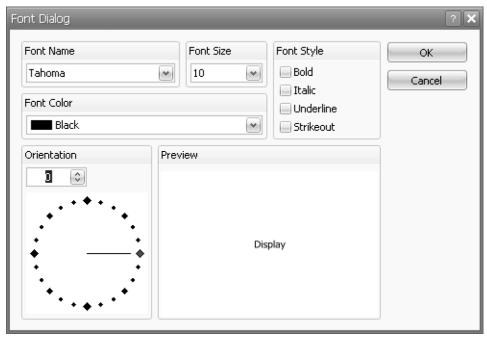
The Plot Setup window displays.



- In the navigation panel, click **Plot Labels**.

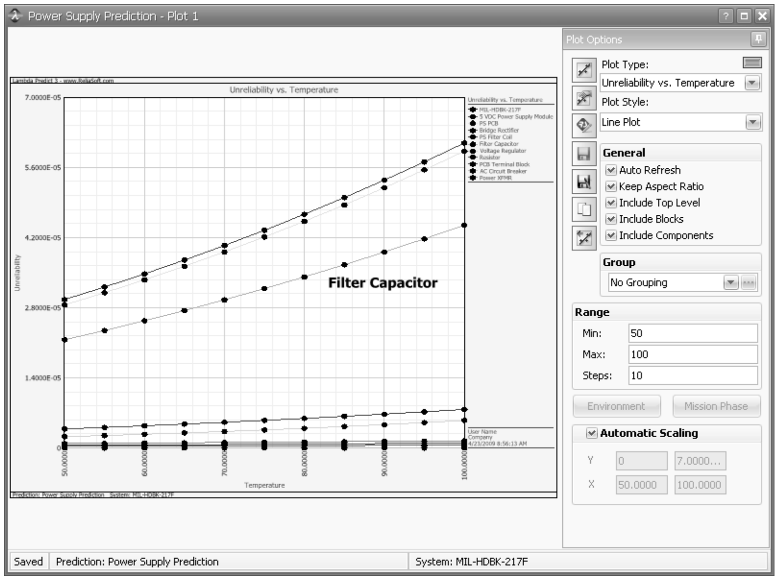


- In the Plot Labels area, click the **Set Font** button. The Font Dialog displays.

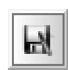


- Change the **Font Size** field to **20** and select the **Bold** check box.
- Click **OK** to close the Font Dialog and then click **OK** again to close the Plot Setup window.
- To add a custom label to the plot, press **CTRL** and click near the blue Filter Capacitor line. A new label will appear in the plot as shown next.

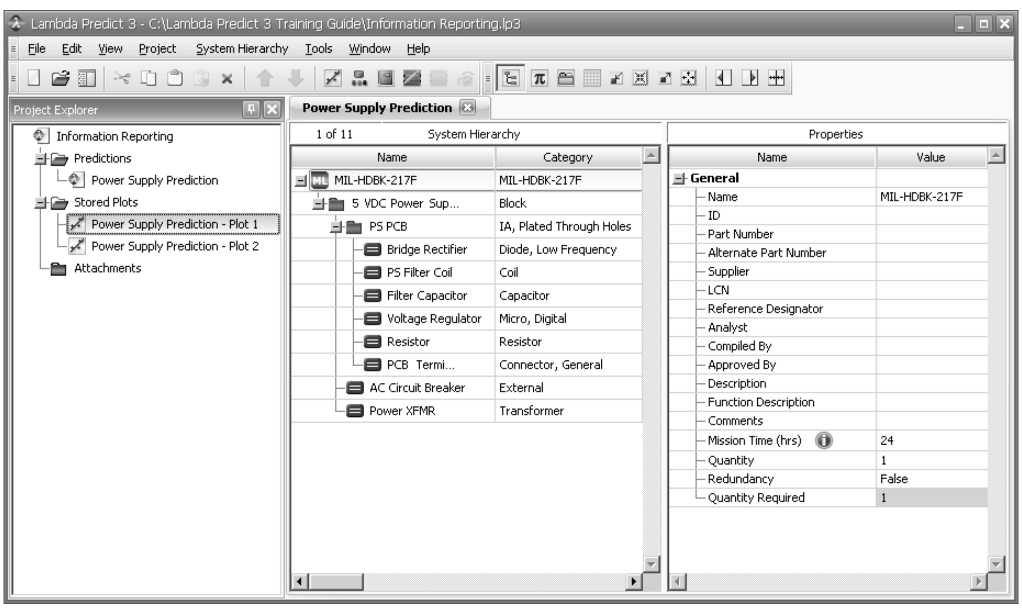
- Delete the old text, type **Filter Capacitor** and then click on the plot. The Plot window will look like the one shown next.



- Click the **Save As** icon on the Plot Control Panel.



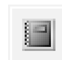
- In the Save Plot window, accept the default name and click **OK**.
- Close the Plot window. The MDI will look like the one shown next.



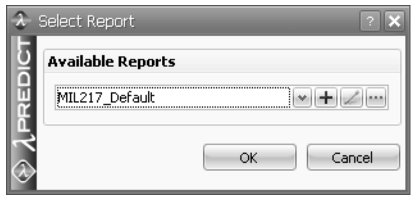
4.9.5 Creating a Report

Lambda Predict gives you the ability to generate template-based reports for the systems in your predictions. You can customize the appearance of all predefined report templates and also build and manage your own custom report templates. Reports are generated in Microsoft Excel®, which provides maximum flexibility for additional post-generation customization and distribution.

- To create a report, select the **MIL-HDBK-217F** system in the System Hierarchy panel. The report will include data for this system and its subsystems. Choose **Tools > Report** or click the **Report** icon.



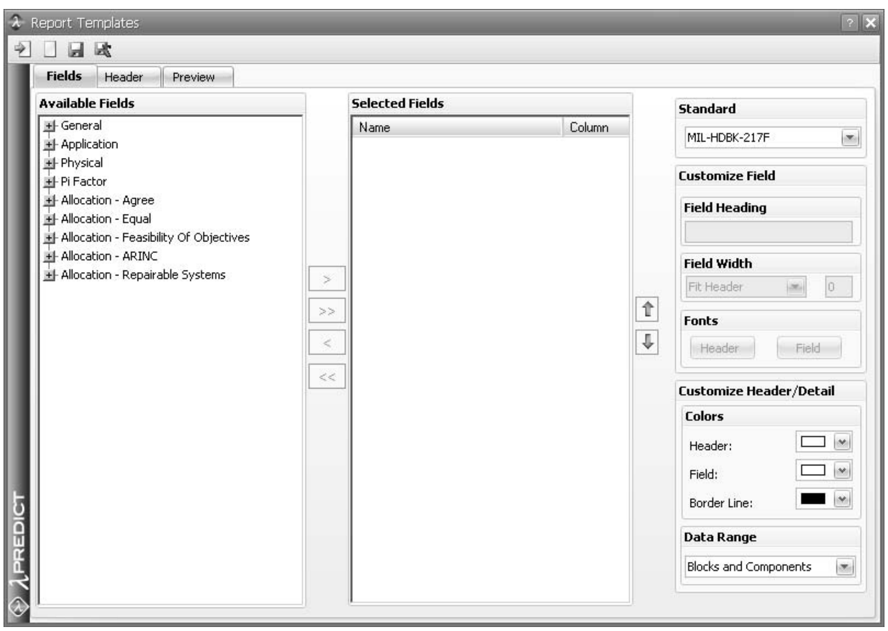
The Select Report window displays.



For this example, you will create your own custom report template.

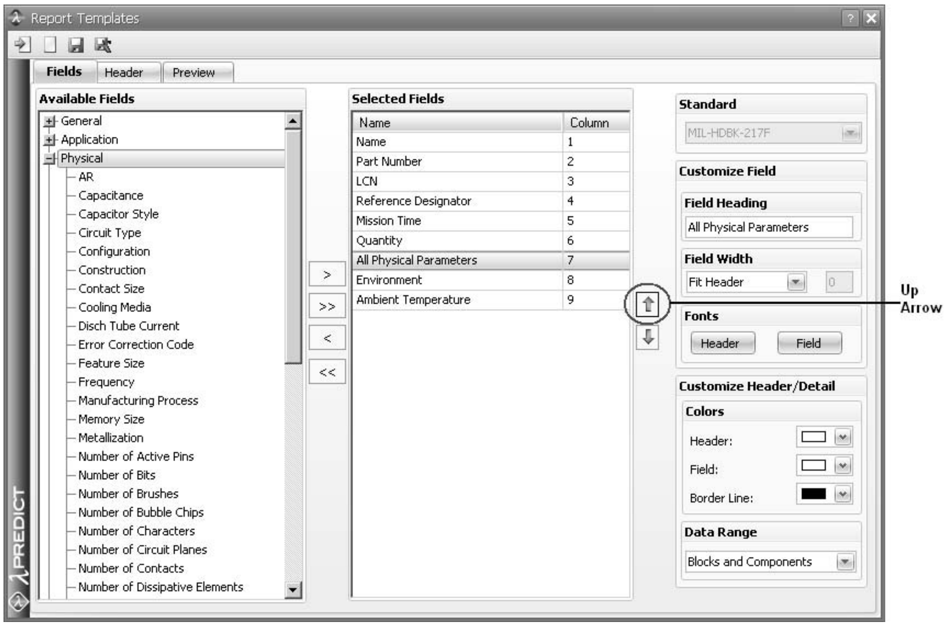
- Click the **Add Report** icon.

The Report Templates window displays.



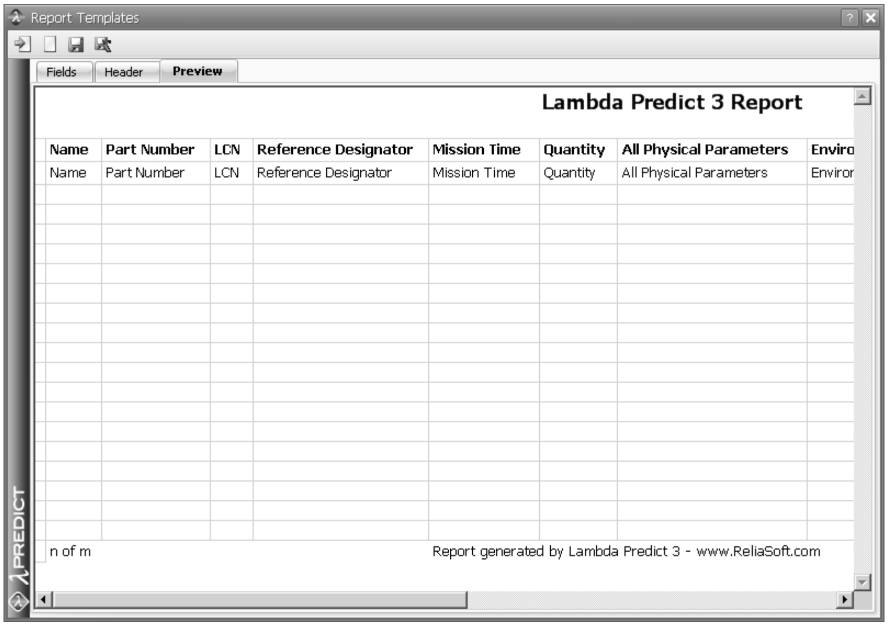
- Click the plus (+) button to open the General group.
- Click the **Name** field and then click the **Include** icon (>) or simply double-click the **Name** field to move it from the Available Fields area to the Selected Fields area.

- Add the following fields to the Selected Fields area in this manner, in the order given below.
  - General heading: **Part Number**, **LCN**, **Reference Designator**, **Mission Time** and **Quantity**.
  - Application heading: **Environment** and **Ambient Temperature**.
  - Physical heading: **All Physical Parameters**.
- Once you have added all of the fields, click the **All Physical Parameters** field in the Selected Fields area and use the up arrow to move the field below the Quantity field, or simply drag the **All Physical Parameters** field to the desired position, as shown next.



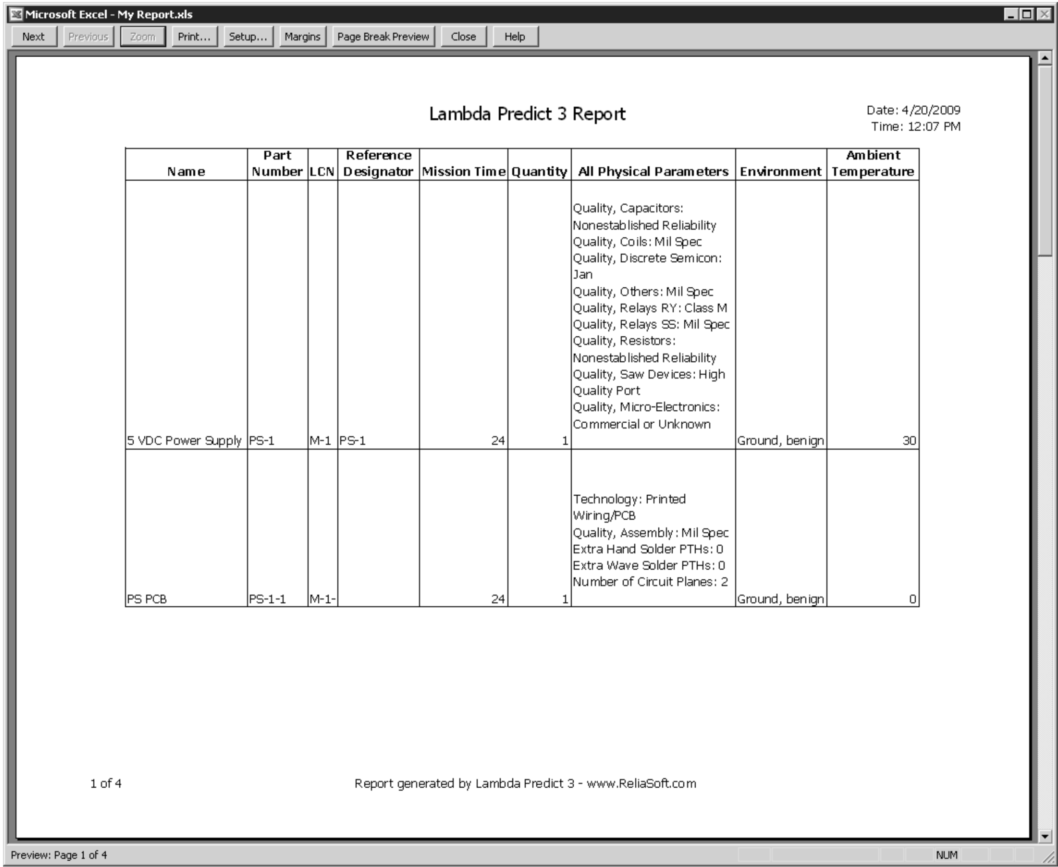
- Click the **Header** tab.
- In the Header Options area, select the **Display on every page** check box. This ensures that the header will appear on every page.

- To see what the report template looks like, click the **Preview** tab, as shown next.



- Click the **Save** icon and save the report template that you have created as **My Report Template**. Save it in the default location.
- Close the Report Template window. Notice that your new report template is selected in the Select Report window.
- Click **OK**.
- In the Save As window, type **My Report** and then click **Save** to save it to the default location. By default, Lambda Predict saves reports to the ReliaSoft\Lambda Predict\Reports directory within your My Documents folder. Lambda Predict generates the report and displays it in Excel.
- You may wish to adjust the column widths to your liking.

- To view the report with the header displaying, you can use Excel's Print Preview functionality, as shown next.



Lambda Predict 3 Report

Date: 4/20/2009
Time: 12:07 PM

Name	Part Number	LCN	Reference Designator	Mission Time	Quantity	All Physical Parameters	Environment	Ambient Temperature
5 VDC Power Supply	PS-1	M-1	PS-1	24	1	Quality, Capacitors: Nonestablished Reliability Quality, Coils: Mil Spec Quality, Discrete Semicon: Jan Quality, Others: Mil Spec Quality, Relays RY: Class M Quality, Relays SS: Mil Spec Quality, Resistors: Nonestablished Reliability Quality, Saw Devices: High Quality Port Quality, Micro-Electronics: Commercial or Unknown	Ground, benign	30
PS PCB	PS-1-1	M-1-		24	1	Technology: Printed Wiring/PCB Quality, Assembly: Mil Spec Extra Hand Solder PTHs: 0 Extra Wave Solder PTHs: 0 Number of Circuit Planes: 2	Ground, benign	0

1 of 4

Report generated by Lambda Predict 3 - www.ReliaSoft.com

- After you are finished reviewing the report, close it.
- Close the database.